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MULTI-ELEMENT GEOCHEMISTRY FOR BULK MINERAL CHARACTERIZATION OF HYDROTHERMAL ALTERATION ASSOCIATIONS IN PORPHYRY COPPER DEPOSITS: APPLICATIONS TO PREDICTIVE GEO-METALLURGICAL MODELING BASED ON DATA SCIENCE

Townley B[1,2,3,5], Luca R[3], López F[3], Muñoz M[4], Baeza D[2,5], Navarro F[2,5], Garrido M[2,5], Egaña A[2,5]
[1]Department of Geology, Universidad de Chile, [2]Advanced Mining Technology Center, AMTC, Universidad de Chile, [3]GeoAnalytical Vision S.A., [4]Departamento de Ciencias de La Tierra, Universidad Andrés Bello, [5]Advanced Laboratory for Geostatistical Supercomputing, Universidad de Chile

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

ABSTRACT
In this study the value of multi-element geochemistry in ore modeling and the applications to predictive geometallurgical modeling are discussed. In mine production much effort is placed on geological modeling, base for mine planning and mineral processing behavior models, from blasting to metallurgical recovery, down to waste disposal and environmental management. High confidence geological models are commonly based on mapping of drill cores, combined with other characterization techniques (e.g., petrography, QEMSCAN®, XRD, etc.). Unfortunately these techniques are applied to limited numbers of samples and hence lack representation. Geological mapping may provide continuous data, but with a degree of uncertainty, mostly based on qualitative estimates. The combination of information provides geological models that are hard to combine with metallurgical data, geometallurgical modeling complicated by varying sample supports and discontinuity of data. As multi-element geochemistry reflects the mineral composition of rocks, a generic case study on a porphyry copper deposit is presented, the techniques developed allowing characterization of lithology, alteration types and mineralization. Quantitative high resolution mineral characterization is cross referenced to metallurgical test-samples and linked to geometallurgical properties of rocks and modeling. The large volumes and varying types of data are modeled by data science techniques, a non-supervised multi-variate analysis presented.

KEYWORDS
Geochemistry, mineral characterization, geo-metallurgical modeling, Data Science

0

The timing and drivers of the expansion of C4 vegetation in Australia

Andrae J

TS5 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 3:30 PM - 5:30 PM

Vegetation using the C4 photosynthetic pathway first expanded around the globe beginning in the late Miocene. However, the timing and drivers of C4 vegetation expansion on the Australian continent had not been documented.
In this study, we measure carbon isotope ratios of plant wax n-alkanes extracted from scientific ocean drilling material collected from ODP Site 763, off north-west Australia. Beginning at ~3.5 Ma, we observe a shift toward more 13C-enriched n-alkane carbon isotope ratios. These results indicate a late Pliocene onset of expansion of C4-dominated ecosystems on the Australian continent, later than many other regions. Furthermore, n-alkane ratios along with fossil pollen from this site indicate high abundances of grass and chenopod taxa prior to 3.5 Ma, which we interpret as significant C3 open habitats on the Australian landscape prior to C4 expansion.
An extended period of increased aeolian flux to the North Pacific Ocean beginning at ~3.5 Ma is interpreted as marking intensification of the East Asian Winter Monsoon (EAWM). Paleoclimatic records indicate that a cross-hemispheric link between East Asian Winter Monsoon (EAWM) and Indo-Australian summer monsoon intensities has existed since at least the Mid-Late Quaternary. Given this link between the EAWM and the Indo-Australian summer monsoon, we hypothesize that the Australian C4 expansion we observe from 3.5 Ma onwards was driven by the advent of a highly seasonal precipitation regime in northern Australia related to increased influence of the Indo-Australian summer monsoon in this region.

0

GSA Ringwood Medal Lecture: Illuminating Mantle Metasomatism

Foley S

TS8 - 1.5 The solar system and beyond, Hall C, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Stephen Foley is Professor in the Department of Earth and Planetary Sciences at Macquarie University, and Research Co-ordinator in the ARC Centre of Excellence for Core to Crust Fluid Systems. A native of northern England, he completed a BSc at Southampton, MSc at Memorial University of Newfoundland, and PhD at the University of Tasmania, after which he spent 26 years in Germany before returning to Australia in 2013. He was Professor at the Universities of Greifswald and Mainz and led a Centre of Excellence in Earth System Science at Mainz between 2005 and 2013. His research lies mostly in the fields of igneous petrology and geochemistry, including high-pressure experimentation.

Dept. Earth and Planetary Sciences and ARC Centre of Excellence for Core to Crust Fluid Systems, Macquarie University, North Ryde, New South Wales 2109, Australia.

The concept of mantle metasomatism has been with us for 45 years now, and yet when invoked, it is usually to describe the mineralogical or geochemical effects, but not the origin. These result in labels such as modal metasomatism, cryptic metasomatism, and most recently stealth metasomatism [1], which describe the products of the metasomatic process, but do little to illuminate its causes. From fluid inclusions in diamonds and high-pressure experimental studies of melting at mantle pressures, were are on the verge of deciphering the origin of different types of mantle metasomatism. High-density fluid inclusions in diamonds distinguish between carbonatitic, saline and silicic fluids that are probably also distinct agents of mantle metasomatism [2].

Partial melting experiments on mantle rocks are relevant to mantle metasomatism only where the melts contain considerable amounts of COH volatile components. This presents a practical challenge in that these melts do not quench to glasses but result in complex masses of intertwined quench crystals, so that the determination of the original melt compositions is difficult. Advances in experimental techniques and in the careful and systematic analysis of former melt volumes are now allowing the determination of melt compositions in the presence of H_2O+CO_2 and H_2O+CH_4 mixtures in which we can have a high degree of confidence. They define the pressure-temperature conditions close to natural geothermal gradients in which a variety of alkaline melts can form, including where a continuum between carbonate and silicate melts can exist and where it cannot. Integration of this information will lead to the definition of possible and impossible agents of mantle metasomatism.

[1] O'Reilly, SY, Griffin, WL (2013) In Metasomatism and the chemical transformation of rock, Springer-Verlag, Berlin, pp.471-533
[2] Weiss Y, McNeill, J, Pearson, D.G., Nowell, G.M., Ottley, C.J. (2015) Nature 54, 339-342

2

Petrophysical Modelling from 3D Seismic Volumes

Emery W[1]
[1]*iRPM Pty Ltd*

TS4 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Wesley Emery gained a Post Graduate in Petroleum Engineering at Curtin University. He started his career as a logging engineer at Halliburton and Schlumberger before joining Crocker Data Processing for 4 years, then working and analysing data in throughout South East Asia. Wesley joined Chevron in Perth in 2010 as a Senior Petrophysicist, working on the Barrow Island Gorgon CO2 Reinjection project and West Tryal Rocks Gas appraisal field and reviewing all Fields in North West Shelf of WA. In 2015, he started his own company, specializing in 3D Petrophysics from Seismic. Wesley has been treasurer of FESAUS since 2013.

The Oil and Gas Industry has traditionally used conceptual, statistical three dimensional modeling, often constrained to Seismic attributes to predict reservoir properties. Rarely if ever are deterministic relationships used between the Seismic attributes and the reservoir quality, with direct links to the Petrophysical interpretations results without the use of averages.

Deterministic relationships have been developed between the Seismic Impedance property and the Petrophysical interpretation results of volume of clay, porosity, permeability and saturation. These properties can be populated into the Reservoir property model at the same sampling rate used to determine the deterministic relationships. At least one well needs to be used to determine these relationships and these can then be used to blind test against any existing well or any exploration well yet to be drilled. Blind testing provides a true measurement of the accuracy and uncertainty of the model property prediction. Unfortunately this is rarely done in the oil and gas industry. An obvious benefit is a significant reduction in appraisal well drilling requirements.

This presentation show the accuracy of using these deterministic relationships from an existing well, blind test the predictions against several other existing wells and also populate these predictions into the three dimensional space in the Wheatstone Field in the North West Shelf and also in the Petrel field in the Timor Sea.

Deterministic three dimensional reservoir property modeling uses mathematical relationships between the Seismic Impedance property and the Petrophysical interpretation results. These relationships help determine drilling location to penetrate higher reservoir quality areas.

3

Petrography and geochemistry of sandstones of Permian Vryheid Formation, Highveld Coalfield of South Africa: Implications for provenance and palaeo-weathering conditions

Ncube L[1], Zhao B[1], van Niekekr H[1]
[1]*University Of South Africa*

Biography:

Dr Lindani Ncube is a Post-doctoral Fellow at the University of South Africa. Her research interests includes coal geology, basin evolution, evolution of river systems, paleoclimate , simulation and modelling.

Provenance, palaeo-weathering and palaeo-redox conditions of sandstones of the Ecca Group in the Highveld Coalfield, South Africa, were studied. The investigation approach involved collecting sandstone samples from borehole cores, followed by laboratory studies of mineralogy and petrography, major and trace element analysis by X-Ray Fluorescence. Mineralogy and petrographic analyses indicates that these sandstones are arkosic to sub-arkosic arenites. The generalized mineralogical compositions, consist of monocrystalline and polycrystalline quartz, plagioclase, igneous and volcanic rock fragments and minor to trace amounts of mudstone clasts. Quartz grains are predominantly monocrystalline, implying they came from granitic and volcanic rocks and as well as hydrothermal quartz veins. The presence of higher amounts of feldspars favours either a fast/high depositional rate and relative dry or a cold climate at the source area, and is also indicative of dominance of felsic igneous or metamorphic rocks in the source area. The ratio of K2O/Na2O, plots of Na2O-CaO-K2O and Th-Sc-Zr/10 attest to a passive margin tectonic setting. Observed patterns of REE values, ratios of K2O/Al2O3, Al2O3/TiO2, La/Sc, Th/Sc, Th/Co, and Th/Cr, plots of Th/Co vs La/Sc, Hf vs La/Th, Th vs Sc, V-Ni-Th and discriminant function further suggest felsic rock sources. The sediments were deposited by glacial material, underwent mechanical weathering and grinding, and therefore the sediments deviate from normal chemical weathering trends. The chemical index of alteration (CIA) suggests minimal chemical weathered source rocks typically deposited under a cool to temperate climate. U content, authigenic U, V/Cr, Ni/Cu and Cu/Zn ratios attest to an oxidic depositional environment.

4

Geological Factors Matching of Shale Oil accumulation in Rifted Lacustrine Basins

Jing T[1]

[1]China Huaneng Clean Energy Research Insititute

Biography:

Jing Tieya, a graduated student in the Energy School, China University of Geosciences. I devote my full energy to developing the shale gas and shale oil program of China. Now, I am a senior engineer in China Huaneng Clean Energy Research Institute.

Geological characteristics and accumulation mechanism in rifted basins in China restrict commercial development of shale oil in China. This paper focuses on the geological conditions and its matching relationship of shale oil accumulation for 3rd Member of Shahejie Formation in Liaohe Western Depression. Sedimentary analysis, core observation and the experiments on mineralogy, geochemistry, oil content and hydrocarbon generation were carried out. The shale formation had experienced rapid subsidence, accounting for massive sedimentation of organic-rich shale. The shales developed in the deep and semi-deep lacustrine facies are characterized by high organic matter content with an average TOC over 2.0%, type I-II1 kerogen with relatively low thermal maturity ranging from 0.4-0.9%Ro due to shallow burial depth, which resulted in oil generation mainly in the formations. Various pore-fractures developed for shale oil-gas storage. Clay is dominated in shales and brittle mineral content such as quartz is relative low, which are challenging for hydraulic stimulation. The geological conditions for shale oil are good matching and the shale oil resource potential is considerable. The "sweet spots" mainly develop in fracture or brittle mineral zones at a certain burial depth in good organic richness area.

6

Marine shale gas development characteristics in complex structural areas

Jing T[1]

[1]China Huaneng Clean Energy Research Insititute

Biography:

Jing Tieya, graduated from China University of Geosciences with Doctoral degree on unconventional hydrocarbon exploration and exploitation and devote the full energy to developing the shale gas and shale oil program of China. Now, I am a senior engineer in China Huaneng Clean Energy Research Institute.

Major breakthroughs on shale gas in Sichuan Basin made China the third country producing industrial shale gas. Besides Sichuan Basin, two sets of organic-rich shale with large thickness and stable distribution also deposited in the surrounding area of South China. Because of northwestward compression of Pacific Plate in Himalayan period, massive folds and faults developed in such areas. The shales have type I-II1 kerogen and moderate-high thermal maturity, and the previous exploration activities showed a good resource potential. Due to the multiple structural movements, shale gas preservation conditions are relatively poor that makes the hydrocarbon abundance low and the commercial shale gas production has not yet achieved. The field desorption experiments show that the Lower Cambrian shale has low gas content and it contains mostly nitrogen. The Lower Silurian shale has the characteristics of low formation pressure that makes the flow back slow when fracturing. The favorable accumulation areas can be optimized by 3-D seismic and good preservation conditions, which depends on distance from outcrops, fracture property, stratum dip, depth, reservoir temperature and stress.The shale gas resources will be well exploited and the accumulation theory can be supplemented once commercial breakthrough on shale gas are made in complex structural areas in China.

7

Underground Coal Gasification (UCG) - A Pilot Study within the Jamalganj Coal Basin, Joypurhat District, Bangladesh

Masum M[1]

[1]*Geological Survey Of Bangladesh*

Biography:

Mohammed Masum is the Assistant Director (geology) of Geological survey of Bangladesh. He completed M.S. and B.Sc. (Hons) in Geology at the University of Dhaka and has worked in the branch of Economic Geology and Resource Assessment since 2007. He has also worked as a field and site geologist during exploratory drilling activities for coal basin identification in the western part of Bangladesh. Additionally, Mohammed is experienced in exploration activities for China Clay, Peat, Silica Sand, Gravel and Heavy minerals around the country.

Geological Survey of Bangladesh has been entrusted with the responsibilities of investigation and exploration of several kinds of solid mineral resources and discovered four major Gondwana coalfields at southern slope of Rangpur saddle of Bangladesh. Underground Mining is going on only in Barapukuria coal field and the rest of coal fields mining operation at this stage still not possible due to the greater depth. Jamalganj coal basin is one of the largest coal basin of Bangladesh where underground mining method for further mining may be really difficult. Around 4000 million tons of coal deposited in that coalfield which equivalents (due to energy) to about 130 Tcf Gas. It is not might be technically feasible or economically viable to mine coal resources of that coalfield till now. Potential for Underground coal gasification in the specific area of Jamalganj coalfield of Bangladesh should be needed to study. It has adequate depth (600-800m) and workable overburden as well as their chemical properties of coal (Calorific value-26.84%, Sulfur content- 0.55%, Fixed carbon- 36.72%, Volatile matter- 36.92%, Moisture content and Ash content 3.58%) which might be positive sign for UCG implementation. The high-volatile to medium-volatile bituminous coal is very suitable for UCG exploration in terms of their depth of occurrence, thickness of coal seam, coal reserve and areal extent. The thickest seam-III (over 40 m) can be a primary target for UCG development especially where it combines with seam-II in the eastern part of the coalfield.

8

Application of Information and Communication Technology for Geo Science and Geo Disaster Education.

Chaudhari K[1], Philip P[2]
[1]Institute For Sustainable Development And Research,ISDR,India, [2]Institute For Sustainable Development And Research,ISDR,India

Biography:
Kalpana Chaudhari has obtained post graduate degree in engineering and technology. She has pursued the Ph.D. in engineering and technology.Her Ph.D. work consists of interdisciplinary subjects includes science and technologies and its application for socio-economic and sustainable development at RTM Nagpur University.She has also obtained the Post graduate Diploma in Urban and Housing studies from Institute of Urban and Housing studies, Erasmus University, Rotterdam ,The Netherlands. She has 21 years academic, research and professional experience. She is working as Vice President of Institute for sustainable development and research ,ISDR, India, an organization having consultative status with UN-ECOSOC, UN-Habitat, UN-CTAD, UN-WCDRR.

As per the United Nations estimates, the world population reached 7.3 billion as of mid-2015, implying that world has added approximately one billion people in the span of the last 12 years. The total population on earth is predicted to increase by more than one billion people within the next 15 years, reaching 8.5 billion in 2030, and to increase further to 9.7 billion in 2050 &11.2 billion by 2100. Looking at the ever increasing urbanization, in 2016, an estimated 54.5 % of the world's populations inhabited in urban region. By 2030, urban areas are projected to shelter 60 % of people worldwide. On the basis of these figures and other global trends, it would appear that Africa and Asia will have the highest share of world's urban growth in next 25 years, resulting consideration rise of several metropolitan cities and towns along coastal region of Asia-Pacific. Therefore the task of transformation through environmental sustainability and building disaster resilient societies creating organizational, operational and financial management problems in urban environmental system as well as coastal ecosystem will be vital. This presentation deals with issue involved in geo-science and geo-disaster education related to transformation towards disaster resilient societies through sustainable use of marine and coastal ecosystems in urbanized world for better urban governance in coastal zone. The presentation focuses on application of information and communication technology for resources planning,coastal risk and vulnerability , social-ecological vulnerability and disaster resilience in coastal communities, Human Pressures on Coastal Environments, land water-seawater interactions.

9

Managing Artificial Recharge of Groundwater, The Indian Experience

Singh R[1]
[1]Banaras Hindu University

Biography:
M.Sc.(1975).
Ph. D: (1980).
P.G. Dipl. in Geothermic, Pisa Italy1990
ItalyPisa 1989-90, under UNESCO Fellowship.
Washington D.C.1989, XXVIII- I.G.C.
Kyoto,1992, XXIX- I.G.C.
Edmonton-Alberta, 1995,XXVI- IAH.
Las-Vegas,1998, XXVIII- IAH. (Chaired)
(Shanghai), 2005 to attend the SISOLS.(Compared)
(Phoenix), 2007, ISMAR-6.
(Valencia), 2008, Arsenic in Environment.
(Irvine), 2008 Water Scarcity Conference.
(Krakow) 2010, XXXVIII- IAH Congress.
South Africa) 2011, GWD conference
Seoul, Incheon University 2017
Book: 1) Structural Geology: A Practical Approach,
2. Water Scarcity in India. (UP 2015).
3. Arsenic at a Glance 2016
CHAIRMAN, Disciplinary Committee, Faculty of Science for (2010-11).
E.C.M, Indian Geological Congress (2003-2005).
Publications: Papers – 56

Water is essential for mankind and measures needs to be taken to manage its growing demand. The artificial groundwater recharge techniques are specific depending upon the availability of water, hydrology, topography etc. To strike a balance between groundwater resources and exploitation entails harnessing the high runoff, during the monsoon, for artificially recharging the groundwater in post monsoon periods. The artificial recharge structures like surface infiltration, typical infiltration basin, geo-purification through Soil Aquifer Treatment (SAT), vadose zone recharge wells, percolation well used for grey water renovation, well recharge system, surface and vertical infiltration systems, roof tops rain water harvesting, energy aspect of artificial recharge and finally the environmental, economic and socio-cultural influences are the major components of water- management. Each components vary from region to region and their composition, as well as the degree of their importance will depend on the needs of the local population, as well as on the prevailing environmental conditions. Climate, physiographic, geology, hydrology, geochemistry and biology cant be modified by human endeavors. The recharge through enhanced infiltration requires permeable surface soils, where these are not available, trenches, abandoned dug well, tube well or shafts, in the unsaturated zone can be used. Direct recharge or injection well are used, where (1) permeable soil and/or sufficient land area for surface infiltration is not trenches or wells (2) Vadose zones are not suitable for trenches or wells (3)Aquifers are deep and/or confined ,to tackle the challenge of groundwater level depletion and associated environmental and socio-economic impacts of the country.

10

Developing an Engineering Geological Ground Model in a remote Part of Papua New Guinea for a New Tailings Storage Facility

Rynhoud M[1], Flynn S[1]
[1]*Klohn Crippen Berger*

TS7 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Mark Rynhoud is a senior engineering geologist who has nine years geotechnical experience in Australia and the Pacific, and in excess of fifteen years earth-science and environmental experience in South Africa. Mark has practised in the fields of engineering and environmental geology and has provided earth-science input for a broad client base. The Australasian and Pacific experience includes field work in remote locations under challenging conditions, including varying proficiencies with geotechnical and hydrogeological field programmes. Mark currently provides engineering geological direction on major mining engineering projects and has been involved in senior project management.

The Hamata tailings storage facility (TSF) at the Hidden Valley mine is being constructed in a remote, high rainfall, tropical environment in the mountainous region of Papua New Guinea. The site is characterised by high annual rainfall with no clear dry season, deeply weathered tropical soils, high seismicity and steep terrain. At the time of TSF design in the mid-2000s there was no precedent for major earthworks on the weak soil and weathered rock typical of the Hidden Valley site. The TSF design therefore had to rely on the engineering ground model developed for this project and which continues to be updated during the life of the project. The material characterisation included in the ground model was developed during the initial design phase and was the first step in the successful construction of this TSF, which is the first and only large TSF in Papua New Guinea.
This paper summarises successful engineering geological practise that was used to develop a baseline geological model of the project site and surrounds. This ground model includes critical geotechnical properties ascribed to the various geological units and sub-units that can influence the performance of the TSF at the Hidden Valley site. Some key design changes implemented during TSF design and construction are summarised in this paper.

11

What should we do about naturally occurring fibrous amphiboles: do they pose the same health risk as asbestiform varieties?

Hendrickx M[1]
[1]*marchgeo.com*

TS5 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Marc Hendrickx has been active in the area of Natural Occurrences of Asbestos (NOA) since 2002. In 2010 he completed a MPhil at Macquarie University that investigated possible connections between NOA and mesothelioma in eastern and southern Australia. He has undertaken numerous geological assessments for NOA in New South Wales for various clients. He also specialises in geotechnical risk to transport infrastructure especially landslides. He is Principal Geologist and Director of Marc Hendrickx and Associates (marchgeo.com).

Asbestiform amphiboles are listed as a Group 1 carcinogens by the International Agency for Research on Cancer (IARC). They include asbestiform varieties of riebeckite (crocidolite), cummingtonite-grunerite (amosite), tremolite, actinolite, anthophyllite, winchite and richterite. It is likely that other asbestiform amphibole varieties have similar adverse health effects. Amphiboles have a wide range of mineral habits and may show variation from columnar, fibrous and asbestiform habits, sometimes in a single specimen. Tremolite schists in Ordovician meta-volcanics in central NSW mainly comprise fibrous tremolite-actinolite. They are associated with tremolite asbestos occurrences, and small quantities of asbestos were mined from narrow vein deposits in this area last century. When pulverised the host tremolite schist releases mineral fragments that fall into the classification range for countable mineral fibres and may be classed as asbestos, despite not having an asbestiform habit. The ambiguity in classification of this type of natural material raises significant health and safety, legal and environmental issues that require clarification.
While the health effects of amphibole asbestos fibres are well known and procedures are in place to reduce the risks, the consequences of exposure to non-asbestiform, fibrous varieties is not well studied. This group of minerals deserve more attention due to their widespread occurrence in metamorphic rocks in Australia, and their potential disturbance through mining, civil construction, forestry and farming practises. Toxicological studies for instance would improve our understanding of the risk of exposure.

12

Climbing Geological Wonders: How myth and superstition are preventing our enjoyment of the natural world.

Hendrickx M[1]
[1]*Marc Hendrickx and Associates*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Marc Hendrickx specialises in assessing geotechnical risk to transport infrastructure especially in the areas of landslides and natural mineral hazards. He is Principal Geologist and Director of Marc Hendrickx and Associates (marchgeo.com).

Adventure tourism in the form of hiking or climbing up geological wonders is an important source of education and inspiration for current and future geo-scientists. Recent proposed bans on accessing major geological features in Australia; Uluru/Ayers Rock in the Northern Territory, Mt Warning in northern NSW and St Mary's Peak in South Australia's Flinders Ranges, puts this source of wonder, inspiration and education at risk.
This presentation:
-explores the history of exploration and scientific investigations at Uluru/Ayers Rock,
-seeks to correct widespread mis-information about the Uluru-Ayers Rock/Mt Warning/St Mary's Peak summit climbs,
-examines the importance of wonder and awe in directing people into the geological sciences, and
-outlines a way for these features may remain accessible to all.

13

SUMMARY OF "THE ORIGIN OF ROCKS AND MINERAL DEPOSITS - using current physical chemistry of small particle systems"

Elliston J[1]
[1]*Elliston Research Associates Pty Ltd*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
John Elliston joined a small mining company in 1956 where studies led to understanding the origin of the local intrusive ironstone deposits. The new concepts led to a series of exploration successes, dramatic company growth and to establishing technical teams who developed further significant Australian resources. By 1975 his company had established an outstanding lead in cost-effective exploration.
As an independent consultant from 1984, he was offered a series confidential research contracts. Publication of research results was deferred but generous funding, facilities and access to leading world academic advisers were provided. His current book summarises the revolutionary results recently published.

This book is a comprehensive interdisciplinary scientific treatise that introduces revolutionary new knowledge achieved by competent use of the scientific method. The research on which it is based has been more thoroughly and critically reviewed than is usual for scientific works and the international edition has recently been published.
However, correct statements and advertising of publisher and booksellers are disbelieved because many scientists assume the author is claiming to have discovered the origin of rocks and mineral deposits. Millions of dollars are spent each year on research endeavouring to understand the formation of ore deposits. It is a preposterous misconception that any one scientist could discover the origin of rocks and mineral deposits. The book definitely does not introduce a new geological theory or revise an existing one. Using the basic scientific method of logical conclusions from direct observation it reinterprets geological phenomena and processes using currently established physical chemistry of small particle systems. The title of this book, "The Origin of Rocks and Mineral Deposits – using current physical chemistry of small particle systems" is not a boastful or exaggerated claim. It summarises the results of over 50 years of systematic industrial research that actually achieved an understanding of how modern surface chemistry now explains the otherwise puzzling features and textures we see preserved in the rocks and the release of ore minerals in various geological environments. It is the culmination of the work of many outstanding scientists guiding and mentoring a highly competent and successful mineral exploration team.

14

Clues to Broken Hill Structural History and Geometry from Mapped Megastructures

Stevens B[1]

[1]*Broken Hill Expertise*

TS8 - 1.6 Advances in structural, igneous metamorphic and sedimentary geology, Room R1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Led the Geological Survey of NSW Broken Hill mapping and research program. Subsequently undertook contract exploration work.

Megastructures revealed by NSW Geological Survey mapping, and underutilised by structural researchers, provide critical information not available from outcrop studies.
The Ettlewood Structure can only be explained as a recumbent fold pair overprinted by an upright, non-cylindrical synform. The West Eldee Structure, a closed loop with SW plunges at both ends, approximates a sheath fold superimposed on a recumbent fold. The Little Broken Hill Structure, a closed loop, also with SW F2 plunges all around, is best explained as a sheath fold, probably refolding earlier recumbent folds. No small scale examples of sheath folds are known, but the small scale may not always reflect the large scale. The sheath fold concept may be applicable to the Broken Hill Synform and Hanging Wall Synform, perhaps explaining why the expected intervening antiform is so difficult to identify. The northern closure of the Broken Hill Synform is known to plunge to the SW, while the SW end of the structure is obscured by soil. However, the limbs are converging to the SW, suggesting a closed loop, possibly a sheath fold.
In some areas the stratigraphy is upside down. This can result from either F1 nappe folding or from inclined F2 sheath folding. Two candidates for nappes are identified: the Allendale Fold and a structure associated with the Bijerkerno Synform.

15

Induced Polarization and Well Logging Investigations for Groundwater in a Khondalitic Terrain of Eastern Ghats of India

Bekkam V[1], Yellapu S[2]
[1]Institute Of Science And Technology, Jawaharlal Nehru Technological University Hyderabad, [2]Research Scientist, National Institute of Hydrology, Kakinada

Biography:
B. Venkateswara Rao did his Masters in Geophysics and Doctorate in Water Resources. He has published more than 150 papers in National and International journals and conferences in the fields of Hydrogeophysics, Groundwater and Water and soil conservation. He has executed number of National and International research projects and guided several Ph.D candidates. He has established and developed academic centres such as Centre for Water Resources and Centre for Earth and Atmosphere and Weather Modification Technologies. He has been awarded several prestigious national and international awards from government of India, Indian National Science Academy and several geophysical Professional bodies.

The khondalitic terrain (garneti ferrous, sillimanite and gneiss) of northern parts of Eastern ghats near Cheepurupalli town of Vizianagaram district, Andhra Pradesh, India is mostly faced with the problem of identification of the depth of kaolinisation of the aquifer. In this terrain, the yield is reduced due to the presence of kaolinized zones (highly weathered material) below the subsurface. The traditional One Dimensional (1D) Vertical Electrical Sounding data could not identify the kaolinisation of the aquifer since at both the success and failed wells aquifers are showing the same resistivity. To identify the depth of kaolinization, the Two Dimensional (2D) Induced Polarization Imaging surveys are attempted at three pairs of success and failed wells which are very nearer to each other. The 2D Chargeability Images at success and failed wells have deciphered the extent of kaolinization at these wells. The layers having the high thickness obtained at greater depths with higher chargeability values below the success well are identified as aquifer layers and the layers having the high thickness obtained at greater depths with lower chargeability values below the failed well are indicating the kaolinised formations in the khondalitic suit of rocks. Well logging studies are also carried out in the bore wells. The fractured zones having the resistivity value of 30 Ohm-m are identified as aquifers with the lateral resistivity logging. The well logging investigations have revealed that the aquifer porosity is of the order of 28% in the region.

16

Process geomorphology for rangeland management: better outcomes by looking beyond outdated ideas

Wakelin-King G[1]
[1]*Wakelin Associates*

TS6 - 5.2 Prediction, process, place: Geomorphology, Room R8, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Gresley started a career in geology in the NTGS's regional mapping team, tramping over the amazing rocks and landscapes of the Arunta Block. Fieldwork in the desert and a background in sedimentology and geomorphology led to doctoral work in the ephemeral streams of the Barrier Range. Gresley's current consulting and research is the presently undocumented fluvial processes and landscape units of the Lake Eyre Basin's rivers.

Geomorphology is the science of landform materials, shapes, behaviours, and evolution. It's important to land management because system limits govern how ecosystems behave. In the Australian rangelands, the limits are water and nutrients. Fluvial geomorphology controls surface waters, dominating both aquatic and terrestrial ecosystems. Nutrients, salinity, and subsurface water are affected by Australia's tectonic and regolith geomorphology.

Though the influence of rivers and soils is widespread in the biosphere, conditions in the rangelands are unusual. Drylands rivers are qualitatively unlike perennial temperate rivers, in ways that invalidate standard approaches to e.g. topographic data collation, pastoral practices, infrastructure or mine design, land condition assessment, and minimisation of environmental impact. Australia's regolith character is similarly unlike information conveyed in most life science education.

Old narratives hang around and prevent land managers and policy makers from truly seeing what landscapes need. Some are scientific ideas from previous generations: inland seas, Australia's tectonic quiescence, or what constitutes a river. Some are mental habits that give an illusion of understanding: confusing physical habitat description with geomorphological investigation, or naming landforms and falling into the trap of equifinality. Some very broad ideas have consequences in day-to-day activities like vegetation monitoring or choosing culverts for road construction. Understanding landscape processes is the key skill.

Presently, Australian dryland geomorphology is under-researched, insufficiently taught, and too often attempted by non-geomorphologists. Looking forward, better outcomes will arise when earth-science postgraduate programs create River Styles™ reports for key drylands rivers, producing accessible knowledge and a body of informed professionals.

17

Misnamed rocks in Western Australia are affecting gold exploration

Schwann P[1]

[1]Aruma Resources Limited, [2]F Aus I M M, [3]F A I G, [4]M SEG

Biography:

Peter Schwann graduated from WAIT (Curtin University) in 1975 and has worked for major Australian companies in base, precious and ferrous metals in Australia and many countries worldwide. His interest in ore genesis led him to alternative theories for mineralisation and host lithologies, which have often been against company and current taught theories. This presentation is aimed at getting people to use context and question to advance the exploration models.

Western Australia hosts world class orebodies such as the Golden Mile but exploration has been unsuccessful for many years. This lack of success can be attributed to misidentification of rocks and structures. Context will solve a lot of this and boost exploration success.

The critical rocks in WA are the “Intrusives” and “Shears” which are the predominant hosts for mineralisation, and sediments are overlooked as hosts by most companies and universities. This is at odds with the rest of the world and this presentation is designed not as a paper as such, but a discussion on the shortcomings and diversions caused by this ideology.

The use of local nomenclature and a complete ignorance of the Bouma Sequence has seen exploration and research become irrelevant in WA, with minor exceptions where “new blood” has been allowed to drive exploration. A powerful example is where a world class institution repeated the dogma in a new paper because “It would never have been published if we put the truth about the Golden Mile Dolerite in the paper”.

The old adage of “they are only names” cannot be used as a Nuremburg Defence, and we must correct this problem now! We must develop exploration in the sediments in WA and use stratigraphy and structure so that we can vector to future orebodies. A classic example recently occurred in WA where “Conglomerates” caused a gold rush and share bubble due to comparisons with the Witwatersrand.

Time to make the change!

18

Ultrafine soil fractions for improved near surface exploration through cover

Noble R[1], Lau I[1], Anand R[1], Pinchand T[1]
[1]*CSIRO*

TS7 - 3.1.1 Effective exploration and discovery under cover, Room R2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Dr. Ryan Noble is a Principal Research Scientist with CSIRO. His research is primarily related to regolith and groundwater geochemistry applied to improving gold, base metal and U exploration. Ryan is the Past President and a Fellow of the Association of Applied Geochemists and an Executive Board Member of Earth Science Western Australia.

Much of Australia's remaining mineral wealth is masked by a thick transported cover that poses a major challenge for future mineral exploration. Tests have shown metal migration through cover is fine, transient and adsorbed to soil surfaces. To explore through this cover the fine soil fractions (<2 µm) host much of the adsorption sites and have the potential to show a better signature of buried ore. The problem is that the fine fraction is difficult to separate, the benefits have not been well tested and demonstrated and there are limited commercial providers, and so exploration companies are almost forced to follow routine methods. A robust assessment of ultrafine (<2 µm) soil fractions was conducted. Tests included size fractions down to 200 nm, physical extraction methods, chemical assay methods and sample sizes among others, from more than 20 key mineral deposit sites. From these tests a new workflow was established that includes separation of <2 µm soil fraction, along with particle size distribution, spectral mineralogy and other parameters. This presentation will show the highlights of the test work and the orientation and regional geochemical surveys that were analysed with the ultrafine fraction workflow to produce superior results. Key advantages of the technique are the small sample size, no nugget effects or below detection results for Au. The regional map shows how previously collected samples could be re-assayed to provide an easy and relatively inexpensive method to generate new targets through cover that were previously all below detection for Au.

19

Diagenesis and reservoir properties of the Ecca Group mudrocks in the Eastern Cape, South Africa: Implication for shale gas potential

Baiyegunhi C[1], Liu K[1], Liu O[1]
[1]*University Of Fort Hare*

Biography:
Dr Christopher Baiyegunhi is a postdoctoral fellow at the department of Geology, University of Fort Hare South Africa. He is an active and intelligent scholar with high capacity to stimulate thoughts in academic research. Dr Baiyegunhi is a registered member of the Geological Society of South Africa, Nigerian Association of Petroleum Explorationists, Society of Exploration Geophysicist and European Association of Geoscientists and Engineers. His current research interest focuses on the "Sedimentology and shale gas potential of the Ecca Group, Karoo Supergroup in the Eastern Cape Province of South Africa". He intend to become a renowned academic in the nearest future.

Diagenesis is one of the most important factors that affect reservoir rock property. Despite there are many previous studies on the stratigraphy, sedimentology and general geology of the Ecca Group in the Main Karoo Basin of South Africa, there is still lack of knowledge on the diagenesis of the potentially feasible or economically viable sandstones and mudrocks of the Ecca Group. This study aims to provide an account of the diagenesis of mudrocks from the Ecca Group. Twenty-five diagenetic textures and structures are identified and grouped into three stages that include early diagenesis, burial diagenesis and uplift-related diagenesis. Clay minerals are the most common cementing materials in the rocks. Smectite, kaolinite and illite are the major clay minerals that act as pore-filling matrix and pore lining rim-cement. The rocks were subjected to moderate-intense mechanical and chemical compaction during its progressive burial. Intergranular pores, secondary dissolution and fractured pores are well developed in the rocks. The presence of fractured and dissolution pores tend to enhance reservoir quality. However, the isolated nature of the pore linkage makes them unfavourable producers of hydrocarbons, which at best would require stimulation. The understanding of the space and time distribution of diagenetic processes in these rocks will allow the development of predictive models of their reservoir quality, which may contribute to the reduction of risks involved in the hydrocarbon exploration.

20

Geochemical evaluation of the Permian Ecca shale in the Eastern Cape Province, South Africa: Implications for shale gas potential

Baiyegunhi C[1], Liu K[1], Gwavava O[1]
[1]*University Of Fort Hare*

Biography:
Dr Christopher Baiyegunhi is a postdoctoral fellow at the department of Geology, University of Fort Hare South Africa. He is an active and intelligent scholar with high capacity to stimulate thoughts in academic research. Dr Baiyegunhi is a registered member of the Geological Society of South Africa, Nigerian Association of Petroleum Explorationists, Society of Exploration Geophysicist and European Association of Geoscientists and Engineers. His current research interest focuses on the "Sedimentology and shale gas potential of the Ecca Group, Karoo Supergroup in the Eastern Cape Province of South Africa". He intend to become a renowned academic in the nearest future.

Recently, shale gas has been the exploration focus for future energy supply in South Africa. Specifically, the black shales of the Prince Albert, Whitehill, Collingham, Ripon and Fort Brown Formations are considered to be one of the most prospective areas for shale gas exploration. In this study, outcrop and core samples of the formations were analysed to assess their total organic carbon (TOC), organic matter type, thermal maturity and hydrocarbon generation potential. The results show that these rocks have TOC ranging from 0.11 to 7.35 wt%. The genetic potential values vary from 0.09 to 0.53 mg HC/g, suggesting poor hydrocarbon generative potential. Most of the samples have Hydrogen Index (HI) values of less than 50 mg HC/g TOC, thus suggesting Type-IV kerogen. Tmax values range from 318 to 601℃, perhaps indicating immature to over-maturity of the samples. The vitrinite reflectance values range from 2.22 to 3.93%, indicating over-maturity of the samples. Binary plots of HI against Oxygen Index (OI), and HI versus Tmax shows that the shales are of Type II and mixed Type II-III kerogen. Based on the geochemical data, it can be inferred that source rocks are immature to over-matured and have potential of producing gas in present-day.

21

An integrated geophysical approach to mapping and modelling the Karoo dolerite intrusions in the south-eastern Karoo Basin of South Africa

Baiyegunhi C[1], Gwavava O[1], Liu K[1]
[1]University Of Fort Hare

Biography:
Dr Christopher Baiyegunhi is a postdoctoral fellow at the department of Geology, University of Fort Hare South Africa. He is an active and intelligent scholar with high capacity to stimulate thoughts in academic research. Dr Baiyegunhi is a registered member of the Geological Society of South Africa, Nigerian Association of Petroleum Explorationists, Society of Exploration Geophysicist and European Association of Geoscientists and Engineers. His current research interest focuses on the "Sedimentology and shale gas potential of the Ecca Group, Karoo Supergroup in the Eastern Cape Province of South Africa". He intend to become a renowned researcher in the nearest future.

The south-eastern Karoo Basin is considered to be one of the most prospective areas for shale gas exploration in South Africa. The basin has several dolerite intrusions that possibly introduced heat into the basin and resulted in the large scale conversion of oil to gas. To date, the geometry of these dolerite intrusions and variations in electrical resistivity of the purported shale gas hosting Ecca Group is poorly documented despite over 30 years of research in the area. In this study, we investigate the variations in resistivity of the Ecca Group, estimate the average depths to magnetic signatures, and produce gravity profile models that reveal the configuration of the basin and how dolerite intrusions are interconnected at depth. The magnetic map shows some ring-like structures and lineaments which coincides with the mapped dolerite intrusions. The average depth to the top of the shallow and deep magnetic sources is estimated to be about 700 m and 15100 m, respectively. Depth slicing revealed that the dolerite intrusions are pervasive in the area, extending up to 5400 m. The Bouguer anomaly map shows an increase in gravity values from inland to coastal areas. The 2½D gravity profile models revealed the basin architecture and that the dolerite intrusions form a network of interconnected sills, dykes and inclined sheets at depth. The pseudo-sections show that the lower Ecca Group rocks are generally characterized by low resistivity. These dolerite intrusions could have impacted the shale resources and still poses threat to fracking operation.

22

Conservation as a Way to Reduce Risks: Turrialba Volcano, Costa Rica.

Duarte E[1]
[1]OVSICORI-UNA

TS4 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Eliécer Duarte has work on Costarrican active volcanoes for more than 25 years at the Volcanological and Seismological Observatory.
Some of his duties include: Documenting physical changes on volcanoes, research on thermal springs and community outreach.

After 9 years of awakening signals Turrialba volcano intensified its degassing in 2005, producing phreatic events in January 2010, mid 2011, January 2012 and may 2013. After October 2014 phreato-magmatic activity resumed to produce severe impact on many spheres of Costarrican life.
Since early 2007 negative effects on surface were visible. Thousands of hectares in pasture, forest and agriculture have been devastated due to toxic and acid gases. Repetitive killing of pasture land provoked voluntary displacement of settlers located downwind on the NW, W and SW flanks. A large portion of natural and secondary forests, within (and beyond) the National Park limits, were completely burned and converted into debris after the second year of impact. Local peasants left their potato and carrot fields searching for safer land. The emplacement of a kill zone along an axis of some 4 kms has turned that sector in a cemented crust with low hope for vegetation re-birth in the short run.
Given the severity of losses in local economy and infrastructure it is necessary to come up with a vision capable of bringing together the interest of those most affected with future generations. Local and national government may declare the area of national and regional interest so to maintain an extension of the current National Park. In such case settlers can be compensated for their losses and the land left for natural regeneration. This buffering area will assure a natural way to reduce obvious volcanic risks acting as a natural form of mitigation.

23

Origin of the Neoproterozoic Rim Dolomite as Lateral Carbonate Caprock, Patawarta Salt Sheet, Flinders Ranges, South Australia

Kernen R[1], Giles K[1], Poe P[1], Gannaway C[1], Rowan M[2], Hearon T[3], Fiduk J[4]
[1]University Of Texas At El Paso, [2]Rowan Consulting, Inc., [3]EOG Resources, [4]Fiduk Consulting, LLC

TS3 - 2.1 The origins and development of life & 2.2 Ediacaran and Cambrian Symposium, Room R1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Rachelle Kernen holds a B.S. in Geology from the University of Wisconsin-Oshkosh and a M.Sc. in Geology from New Mexico State University. Rachelle is currently working on her PhD in geology at the University of Texas at El Paso where her focus is to integrate field work, seismic data, geochemistry, stratigraphy and structural geology to answer complex petroleum-related questions about geological processes within salt diapirs and along the salt-sediment interface.
Rachelle is also passionate about being a board member of non-profit organizations such as the Sedimentary Division of the Geological Society of America and the Association for Women Geoscientists.

In the Flinders Ranges, South Australia, the rim dolomite is a prominent ridge-forming, layered dolomitic and siliceous unit that is found at the salt-sediment interface between Patawarta diapir and the Ediacaran Bunyeroo Formation. The rim dolomite is interpreted to be a lateral dolomite caprock because it displays the following field relationships: 1) dolomicrite base that parallels the diapiric matrix and overlying stratigraphy, 2) exclusive presence of the dolomite at the salt-sediment interface, 3) lack of sedimentary structures or fossils, 4) a lack of interbedded Bunyeroo lithofacies, and 5) inability to trace the rim dolomite fabrics into the outboard stratigraphy away from the diapir margin. The rim dolomite displays the following textural fabrics: 1) massive – microcrystalline dolomite, 2) porphyritic – two distinct crystal sizes of microcrystalline dolomite groundmass and rosettes of silica, 3) banded – microcrystalline dolomite forming pressure-dissolution layers of silica and authigenic hematite, and 4) brecciated – mosaic to disorganized subfabrics forming a microcrystalline dolomite groundmass, which contains remnant clasts of Callanna non-evaporite lithologies, such as quartz arenite to arkosic sandstones and basalts, surrounded by a cement-filled vein network. The rim dolomite is likely a lateral caprock because it matches the field relationships and textural fabrics of other caprocks in salt basins, such as the Paradox Basin and Gulf Coast, USA. The rim dolomite interpreted as caprock is a direct indicator of the presence of hydrocarbons generated during the Neoproterozoic, as the sulfate-reducing bacteria required to alter anhydrite caprock to carbonate caprock are carried in by migrated hydrocarbons.

24

Sedimentary Models of Permian Nearshore Subaqueous Fan in Lukeqin Area of Turpan-Hami Faulted Lake Basin, Xinjiang, China

Yang S[1], Wang Y[1], Xue C[1], Chen X[2]
[1]China University of Petroleum (East China), [2]CNPCTuha Oilfield Company

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Shaochun Yang is male, PhD, professor and work in China University of Petroleum (East China). He graduated from institute of geology in China academy of sciences. He long engaged in oil and gas geology and sedimentology study and have in-depth study for China's faulted lake basin and compressional basin. He made some innovative achievements in sedimentary facies research fields such as fan delta,braided river delta, nearshore subaqueous fan, littoral and shallow lake dam etc. and formed well-seismic-logging combined with technical expertise.

The Lukqin area was a faulted lake basin of Turpan-Hami Basin, Xinjiang, China during the deposition of Permian. In Permian of this area the tectonic movement entered the Hercynian movement IV to Indo-China Movement I and syndepositional deep-faults were developed which led to the formation of the steep-raised terrain in the east and west and the relatively low-lying terrain in the middle. Based on core observation and comprehensive analysis of well logging and seismic data, it is concluded that the southeastern and southwestern parts in the area were mountains formed by volcanic eruptions during the early depositional period of the Permian, which was the parent rocks area deposited in this area. The sediments directly into the lake with a high water surface, forming a large area of nearshore subaqueous fan deposition near mountains with thick layers of coarse gravel rock and middle folder thin gray mudstone. An intense and widespread erosion occurred after the late tectonic uplifting, resulting in the development of middle and edge fans deposits in the study area, while the root fan deposition was basically absent. The middle fan of the nearshore subaqueous fan consists of a series of distributary braided channels which present apparent seismic facies features of foreset filling on the seismic section. Due to the lack of deep-faults on the east and west sides of the lake basin, the provenance can only enter the lake basin directly along the steep slope zone on both sides.

25

Overview of Artificial Neural Networks Applications in groundwater studies

Sage N[1,2], Fourie F[2]
[1]Tenke Fungurume Mining, [2]University of the free State

Biography:
Sage Ngoie was born in Democratic Republic of Congo. He obtained a Degree in Geotechnical and Hydrogeological Sciences. He holds a PhD in Geohydrology from the University of the Free State in South Africa. He is currently teaching to the University of Kolwezi and the Kolwezi Institute of Applied Technology. His researchers are based on Mathematical Modeling and Artificial Intelligence

The application of Artificial Neural Networks (ANNs) has increased in many fields of engineering and sciences. In groundwater studies, ANNs have been successfully used to solve many problems. In this research, the literature review shows that ANNs have been applied successfully in groundwater hydrodynamic, water management, water
resources, hydrochemistry, time series forecasting, hydro-geotechnical
engineering, sea-aquifer interaction, hydro-geochemistry, data collection in harsh environments and pit dewatering. The aim of this research is to provide an overview of the capacity of ANNs to solve some hydrogeological problems. This paper does not intend to show each single application of ANNs that can be found in the literature.

26

Lithospheric discontinuities in Central Australia

Kennett B[1], Sippl C[2]
[1]Research School of Earth Sciences, Australian National University, [2]Deutsches GeoForschungsZentrum,

TS1 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Brian Kennett FAA FRS is now Emeritus Professor of Seismology at RSES, ANU. His research has covered a very wide range of topics in seismology, from reflection seismology to studies of the deep Earth and from theoretical to observational studies.
He also has worked on geodynamic problems particularly associated with subduction and the nature of the lithosphere.
He has received recognition through many medals and awards including the Gold Medal in Geophysics from the Royal Astronomical Society, the Jaeger and Flinders Medals from the Australian Academy of Sciences and the Lehmann Medal of the American Geophysical Union.

Lithospheric discontinuities are elusive, with properties that are strongly frequency dependent. Results from the BILBY temporary deployment of broadband stations along a north-south transect through Central Australia, and the permanent arrays ASAR and WRA, are used to evaluate the spatial coherence of lithospheric features, particularly mid-lithospheric discontinuities. We exploit techniques that use receiver based information from distant earthquakes using both direct waves and conversions. Stacked station autocorrelograms provide an estimate of P-wave reflectivity beneath stations, with imaging methods exploiting teleseismic arrivals. We exploit both common conversion point (CCP) stacking from Ps receiver functions and reflection point imaging using the autocorrelation of the P wavetrain. The results tie well for the Moho and have a good general correspondence for deeper levels.
Although indications of mid-lithospheric discontinuities from changes in the frequency of reflectivity occur at similar depths, the spatial continuity of specific features at high frequency (around 2 Hz) is of the order of 10-15 km. Broader trends can be tracked across the profile, but no strong lithospheric interfaces can be mapped, except for a prominent south dipping feature traversing the lithosphere on the southern part of the profile that is likely to be a former mantle detachment zone associated with the development of the Central Australian basins.

27

Achievements of scientific ocean drilling in the Australasian region

Exon N[1]
[1]*Australian National University*

TS6 - 1.3 Marine Geoscience - The evolving oceans/IODP, Room R1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Neville Exon had a long history as a land and marine geologist based in Australia, with Geoscience Australia and its predecessors, until 2005. He was heavily involved in scientific ocean drilling in various ways, including as a scientist on two expeditions of the research drilling vessel JOIDES Resolution, one as co-chief scientist. From 2008 to 2017 he was Program Scientist with the Australian and New Zealand Consortium within the IODP drilling program, based in ANU. He edited a book reviewing our role in IODP entitled Exploring the Earth Under the Sea, which was published by ANU Press in 2017.

In our region, international scientific ocean drilling expeditions started in 1973, and they continue at present. This hugely successful program has greatly increased global geoscientific knowledge by investigating the sequences and basement rocks beneath the seabed. Pure research is favoured, but many results have resource significance, especially for petroleum exploration. IODP's present operational budget for drilling vessels and core stores is ~$US180 million, and >400 km of core is stored. All results and data go into the public domain, and the core is accessible to any scientists. Most individual sites core 400-1000 metres below the sea bed, but some core much deeper, and continuous coring and sophisticated wireline logging is now normal. The 23 IODP member countries include Australia and New Zealand.
Worldwide proposals come from international teams and are considered purely on scientific merit. In this broad region, we have been involved in and commonly led numerous proposals. Altogether we have seen more than 40 two-month regional expeditions, yielding roughly 100 km of core, an outstanding scientific achievement. We have an advantage in that our region is scientifically important but remote from most IODP countries, and we have very capable marine geoscience teams. Expeditions have covered areas such as plate tectonics; continental margins and plateaus; deep ocean basins, volcanic plateaus, island arcs and oceanic crust; paleoceanography and paleoclimate in many regions and over varied time frames; subduction zones, earthquakes and tsunamis; and the extensive extremophile microbiota beneath the sea floor. Examples will be given in my talk.

28

ECORD Mission-Specific Platform expeditions in the International Ocean Discovery Program: flexible operations and technological developments.

Cotterill C[1,2,3], McInroy D[2,3], Smith D[2,3]
[1]European Consortium For Ocean Research Drilling, [2]British Geological Survey, [3]ECORD Science Operator

TS7 - 1.3 Marine Geoscience - The evolving oceans/IODP, Room R1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Carol is a senior marine geoscientist with the British Geological Survey. She has developed a respected scientific role within both industry and academia, having developed and led multi-disciplinary projects, using the results to guide commercial clients, policy makers and scientific research sectors. She has managed national and international drilling projects in different environments, involving up to 80 staff and resources from different countries, on behalf of the International Ocean Discovery Program. This often involves coordinating new science-driven technological developments. Moving on within IODP, she has been the European Consortium for Ocean Research Drilling Outreach Manager for the last 2 years.

The International Ocean Discovery Program (IODP) is supported by multiple Funding Agencies from around the world, and delivered by 3 Platform Providers; the US National Science Foundation provides the JOIDES Resolution, Japan's Ministry of Education, Culture, Sports, Science, and Technology provides the D/V Chikyu, and the European Consortium for Ocean Research Drilling (ECORD) provides mission-specific platforms (MSPs) which are contracted on a case-by-case basis. Each IODP platform provides specialist capability. However, as capable as the two dedicated IODP platforms are, they are unable to reach all geological targets, such as those located under ice-covered seas, in shallow water, in environmentally sensitive areas or in certain hard-to-drill lithologies. To date, ECORD has implemented 8 MSP expeditions in a wide range of challenging environments. Whilst these projects had multiple objectives, including the recovery of records of climate and sea level change, and previously unknown buried microbiological communities, all of them are driven by scientific demands.

As the IODP evolves, so do the methods used to collect cores from below the sea bed. From utilisation of In-Kind Contributions of vessels through to development of new tools with industry, ECORD aim to realise the call from the scientific community to continually push the scientific boundaries. ECORD is driving an initiative to use alternative coring technologies in addition to the wireline coring that is traditionally used for scientific drilling. This includes development of remotely operated seabed rockdrills and associated battery triggered wireline logging tools, to borehole plugs and water sampling and analysis whilst drilling capability.

29

Designing the structure of web-based Nepalese landslide information system

Meena S[1,2], Westen C[2], Mavrouli O[2]
[1]Z_GIS, University of Salzburg, [2]ITC, University of Twente

Biography:
Sansar Raj Meena is a PhD Researcher at Department of Geoinformatics-Z_GIS, University of Salzburg, Austria. He received his Bachelor's in Geography from University of Delhi, India and Master's in Geoinformation Science and Earth Observation from ITC, University of Twente, Netherlands. His research interests include the development of novel methodology for landslide mapping in Himalayas for better landslide hazard and risk assessment that leads to better Improved Planning and Decision Making.

Landslide inventory in Nepal is currently not done continuously and coherently, and efforts are made after major triggering events only, such as the 2015 Gorkha earthquake. There is a lack of sharing of knowledge and cooperation among stakeholders to coup with significant disaster events. This research will focus on filling those gaps by designing an approach for sustainable landslide inventory mapping in Nepal. The overall framework of research is to make a conceptual design of a Nepalese landslide information system and to show how different stakeholders can be involved. The use of a Nepalese landslide information system, to report and provide landslide data would benefit the stakeholders involved in data collection and landslide management.
The landslide database system should be designed in such a way that it can incorporate information about different landslide characteristics and types. Availability and extraction of landslide data from the database are the key aspects considering a variety of users of landslide information in Nepal. For the reporting of landslides directly in the system, a web portal is proposed. Stakeholders who can contribute to the reporting of landslides are identified by field interviews and questionnaires. Also, different methods for generating the inventory data are analysed, and the applicability and efficiency of various collection methods are tested. Based on field investigations and literature reviews the optimal format of the landslide database is proposed for the Nepalese landslide information system.

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Biofacies, Biogeochemistry and Thermal Maturity of Early-Middle Cambrian Microbialites from the Arrowie Basin, South Australia

Teece B[1,2,3], George S[2], Brock G[3]
[1]School of Biological, Earth and Environmental Sciences, University of New South Wales, [2]Department of Earth and Planetary Sciences, Macquarie University, [3]Department of Biological Sciences, Macquarie University

Biography:
Bronwyn is a PhD student at the Australian Centre for Astrobiology at UNSW. She gained a Master of Research and a Bachelor of Arts and Science from Macquarie University. Her research interests involve palaeobiology, biogeochemistry, early life, and biogenicity requirements. She is passionate about scientific communication, particularly bridging the gap between the public and the astrobiological community. She has spent so long working on stromatolites that her phone now autocorrects 'cya' to 'cyanobacterial'.

Microbialites are organo-sedimentary deposits, sometimes composed of accumulations of cyanobacteria and other bacteria, which form at the sediment-water interface. Microbialites represent one of the earliest records of life on Earth, with stromatolites causing increased atmospheric oxygen levels on Earth as part of the Great Oxidation Event. The early Cambrian bilaterian radiation coincided with a sharp decline in stromatolite diversity and abundance. In this study, microbialites from Cambrian Stage 2 and 5 were sampled from a range of shallow marine carbonate facies in the Arrowie Basin, South Australia. The appearance, construction, and biogeochemistry of stromatolites and thrombolites from different depositional environments were described to investigate morphological variation and ecological associations. Stromatolitic and archaeocyath bioherms from Cambrian Stage 2 were found in association with hypersaline and sabkha environments. Thrombolites from Cambrian Stage 5 were deposited sub-tidally prior to a transgression event, based on biomarker evidence, with Pr/Ph ratios ~1. This project investigated morphological variations in microbialites through petrographic observations, and resolved previously unanswered biogeochemical questions using multi-disciplinary techniques, including field relationships, hand and thin section observations, gas chromatography-mass spectrometry, Raman spectroscopy, fourier transform infrared spectroscopy (FTIR), and X-ray fluorescence. The distribution of aromatic hydrocarbons reveal a high thermal maturity, which is supported by results from Raman spectroscopy and FTIR. Microbialites are not found in association with any fossils preserved in life position, but n-alkanes and monomethyl alkanes were detected in several samples. FTIR revealed carbohydrate absorption bands that may be related to extracellular polymeric substances secreted by bacteria, or silicification of fossils.

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Architecture and trigger mechanisms of the Cretaceous gravity deposits in Lingshan Island, Eastern China

Li S[1], Yu X[1], Li S[1]
[1]*China University Of Geosciences, Beijing*

TS7 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Shunli Li, a lecturer at China University of Geosciences, Beijing. My research interests are mainly focused on clastic sedimentology including modern and ancient fluvial-deltaic systems, shallow marine sedimentation, and deep water sedimentation.

Outcrops of the Early Cretaceous deposits on Lingshan Island are well exposed to illustrate gravity-flow transitions between turbidity currents and debris flows (causing hybrid event beds, HEBs) at upper slope and basin floor in a lacustrine basin. Outcrop sections (Beilaishi, Shipyard, Lighthouse, and Qiancengya Cliff) were subtly measured to characterize sedimentary records of gravity flows. Facies associations including grey to dark grey, massive (graded) very-fine sandstones with rip-up mudclasts or showing (partly) Bouma sequences; large scale, dark grey, deformed sandy mudstone with thin-bedded fine sandstone; greyish to buff, cross-stratified sandstones and massive sandstones with conglomerates were identified at the Lingshan Island. The fine-grained, muddy deposits with low-density gravity flows at south represented turbidity fans at basin floor. Whereas, the coarsed-grained, sandy deposits with high-density gravity flows at north were interpreted as braided delta front at slope break. Flow transitions occurred both at slope break and basin floor, which produced distinguish sedimentary structures, stacking patterns, and architectural units. Architectural parameters were collected and recalculated from the two systems for characterizing bed variation under different flow regimes. The high-density HEBs with both gravels and mud clasts overlaid by sandy turbidites were mainly triggered by floodwater from river mouths of the deltas that caused hyperpycnal flows associated with slight deformations. Significant slumps showing seismites and syn-depositional mirco-faults were commonly triggered by sediment failure associate with earthquakes on basin slopes, which produced low-density HEBs showing elongate, rip-up mud clasts and intrabed deformations overlaying muddy turbidites.

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Can Systematic Palaeontology survive Modern Metrics?

Webb G[1]

[1]The University Of Queensland

TS2 - 2.4 Ancient and Historical Record of Life in Australia, Room R1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

Gregory Webb is the Dorothy Hill Chair in Palaeontology and Stratigraphy at The University of Queensland. He is a palaeontologist/carbonate sedimentologist/geomicrobiologist who specialises in ancient and modern corals, coral reefs and microbialites (rocks made by microbes). He is actively engaged in using petrographic and geochemical means to study how organisms make rocks, how those rocks are altered through time and how they may record environmental information in their geochemistry and morphology through diagenesis. His research has applications for understanding Earth history, environmental protection and resource exploration.

Increasingly, academic prestige, employment, job advancement and funding are reliant on simple metrics used by governments, university administrations, and external agencies to evaluate and rank universities, research programs and individual academics. However, commonly used metrics do not favour systematic palaeontology. Commonly used publication metrics include citations, journal impact factors (IF), and journal ranking schemes, such as the Nature Index. The push to publish [only] in high IF 'prestige' journals rewards research in areas associated with: 'novel' findings; big data (e.g., modelling, syntheses based on 'treatise mining'); high immediacy ('toast of the day' science), and numerous practitioners. However, despite new taxa being 'novel' by definition, systematics are regarded as 'old school'. The relatively small pools of potential citers for systematic palaeontology papers means slow citation generation. As journal IF is calculated based on average yearly citations per paper over the first two years, it rewards fields with abundant practitioners and 'high immediacy'. Systematic palaeontology accumulates citations slowly, but regularly over timeframes greater than a century. Palaeontology papers in general appear to gain more citations per year fifty years after publication than during the first two to five years after publication. Hence, IF metrics greatly underestimate the impact of systematics papers and the journals that publish them. In the current academic landscape, this negative impact on metrics is a threat to the field itself despite the accepted importance of the fundamental data to the synthetic research that it supports. This presentation seeks to inspire dialogue around this critical topic.

Depositional Characteristics of River Transitions and Implications for Abandoned Channels Based on Outcrop Study and Applied to a Subsurface Example

Li S[1], Li S[1]
[1]*School of Energy Resources, China University of Geosciences, Beijing*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Shengli Li, an Associate Professor at School of Energy Resources, China University of Geosciecnes, Beijing. My research interests mainly include clastic sedimentology, petroleum geology, and reservoir geology.

This study on the sedimentary characteristics and river transitions from proximal to distal zones in Permian fluvial outcrops of the Beijing suburbs reveals the main cause of the meandering-to-braided transition, namely, the change in sediment supply, which is caused by changes in climate conditions. Two abandoned channels are distinguished in this outcrop study. Based on the outcrop interpretation, we discuss the characteristics of the meandering-braided transition zone and its sedimentary sequences. We classify abandoned channels into three types: avulsion, chute cut-off and neck cut-off based on the correlation between sinuosity and channel abandonment. Furthermore, we discuss a typical fluvial Permian gas field in the Ordos Basin as a case study of subsurface formation. We analyze the distribution of fluvial deposition using meandering-braided transition and abandoned channel patterns. Our study reveals that the river type transitioned from braided to meandering and then to high-sinuosity meandering channels from the northern to the southern parts of the gas field. Two abandoned channels were also identified in the transitional and meandering belts in the southwestern part of the gas field. The concept of meandering-braided transition channels and new insights into abandoned channels are helpful for understanding the changes in the fluvial environment over geological time.

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Adjustments for Airborne Induced Polarization Effects - a joint conductivity induced polarization inversion update for 2.5D

Silic J[2], FitzGerald D
[1]Intrepid Geophysics, [2]Jovan Silic and Associates

TS7 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Jovan Silic is a director and principal consulting geophysicist with Jovan Silic and Associates Melbourne, Australia. He has a successful association with the mineral exploration industry over a period of 30 years in a wide range of geological environments spanning five continents. Jovan graduated from University of Western Australia with a Bachelor of Science (Honors) First Class, and in 2000 obtained a Ph.D. (Geophysics) degree from Macquarie University, New South Wales, Australia, on the topic of interpreting TDEM data.

Data acquired by airborne EM time domain systems, reflect mainly the EM induction related to ground conductivity and sometimes, airborne inductively induced polarization (AIP). The presence of AIP from a near surface body can complicate the identification and quantization of the conductivity response at greater depth. The in-loop systems in particular are optimally configured to excite a unique AIP effect including, but not exclusively, negative transients at mid to late times. In many cases these AIP effects are closely related to near surface sources. A decoupling of these IP effects from the pure conductivity induced response is shown to work, by exploiting the differing frequency responses for the two effects.

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Magnetic depths to volcanic sills using regional scale data

Clifton R[2], FitzGerald D[1]
[1]Intrepid Geophysics, [2]Geological Survey of Northern Territory

TS8 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Evren Pakyuz-Charrier holds a MSc in Geology from Orleans University where he worked on the design of the Cell Based Associations algorithm, the basis of an innovative mining predictivity method.
He has recently completed his PhD studies at UWA on 3D geological modelling uncertainty estimation.
His interest in implicit 3D geological modelling and geostatistics made him an early user of the GeoModeller API. He collaborated with IG to improve the API and further his own research work.
Evren joined IG early 2018 as Geology Product Specialist with a focus on continuous improvement of the modelling engine and user experience.
His research interests and skills range from geostatistics to GIS, geological 3D modelling, spatial analysis, mining predictivity, potential field geophysics and coding.

Basalt floods, or volcanic intrusives in a sedimentary setting, are of great interest to the oil and gas sector. Here, results are presented from a variation on a recent method for magnetic depths, which assumes that a volcanic sill is magnetically heterogeneous and that its magnetic response can be simulated by a layer of random dipoles. The depth to one or more layers is obtained by inverting the slope at each frequency along the power spectrum as if it were due to a single dipole. We improve on the previous version of the method by doubling the number of points in the power spectrum and by shortening the fit at low frequencies. The resulting depth spectra are then added progressively to a magnetic transect. The transect looks somewhat like a seismic section, though with reduced horizontal resolution.

The improvements allow the tracking of equivalent layers down to at least 1500 m, doubling the useful range, from the prior art of depths between 200 m and 800 m. A new tool that automates the new aspects has also been developed, with emphasis on providing optimised, easy and user guided input to a 3D interpretation package.

By way of demonstration, a key indicator of some extensive gas-rich shales, the Derim Derim dolerite in the Northern Territory of Australia, is tracked away from its intersection in a borehole. Using regional magnetic data alone, the dolerite is picked out at depths down to 1500 m.

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Using Augmented Reality (AR) to Improve Communications and Decision Making with Stakeholder at a Former Chemical Manufacturing Facility

Fewless T[1], Cyphers S[2], Richardson I[3]
[1]GHD, [2]GHD, [3]GHD

TS5 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Tom is a geologist specializing in hydrogeology and geochemistry. Tom's work employs innovative site characterization methods to support environmental remedies, providing significant cost savings to clients. He focuses on the distillation of large and varied datasets into a cohesive and accessible format. Tom has brought 3D CSMs into the office environment through a holographic projection headset.

Background/Objectives Subsurface impacts at the site have been strongly influenced through mixing varied water densities (fresh, sea, and caustic) along with DNAPL, all of which influence their distribution across the site. Over twenty five years, thousands of individual data values have been collected mainly through monitoring wells and soil borings. A strong understanding of the site geology, hydrogeology, and constituents of concern distribution/mobility has been gained though investigation and analysis was needed to understand the site conceptual site model (CSM).

Approach/Activities. The use of a three dimensional computer model (EVS) was employed to facilitate communication of the CSM to stakeholders and regulators. Difficulty arose with communications regarding potential remedies. Augmented reality (AR) was employed to bridge this gap and bring the information into the real world. AR sets the viewer in the driver's seat, allowing exploration of the data and interpretations from any angle or at any scale including being able to see site conditions and proposed remedial measures at actual size with the actual site as the background. This ability to explore the site details with interactive augmented reality that can be controlled simply through hand gestures and voice commands makes this suitable for all audiences.

Results/Lessons Learned. Results of interactions with stakeholders have been favorable. The ability to allow stakeholders to see the site conditions below the ground and the remedial measures that will be employed to address the conditions at actual scale and with the actual site as the backdrop is revolutionary and allows better stakeholder engagement.

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Apatite U-Pb and fission track mapping to date deformation: implications for mineral exploration

Glorie S[1], Reid A[1,2], Hall J[1], Jepson G[1], Lilly R[1]
[1]The University Of Adelaide, [2]Geological Survey of South Australia

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
BSc, MSc, PhD at Ghent University (Belgium) on thermochronology in Central Asia.
2012: 1 year Post-doctoral research funded by FWO, Belgium
2013-2015: Lecturer at The University of Adelaide
2016-2018: Senior Lecturer at The University of Adelaide
Research interests: the application of thermochronology (particularly apatite fission track and apatite U-Pb methods) to unravel the thermal history of orogens and basins, and to date deformation, exhumation and/or mineralisation.

We use apatite U-Pb (AUPb) and apatite fission track (AFT) age mapping across the structural architecture of old orogens to assess the timing and extent of deformation and associated mineralisation and exhumation. AUPb and AFT mapping results will be presented for Central Australia and Central Asia.

The Gawler Craton study area illustrates the usability of the AUPb technique as a viable alternative to Ar-Ar dating. Our AUPb results show major age steps across shear zones, imaging the major structural architecture of the study area and dating Proterozoic deformation. AFT ages for the same samples date the timing of Phanerozoic reactivation, which has implications for the exhumation level of the mineralised crust. In vicinity of the Olympic Dam IOCG deposit, AFT data reveal a `thermal corridor` of younger cooling ages, associated with the locations of ore deposits. In addition, we will show AUPb results obtained for the Ernest Henry IOCG deposit (Cloncurry) that dates the timing of regional deformation, which controlled mineralisation.

Within Uzbekistan (Central Asia), AUPb ages are indistinguishable from zircon U-Pb ages for samples taken away from the main structures, while in vicinity to the main structures, AUPb ages are significantly younger. These younger (late Permian – early Triassic) AUPb dates match the age of a post-ore porphyry dike that crosscuts the Muruntau Au deposit, and could therefore provide vectors to mineralisation.

Given the association of ore deposits (generation or exhumation/preservation) with deformation, our maps and age data may thus provide useful information for the mineral exploration industry.

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ANSIR portable seismic facility – 21 years of seismic data acquisition and discovery

Salmon M[1], Sambridge M[1], Miller M[1]
[1]*Australian National University, Research School Of Earth Sciences*

TS1 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Michelle Salmon is the Passive Seismic Science Coordinator for ANSIR. She maintains the onshore passive seismic facility out of the Australian National University (ANU). She runs the ANU seismic field program collecting data across Australia as part of the WOMBAT array. Michelle is also an ambassador for Earth Science outreach and she runs the Australian Seismometers in Schools program.

From the humble beginnings of a partnership between the Australian National University and Geoscience Australia the ANSIR portable seismic facility has expanded to more than 200 seismometers including both broadband and short period instruments.
The increase in seismic instrumentation in Australia has allowed the development WOMBAT, an Australian rolling transportable array with seismic station spacing's of ~50 km. The WOMBAT array now includes data from more than 1000 sites across Australia. Data from this array has been used for seismic tomography, crustal receiver functions, and joint inversions of active and passive seismic data. Resulting studies have provided new insights into the tectonic history and structure of the Australian Continent. Alongside this long-term program instruments have been deployed for more targeted studies, including the edges of cratons – e.g. Albany Fraser and Capricorn Orogens, zones of transitioning crustal thickness, and to try to define the extent of buried basins identified in deep reflection profiles – e.g. Millungera Basin. The ANSIR portable seismic facility has been able to support projects across Australia as well as in New Zealand and Antarctica providing an important infrastructure resource for exploring of the region.
There are now 11 partner institutions in Australia and New Zealand sharing these facilities and the data that is collected using them, with a 12th about to join. Our most recent development is a new Australian Passive Seismic Server, AusPass, which will allow the sharing of 2 decades of data collected using ANSIR equipment. http://auspass.edu.au

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Tectonic environments of South American porphyry copper magmatism through time revealed by spatiotemporal data mining

Butterworth N[1], Steinberg D[2], Müller D[1], Williams S[1], Merdith A[1,2], Hardy S[2]
[1]University Of Sydney, [2]Data61 CSIRO

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Nathan learned the crafts of data mining and machine learning
on big data projects with the EarthByte group. He completed a PhD in geosciences entitled, "The dynamics of subduction and its tectonic implications". Before pursuing geophysics, he received his BSc from the University of Wollongong in 2008 and his honours in astrophysics from the University of Sydney in 2009. More recently he spent 2 years engaging the global community with just how cool science is. He now works with the Sydney Informatics Hub where he enables and inspires researchers to embrace modern technology platforms and data science capabilities.

Porphyry ore deposits are known to be associated with arc magmatism on the overriding plate at subduction zones. While general mechanisms for driving magmatism are well established, specific subduction-related parameters linking episodes of ore deposit formation to specific tectonic environments have only been qualitatively inferred and have not been formally tested. We develop a four-dimensional approach to reconstruct age-dated ore deposits, with the aim of isolating the tectonomagmatic parameters leading to the formation of copper deposits during subduction. We use a plate tectonic model with the ocean floor, including subducted portions of the Nazca/Farallon plates. The models compute continuously closing plate boundaries, combined with reconstructions of the spatiotemporal distribution of convergence rates and directions, as well as the age of the downgoing plate through time. To identify and quantify tectonic parameters that are robust predictors of Andean porphyry copper magmatism and ore deposit formation, we test two alternative supervised machine learning methods; the random forest ensemble and support vector machines. We find that a combination of rapid convergence rates (~100 km/Myr), subduction obliquity of ~15°, a subducting plate age between ~25–70 Myr old, and a location far from the subducting trench boundary (>2000 km) represents favorable conditions for porphyry magmatism and related ore deposits to occur. These parameters are linked to the availability of oceanic sediments, the changing small-scale convection around the subduction zone, and the availability of the partial melt in the mantle wedge. When coupled, these parameters could influence the genesis and exhumation of porphyry copper deposits.

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The Australian Earth and Environmental Science Olympiad: An Australian Science Innovations initiative inspiring students to think about Earth Systems Science.

McNamara G[1], Almberg L[1], Carr R[1]
[1]*Australian Science Innovations*

TS7 - 5.2 Prediction, process, place: Geomorphology & 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Greg is a consultant geologist with interests in geoscience education and outreach as well as the sedimentology, stratigraphy and geochronology of Australian vertebrate fossils.

He has taught undergraduate geoscience, helped run a CSIRO science education centre, managed an interactive science museum and established the education centre at Geoscience Australia.
In 2007 he helped create the award-winning Teacher Earth Science Education Programme. Greg also authors e-newsletters GEOZ for the Geological Society of Australia and GeoEdLink for the Australian Geoscience Council.

In 2014 Greg was appointed as the inaugural Program Director of the Australian Earth and Environmental Science Olympiad.

The Australian Earth and Environmental Science Olympiad program selects and trains talented secondary students in preparation to compete at the annual International Earth Science Olympiad (IESO).

Each year, talented Yr9-11 students test their knowledge of Earth and Environmental Science by sitting a challenging national exam. The top 24 are invited to attend an intensive summer school, held at the Australian National University, where their theory and practical skills are developed further.

After an intense, two-week program that puts the students through the equivalent of a first-year university course, a four-member team is selected to compete at the next International Earth Science Olympiad. Team selection is based upon daily and final theory and practical assessments.

The team meets once before the IESO for a week of more theory, practical skills and exam technique training.

The international competition consists of theory and practical exams plus the International Team Field Investigation where teams of students from different countries work together to solve real life geoscience and environmental problems.

In this presentation we discuss the value of the program to talented students and highlight the very successful involvement of Australian students in the International Earth Science Olympiad to date. This includes but is by no means limited to winning Gold, Silver and Bronze medals.

We also discuss the impact the program is having on students and what influence, if any, it has on student subject choices at senior high school and university.

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Why the Mineral Exploration Industry needs to change and a vision for successful 21st Century under-cover exploration

Hronsky J[1]

[1]*Western Mining Services,* [2]*Centre for Exploration Targeting , UWA*

TS1 - 3.1.1 Effective exploration and discovery under cover, Hall E2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:

Jon Hronsky has more than 30 years experience in the mining and exploration industry. He is currently a Principal of Western Mining Services (WMS), a consultancy group that provides strategic-level services to a wide range of groups (from juniors to majors) across the global mineral exploration industry. Jon is Chair of the board for the Centre for Exploration Targeting, an Adjunct Professor at the University of WA, and current Chair of the Australian Geoscience Council. Jon is also a Director of ASX mining companies, Encounter Resources and Cassini Resources, and a partner in PE fund Ibaera Capital.

There has been much discussion in recent years about the need for, and the challenges of, the exploration industry transitioning to an under-cover discovery focus. However, there has been much less discussion about the very significant ways that the industry will need to change the way it operates to be successful in this new search space. The modern petroleum exploration industry looks nothing like the way it did in the early 20th Century when major petroleum deposits could still be found though near-surface expression and we should expect similar major changes to the mineral exploration industry. Although many people have viewed the current transition in the mineral exploration industry primarily through the lens of technology, and this is clearly very important, these required changes will relate as much to the way we finance the exploration process, the strategic and tactical framework for exploration management and the way we train explorers. One way to consider this requirement for change is to develop and articulate an integrated vision of what an idealised hypothetical future exploration industry might look like, at all scales from global financing to project-scale data collection. Such a vision provides us with an aspirational goal or at the least a framework for debate.

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Multi-scale geoelectric structure of the Tasmanian Lithosphere

Ostersen T[1], Reading A[1], Cracknell M[1], Thiel S[2], Robertson K[2], Bishop J[3]
[1]University of Tasmania, [2]Geological Survey of South Australia, [3]Mitre Geophysics Pty. Ltd.

TS2 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Thomas is a PhD student from the University of Tasmania working on the geoelectric structure of Tasmania and interpretation of integrated geophysics datasets toward geological understanding. Thomas returned to study following three years in industry where he developed skills in potential field data acquisition and geophysical project management.

Rapid development of 3D inversion schemes for electromagnetic induction problems such as the magnetotelluric method have enabled 3D imaging of the Earth's resistivity structure at a range of scales. Inverse modelling of crustal and local scale MT data recently acquired in Tasmania as part of the ongoing AusLAMP initiative as well as legacy geothermal energy exploration efforts have yielded new insights into the structure of this geologically enigmatic terrain.

In this contribution, we outline the data collected from this challenging region and present results from inverse modelling. Two datasets were acquired throughout 2016 using ANSIR-built MT instruments as part of the national AusLAMP initiative; a 57-site long period dataset distributed across the island at a spacing of ~35 km, as well as 65 broadband sites acquired along two transects across key locations in west and north western Tasmania. A third study involved joint 3D inversion of legacy broadband and long period MT data from a geothermal prospect in central eastern Tasmania.

Inverse modelling of regional and prospect scale MT data has generated a complete picture of Tasmania's lithospheric geoelectric structure. The Tamar Conductivity Anomaly is confirmed in the context of the geoelectric structure of the state as a major upper crustal feature separating a uniformly resistive East Tasmania Terrane from the more complex pre-Cambrian West Tasmania Terrane. Upper-crustal conductive regions observed in regional and transect modelling tend to correlate with metamorphic core complexes emplaced in the Cambrian, suggesting a causal link between deep Earth processes and surface geological features.

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Findings from a study of Aboriginal cultural association with Geosites and Geotourism in the Gunduwa Conservation Region of Western Australia.

Briggs A[1]
[1]*Murdoch University*

TS4 - 5.1 Geology in Society: geotourism and geoheritage, Room R8, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
After 40 years in Western Australian government and achieving his MBA, Alan lectured in tourism at Edith Cowan University from 1997, becoming an Adjunct Lecture in 2009. From 2011 – 2016 he lectured on campus at Murdoch University.
Alan was a long term committee member of Forum Advocating Cultural and Eco-Tourism (FACET), has strong interests in Eco-tourism, Geo-tourism and Geoparks and Indigenous engagement in land management, tourism and Geoparks.
Alan commenced a PhD in March 2012 at Murdoch University focusing on stakeholder perceptions of establishing a Geopark in the Wheatbelt of Western Australia. Gunduwa Conservation Region provides a case study.

Geotourism is a niche market growing strongly on a global basis. Australia has a strong Nature-based tourism industry and visiting tourists are attracted by the earthy nature of this vast continent with places nationally such as Uluru, Great Barrier Reef; and in Western Australia, iconic attractions such as Purnululu National Park, Ningaloo Reef, Shark Bay and the Pinnacles high on their visitation lists. Lesser known regions such as the Gunduwa Conservation Region of Western Australia with its isolated granite monadnocks, banded ironstone and Aboriginal cultural values and is situated on the Yilgarn Craton, one of the world's oldest land platforms hold special geotourism values. This paper will report on the outcomes of a study based on Aboriginal cultural stakeholder perceptions of geotourism, geoparks and the sharing local geotourism product with tourists; and the potential for geotourism development.

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From continental crust to ocean basin – rapid rifting in the South China Sea – Site U1501, IODP EXP 367/368

Dadd K[1], Liu C, Schindlbeck J, Wan S, Zhong G, Expedition 367/368 Scientists

[1]School of Geosciences, University of Sydney, [2]Department of Geology and Geophysics, Louisiana State University, [3]Institut für Geowissenschaften, Universität Heidelberg, [4]Institute of Oceanology, Chinese Academy of Sciences, [5]State Key Laboratory of Marine Geology, Tongji University

TS7 - 1.3 Marine Geoscience - The evolving oceans/IODP, Room R1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Kelsie is the Program Director with Curious Minds, a national, government-funded program that aims to inspire girls in years 8 and 9 to pursue a career in STEM. She spent 20 years at Macquarie University in the Department of Earth and Planetary Sciences and Faculty of Science and Engineering. Kelsie's interests include volcanology, chemistry and tectonics of volcanic and sedimentary rocks in eastern Australia and the oceans surrounding Australia. Kelsie participated in three International Ocean Discovery Program (IODP) expeditions – Expedition 323 Bering Sea Paleoceanography, Expedition 349 South China Sea Tectonics and Expedition 368 South China Sea Rifted Margin.

The South China Sea (SCS) is a marginal sea located at the junction of the Eurasian, Pacific, and Indo-Australian plates. The SCS was targeted during IODP Expeditions 367 and 368 to test the hypotheses of breakup of the northern SCS margin and to compare its rifting style and history to other rifted margins. EXP367/368 drilled seven sites across the ~150 km wide continent-ocean transition zone and targeted four main tectonic features - the Outer Margin High (OMH) and three ridges within the distal margin. At each of these sites, we targeted syn-rift and post-rift sediments and the acoustic basement.

Drilling at Site U1501, on the OMH, intersected a sedimentary succession extending from the pre-Cenozoic (?) to the Holocene. The succession is divided into three lithologic units each representing different sedimentary environments and separated by major unconformities. Unit III comprises well-lithified sandstone and rare siltstone and conglomerate deposited in a terrestrial to littoral environment with a proximal source. The Unit II/III boundary was not recovered but it is marked by an abrupt change in lithification and represents a significant hiatus with Unit III representing a pre-Cenozoic basement succession. Unit II is siliciclastic-dominated clay, silt and sand with gravel-size grains including shell fragments and glauconite and represents a gradual change from upper continental slope to lower slope depositional environments. Unit I is dominated by clay-rich nannofossil ooze with thin silt beds deposited in a deep-marine environment. The Unit I/II boundary corresponds to a high-amplitude seismic unconformity.

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What do non-geologists think of geotourism?

Witham B[1]
[1]*TBD*

TS5 - 5.1 Geology in Society: geotourism and geoheritage & 5.6 Diversity in the Geosciences, Room R8, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
My interest in tourism developed from growing up in Halls Gap, Victoria where it was the only business in town. Four years working for Parks Victoria helped me create guided geological activities and learn the art of interpretation.

I completed a BSc(Hons) on the structure and quartz vein development in the Gympie Goldfield, Queensland in 1993. Since then I have spent fifteen years working as an exploration geologist primarily in gold, copper, gas and coal. My data management expertise enabled a cross-over back into the government sector for seven years, most recently with the Geological Survey of NSW.

Tourism in Australia is big. Its contribution to Gross Domestic Product (GDP) is comparable to the mining industry, it employs three times as many people and has been regularly identified in our top six fastest growing industries over the past five years. Since geology is integral to so much of Australia's tourism offering it should follow that Australian geologists are well placed to take advantage of this.

This opportunity is usually promoted within geoscientific circles under the banner of geotourism. In Australia, however, this term is yet to gain real traction in the wider tourism industry. Recent examples include experiences at a Savannah Guides' field school (Carnarvon Gorge, Queensland), a survey of Visitor Information Centers in eastern Australia and a case study of interpretation at the Peak Hill Open Cut Gold Mine walking trails (NSW).

The same driving reason behind the lack of emphasis placed on geology was evident from all these examples. Tourists and tourism professionals often find it difficult to relate to, and therefore value, geology outside well established natural attractions, such as Uluru.

There are, however, many successful examples of ways to make geology more relatable and, therefore, geotourism more appealing. This includes using tourists' everyday experiences, storytelling techniques and understanding tourists' motivations for their choices.

The potential for geotourism will not be fully realised while it is regarded by the wider tourism industry as a niche market that only applies to a few special demographics or sites or, at worst, is just a fad.

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The Past, Present and Future of Earth Imaging in Australia

Reading A[1]
[1]*University Of Tasmania*

TS1 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Leads the 'Compute Earth' group in the School of Natural Sciences, University of Tasmania as Professor of Geophysics. Innovative approaches to seismology and data science build on a foundation of experimental field geophysics in challenging regions such as Antarctica, outback Australia and remote areas of Tasmania. Special interest areas include interdisciplinary research and public engagement with science and mathematics. An experienced educator and student research advisor who makes numerous service and policy development contributions to scientific research at university, state, national and international levels. Director of ANSIR 2015-2018.

Earth Imaging, from continental scale right through to sub-prospect scale, is well-developed in Australia. The 3D structure of the Australian plate is slowly being revealed and its architecture, and hence tectonic history, better understood. Given the sheer size of the continent, and relatively sparse population, our ongoing challenge is to make use of higher resolution methods while increasing coverage at a reasonable rate and addressing diverse needs. In reviewing the past and present, and highlighting opportunities for the future, it is hoped that the academic, government and industry community will be inspired to undertake discussions on future Earth imaging opportunities for mutual benefit.

This presentation reviews the diverse history of Earth Imaging including seismic and geoelectric methods at continental and regional scale, and exemplar projects at smaller scales. At present, we are entering a time of disruption whereby multiple agencies are collecting Earth imaging data. Data types are also increasingly varied. Improved computing capability enables legacy datasets to be processed in combination with newly collected data but there is a pressing need for coordination. There is also a need to recognise those individuals and institutes contributing legacy data to aggregated archives. The future of Earth imaging, including high-N data acquisition, necessitates a development from campaigns run by small field teams. The current status and future priorities of Earth imaging in Australia will be highlighted using examples from ANSIR-enabled seismic and magnetotelluric studies.

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Palaeo-history of the Northern Hairy-nosed Wombat (Lasiorhinus krefftii) provides lessons for conservation of modern populations

Price G[1], Wiggins N[1], Webb G[1], Feng Y[1], Zhao J[1], Higgins P[2], Louys J[3]
[1]School of Earth and Environmental Sciences, The University Of Queensland, [2]Department of Earth and Environmental Sciences, University of Rochester, [3]Research Centre for Human Evolution, Griffith University

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Gilbert Price is a Senior Lecturer in Palaeontology at The University of Queensland. He is a vertebrate palaeoecologist and geochronologist, particularly interested in the evolution and emergence of our planet's unique ecosystems and fauna, and their response to prehistoric climatic changes. His major research focus has been on the development of palaeoecological models for Australia's Cenozoic, especially the Quaternary megafauna. Critically, this also involves the production of reliably-dated records for the fossils that he studies. For additional background, see www.diprotodon.com.

The critically endangered Northern Hairy-nosed Wombat (NHW) is an iconic member of Australia's herbivorous marsupial fauna. Once widespread across eastern Australia, the species is today restricted to two areas: a natural population of 240 individuals in Epping Forest National Park (central eastern Queensland), and an introduced 'insurance' population of 10 individuals at St George (southern central Queensland). In 2002, a near-complete NHW fossilised skeleton was recovered in Winton, central Queensland. The fossil site is around 300 km west of Epping, thus markedly outside the known geographic range of the species. We conducted extensive geochemical analyses on the individual's teeth to reconstruct its palaeoenvironment and palaeoecology. Direct U-Th dating of dentine demonstrates that the individual is 30 ka. Rare earth element analyses (n = 41) of molar tooth enamel demonstrate that it is largely unaltered chemically as a result of diagenesis, making it suitable for biochemical analysis. Stable isotopes (C and O; 32 analyses for both) of a serially sampled molar suggests that the region was (and still is) dominated by C4 grasses, but at a time markedly more humid than Winton today. These data suggest that the loss of the NHW Winton population is likely due to a climatic shift towards progressively drier conditions. Moreover, we argue that the insurance population at St George is likely to fail as the region does not receive consistent enough rainfall needed to sustain NHW populations long-term. Future selection of sites for potential 'insurance' populations should ideally consider areas more humid than St George.

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Why should Australian schools offer Earth & Environmental Science at senior secondary year levels?

Altman L[1]

[1]*Geoscience Pathways Project (Inc)*

TS8 - 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Len is a retired geophysicist and a senior secondary science teacher with 40 years of experience teaching Geology, Physics and Vocational Geoscience. He is a former recipient of the Prime Minister's Prize for Science Teaching in Secondary Schools (2009) and a former Chief Assessor (Geology) for the SACE Board. Len currently coordinates the Geoscience Pathways Project (Inc.), and convenes the Education Sub-committee of the SA Division of the GSA.

Why should Australian schools offer Earth & Environmental Science at senior secondary year levels?

This workshop will present an overview of the decline of geoscience education in Australian schools, with a particular focus on SA and a rationale for change.

SACE Geology was taught in SA for the last time in 2017. It's been replaced by the new course 'Earth and Environmental Science' (EES), with significant geoscience content taught in a unique way, with a hands-on, multidisciplinary scientific approach.

EES gives students opportunity to engage with big issues. Students investigate climate change and sustainability of mineral, energy and water resources from a unique historical and scientific perspective. It provides an ideal preparation for informed and responsible citizenship and experience of real science. Students learn about emerging STEM careers, study and training pathways. Importantly, (and unlike the other Year 12 science subjects), there is no external examination. The examination has been replaced by a flexible, externally assessed 'Earth Systems Study'. This alternative assessment enables teaching to focus on authentic, practical 'learning by doing', in local, regional or global contexts, instead of a focus on memory work and exam preparation

Unfortunately, in 2018 SACE Stage 2 EES has been offered in only 4 schools. A total of only 31 students are enrolled in the subject.

Clearly, much needs to be done to increase the low uptake.. This workshop will explore the rationale for action. Participants will be invited to suggest practical strategies to support and promote the teaching of EES in schools.

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Results of stratigraphic drilling in the southern Thomson Orogen, Queensland

Purdy D[1], Brown D[1], Roach I[2]
[1]Geological Survey Of Queensland, [2]Geoscience Australia

TS8 - 3.1.7 Studies on the Thomson Orogen, Room R2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
David Purdy is a senior geoscientist at the Geological Survey of Queensland and has completed regional mapping, geochemistry, geochronology and stratigraphic drilling projects throughout the New England Orogen, Thomson Orogen and Cape York regions. Much of this work has been extended via collaborations with university and other government colleagues. David's primary interests are in regional mapping, volcanic stratigraphy, igneous petrology and tectonics.

The Thomson Orogen occupies a vast area of eastern Australia but is poorly understood due to extensive cover. The southern part of the Thomson Orogen where it straddles the Queensland/NSW border is an area of relatively shallow cover and is considered a greenfield region in terms of mineral exploration. Small areas of outcrop host known mineralisation near Tibooburra and possibly Granite Springs while the remainder of the Thomson Orogen to the north hosts many well-known mines and mineral provinces of different style (e.g. orogenic gold, VHMS, porphyry-related) and age. Areas of shallow cover in the Thomson Orogen, such as the Eulo Ridge, are therefore considered prospective. We tested this by completing a stratigraphic drilling program of 12 holes in the southern Thomson Orogen as part of ongoing collaborative data acquisition and research. Each drill hole tested distinct basement features identified using new regional AEM and MT data, regional magnetics and gravity, and a basement geology interpretation map. Site-based geophysics (passive seismic, refraction seismic, AMT) were acquired prior to drilling to constrain the expected depth to basement and to assess various methods for depth to basement estimation. Each of the five drill holes sited in Queensland intersected potentially prospective lithologies below the Eromanga Basin cover with veining, sulphides and alteration zones locally present. The shallowest basement intersection (49m in GSQ Eulo 2) produced a volcaniclastic boulder conglomerate with carbonate-pyrite altered matrix overlying altered ignimbrite with zones of strong alteration, veining and anomalous arsenic.

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BayesReef: A Bayesian inference framework for modelling vertical reef growth and responses to environmental change

Pall J[1], **Chandra R[1]**, Azam D[1], Salles T[2], Webster J[2], Cripps S[1]
[1]Centre For Translational Data Science, University of Sydney, [2]School of Geosciences, University of Sydney

TS5 - 1.1.2 Optimisation and uncertainties in Earth models, Hall C, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Jodie Pall is a research assistant with the Centre for Translational Data Science, collaborating with Research Fellow Dr Rohitash Chandra. Jodie completed her first-class Honours thesis in Geology in 2017, receiving the University Medal.
Dr. Rohitash Chandra is USyd Research Fellow at the Centre for Translational Data Science and School of Geosciences at the University of Sydney. His research interests are in areas of deep learning, neuro-evolution, Bayesian methods, solid Earth Evolution, reef modelling and mineral exploration.

We present an implementation of Bayesian inference using a Markov Chain Monte Carlo sampling method (MCMC) for inferring free parameters in pyReef-Core model through a novel framework called BayesReef. Communities of corals and coralline algae (coralgal assemblages) are indicative of a continuum of modern reef environments that change laterally across a reef and with depth. Evolving ecological dynamics between assemblages and interactions with environmental conditions determine the depth distribution of assemblages in drill cores, which represents the response of reef growth to changing palaeo-environmental conditions. However, the environmental processes controlling vertical reef development are unobservable. pyReef-Core is a carbonate stratigraphic forward model designed to solve this inverse problem by simulating the key biological and physical processes that determine vertical accretion and assemblage changes in reef drill cores. pyReef-Core models have non-unique (multi-modal) solutions as different combinations of interacting parameters produce identical sequences. Bayesian inference provides a methodology for estimation and uncertainty quantification of free parameters in models even in the presence of multi-modal distributions. Here, BayesReef is tested in proof-of-concept experiments and calibrated with realistic, synthetic data to evaluate the accuracy and quantify the uncertainty in predicting vertical sequences in reef drill cores. The results highlight the multi-modal nature of pyReef-Core solutions and establish BayesReef as a method that produces accurate reef core predictions. While BayesReef cannot reliably recover unique synthetic parameter values, it provides insight into the complex posterior distributions of parameters in pyReef-Core.

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BayesLands: Distributed parallel tempering for uncertainty quantification in basin and landscape evolution via Badlands

Chandra R[1], Muller D[2], Deo R[1], Azam D[2], Buttersworth N[1], Salles T[2], Cripps S[1]

[1]Centre for Translational Data Science, The University of Sydney, [2]School of Geosciences, The University of Sydney

TS5 - 1.1.2 Optimisation and uncertainties in Earth models, Hall C, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Dr. Rohitash Chandra is USyd Research Fellow at the Centre for Translational Data Science and School of Geosciences at the University of Sydney. His research interests are in areas of deep learning, neuro-evolution, Bayesian methods, solid Earth Evolution, reef modelling and mineral exploration. He is involved in projects that employ machine learning methods and Bayesian inference via parallel tempering for solid Earth evolution, mineral exploration, and reef modelling.

In recent years, Bayesian inference has become a popular methodology for the estimation of parameters in geological and geophysical forward models. Bayesian inference provides uncertainty quantification via the posterior distribution of the parameters, as opposed to optimization methods that provide single point solutions. Badlands is a basin and landscape landscape evolution model for simulating topography development at various space and time scales. Parallel tempering is a Markov Chain Monte-Carlo (MCMC) method for implementing Bayesian inference for multi-modal distributions. Moreover, they are more suitable to have multi-core implementations that can speed up the sampling process. In this paper, we present parallel tempering for the Badlands model over selected synthetic and real-world problems. The parallel tempering algorithm is implemented in parallel computing architecture to reduce the sampling time. The results show that parallel tempering Bayeslands not only reduces the computation time, but also provides a means to improve the sampling process in a multi-modal landscape. This motivates its use in bigger problems in landscape evolution that can span millions of years and require larger computation time.

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What controls d18O of precipitation in subtropical settings? A 5-year, daily resolved rainfall record from Krabi, Thailand

Löwemark L[1], Chabangborn A[2], Chawchai S[2], Duerrast H[3], Liang M[4], Madhavan M[5], Wang C[6]
[1]Department of Geosciences, National Taiwan University, [2]Department of Geology, Faculty of Science, Chulalongkorn University, [3]Department of Physics, Faculty of Science, Prince of Songkla University, [4]Research Center for Environmental Changes, Academia Sinica, [5]Department of Atmospheric Sciences, Cochin University of Science and Technology, [6]Institute of Earth Sciences, Academia Sinica

TS5 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
PhD Kiel University, Germany (2001)
MSc Stockholm University, Sweden (1996)

Variations in oxygen isotopes in speleothems are often interpreted to reflect variations in the amount of precipitation controlled by changes in climate phenomena such as the monsoon or ENSO. However, this amount effect has recently been questioned, favoring other mechanisms such as moisture source(s), rainout history, or the influence of local convection. A more than 5 years long daily resolved precipitation and δ18O record from Thailand allows the relationship between precipitation patterns and rainwater δ18O to be examined. Rainfall at the Krabi station was highly irregular with rain events ranging from 0.1 mm to nearly 150 mm per day. Rainwater δ18O values vary from -17.50 to 8.24 ‰, with a long-term average close to -5 ‰. We demonstrate that while daily and amounted weighted seasonal δ18O values show no correlation with rain amount, the amount weighted monthly values display a significant correlation with monthly rainfall. Statistical comparison to atmospheric parameters reveal a strong correlation to outgoing longwave radiation, suggesting that local convection rather than the precipitation amount effect control variations in rainwater δ18O in this region. Comparison to a short cave drip water record suggests that the atmospheric δ18O signal is recorded with a muted amplitude in the drip water, and with a lag of one to two weeks.

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Plate to anticline modelling of the Papua New Guinea margin – predicting gasfield structure

Hill K[1], Mahoney L[2], Beucher R[1], Zahirovic S[3]
[1]University Of Melbourne, [2]Oil Search Ltd, [3]University of Sydney

TS1 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Kevin is a structural geologist who has over 35 years' experience in industry and academia. He worked for BP in Canada and London in their structural specialists group and completed a PhD on the PNG fold belt. He has taught at La Trobe and Melbourne Universities and consulted with many companies in Australia and SE Asia. Kevin has worked for the last 10 years with Oil Search Ltd and now teaches courses throughout SE Asia and carries out research with the Basin Genesis Hub at the University of Melbourne.

A new regional balanced section across the ophiolite and suture with an exotic terrane in PNG has been restored to suggest the nature of the original Jurassic sedimentary margin prior to break-up. Regional G-Plates modelling indicates that the terrane rifted away in the Upper Jurassic creating a marginal basin that then closed in the Paleogene causing regional inversion of old basement normal faults. The uplift, erosion and cooling is supported by detailed modelling of thermochronology data and by extrapolation of the regional unconformity. The loss of the subduction zone during the suture event is consistent with an overridden subducted slab beneath Lake Eyre, detected on tomographic data. A widespread Early Miocene extensional event recorded in seismic and thermochronological data led to subsidence prior to the main collision with the Melanesian Arc in the Late Miocene to Pliocene causing orogenesis throughout PNG and recorded in detail on the balanced section. Finite element and sand-box modelling of the frontal ranges of the fold belt revealed the development of detachment zones just above basement and beneath the thick Miocene carbonates at surface. The intervening Mesozoic section was deformed as box-folds within a giant triangle zone that has no surface expression. One of these structures was successfully drilled for gas in late 2016, proving the box-fold theory and further exploration wells are planned along strike.

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Essential Elements of Geotourism Interpretation

Dowling OAM R[1]
[1]*Edith Cowan University*

TS4 - 5.1 Geology in Society: geotourism and geoheritage, Room R8, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Professor Ross Dowling OAM is Foundation Professor of Tourism, School of Business & Law, Edith Cowan University, Perth. He has a deep interest in the development of Geotourism and he is a passionate advocate for the establishment of UNESCO's Global Geoparks in Australia. He fosters regional development through Geotourism around the world and he convened the world's first three conferences on Geotourism in Australia (2008), Malaysia (2010) and the Sultanate of Oman (2011). He is Deputy Chair of Geoparks WA; Member, Geotourism Standing Committee, Geological Society of Australia; and Geotourism Advisor, UNESCO Global Geoparks.

He conducts international research in the fields of geotourism, ecotourism, and cruise ship tourism. He has written or edited 16 global books on tourism and has written over 200 journal and conference publications. He has co-edited three international books on Geotourism and a fourth, the Handbook of Geotourism, will be published in the UK later this year.

Professor Dowling has degrees in geology, geography (karst geomorphology) and environmental science. In 2011 he was awarded the Medal of the Order of Australia for his contribution to hospitality & tourism, education and the development of ecotourism.

Ross will be speaking in the Geoscience Education summit. His draft title is 'Earth Stewardship - geoscience as earth heritage - geoparks, geotourism'.

This presentation conveys some of the 'Essential Elements' of Geotourism's Interpretation. This is best understood through three 'ABC' elements. They are the 'Abiotic' or Non-living – climate and land (primarily geology and landforms); 'Biotic' or Living - plants (flora) and animals (fauna); and 'Culture' or people – past and present.

When understood and presented in this format then people can easily see the links between how climate and geology have determined the plants and animals which live in an area, which in turn has shaped the way people have lived in a region in the past, as well as today. Thus it is geology which is the key building block to our understanding of all components of the environment and the way in which we live in it.

A second central element of geotourism is the presentation of geology interpreted through its components of 'Form' (landforms and landscape), 'Process' (how the landforms originated) and 'Time' (when the processes occurred and how long they lasted).

By putting this Interpretive approach to Geotourism into action it promotes awareness of geological features within the context of the biota and culture of a region. This 'interpretive bridge' is a central, but often missing, link in bringing geology to life. Once understood and put into practice through geotourism, it can be a powerful tool in the development of geoparks.

This approach will be illustrated with examples from a number of countries.

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Petrophysical Analysis of an Offshore field, Niger Delta Nigeria

Ogunfolabo T[1]
[1]Federal University Of Technology

Biography:
Taofeek has completed his Bachelor degree from University of Ilorin, Ilorin, Nigeria and Master degree studies in Petroleum Geophysics from Federal University of Technology, Akure. Nigeria. He is the Project Manager of Swglobal Nigeria. He has professional certifications in PRINCE2, IWCF and DATABASE MANAGEMENT.

Subsurface data comprising a suite of wireline logs and 3D seismic data from an oilfield offshore Niger Delta was utilized for stratigraphic and structural analysis with the aim of evaluating the hydrocarbon potential of the field. Lithologic interpretation and hydrocarbon reservoir identification was carried out using gamma ray and resistivity log responses. The hydrocarbon bearing reservoirs located at a depth interval of 8080 to 10313 ft subsea have an average net to gross sand of 0.7, porosity 36%, hydrocarbon saturation 80%, volume of shale 8% and permeability 1478 md. Three depositional sequences located within a depth interval of 5211 to 11387 ft accommodated varied number of reservoirs. The main components of depositional sequences such as lowstand, transgressive and highstand sysems tracts influenced facies succession and depositional processes. The isochron maps of the seismic horizons show that the dominant structure harbouring hydrocarbon in the area is a faulted anticlinal structure. The internal reflection configuration of the mapped sequences is parallel/subparallel with low to moderate continuous amplitude. 3D perspective view of reservoir (R3) shows sand and sale distribution in the study area. The time thickness map also complemented 3D perspective view by depicting zones of thick sediment accumulation. The results from log and seismic data analysis show that the environment of sediment deposition ranges from continental shelf to wave dominated slope environment.

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The impact of a digital interactive globe system on students' learning outcomes

Chang C[1]
[1]National Taiwan Normal Univ.

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Dr. Chun-Yen Chang is a science education scholar in Taiwan. Currently, he serves as National Taiwan Normal University (NTNU) Chair Professor, Director of Science Education Center (NTNU), Professor of the Graduate Institute of Science Education and the Department of Earth Sciences (NTNU). Over the past few years, he has been a Visiting Professor at the Taipei Medical University, The Education University of Hong Kong, and the Paris 8 University. Dr. Chang's major research interests include science education, e-Learning, interdisciplinary science learning and science communication.

The aim of this study is to evaluate a Digitally Interactive Globe System (DIGS) on students' learning outcomes. A quasi-experimental study was conducted to evaluate the learning effectiveness of our system. A total of 105 junior high-school students from Taiwan participated in this 4-week experiment. The students were divided into three individual groups of 35 students each, with one control group (CG) and two experimental groups (EG1 and EG2). The data was analysed by one-way Analysis of Variance (ANOVA). The results indicated that participants in the experimental group, who used the digital interactive globe system, outperformed the other two groups, in the post-test as well as in the delayed test. These findings demonstrate that the proposed DIGS can effectively enhance the performance of the learners in an geoscience course.

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Automating the geological interpretation of drill hole data

Hill J[1]
[1]CSIRO

TS3 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Dr June Hill is a Senior Research Scientist at CSIRO Mineral Resources. June has a diverse background including structural geology in multiply deformed high metamorphic grade rocks, extension tectonics, 3D geology modelling, mathematical geosciences and machine learning. She is currently involved in research involving the automation of the geological interpretation of drill hole data for mining and mineral exploration.

Rapid delivery of drill hole data is being facilitated by developments in on-site analytical laboratories and geophysical logging while drilling. In order to take full advantage of this high-speed data delivery, geologists need tools for rapid automated interpretation of the data. This is a challenging problem because effective automated classification systems need to be able to understand spatial context and to integrate multiple variables. They also need to be able to deal with the varying scales of sampling and interpretation. The particular interest of this study is to generate a geological interpretation of the drill hole data that is suitable for building a 3D geology model, taking into account the specified issues.

A method is presented that combines multiscale wavelet decomposition and automated multivariate classification to mimic the geologist's work method. The use of multiscale techniques allows data sets collected at different scales to be integrated and also allows selection of a scale of interpretation that is most relevant to the 3D modelling scale. Methods for appropriate geological classification of geological domains that incorporate multiple samples (i.e. multiple feature vectors) are addressed using a hierarchical classification system.

The concepts presented are applicable to any multivariate set of depth-attributed, continuous numerical drill hole data (or similar 1D spatial data from other sources) provided that a geologically meaningful classification can be applied to it.

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How big was that ocean? - combining new and traditional techniques to inform understanding of ancient ocean basin evolution

Aitchison J[1], Zhou R[1], Buckman S[2]
[1]University of Queensland, [2]University of Wollongong

TS2 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Jonathan Aitchison has spent his career working on convergent plate margins ranging from New Zealand through Japan, eastern Australia to the India-Asia collision system in Tibet. He strongly advocates that detailed field observations and stratigraphy provide the essential basis for unravelling the tectonic evolution of any such zone. To this end he works with a range of fossil groups, especially radiolarians but also uses radiometric age constraints when and when appropriate.
This type of approach has led to numerous advances including a better understanding of the tectonic evolution of areas such as the New England Orogen of eastern Australia

Five decades after development of the plate tectonics paradigm we recognise numerous ancient convergent plate margins and associated subduction complexes. We also have a basic understanding of the configuration of supercontinents through time. What continues to elude us is a comprehensive understanding of the nature of now consumed ancient ocean basins.
Techniques traditionally applied to investigations of subduction complexes in the 1980's and 90's used radiolarian biostratigraphy to constrain the ages of cherts overlying the mid-ocean ridge basalt (MORB) accreted as tectonic slices and revolutionised understanding of the evolution of areas like the Japanese isles.
Significant advances have rendered previously expensive and time-consuming radiometric dating techniques relatively commonplace. Development of LA-ICP-MS allows large quantities of detrital zircons extracted from clastic sediments to be rapidly dated using the U-Pb technique. Data thus generated provide constraints on the ages of the sources of this material. Areas such as the Central Asian Orogenic Belt (CAOB) are already awash with volumes of such data. In the case of subduction complexes sediment that accumulated in trenches is commonly unfossiliferous and no other technique for dating exists. The youngest detrital zircon ages are widely regarded as representative of the age of deposition.
Combining the above techniques provides an opportunity to investigate a '∂age' – in other words the time between initial sedimentation on new ocean crust and its arrival at a convergent plate margin. Combined with sensible estimates of plate motions, such knowledge can then be used derive estimates of the extent of former ocean basins.

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Insights on the geological evolution and mineral resources of the Mount Isa inlier from mafic geochronology and geochemistry and petrology

Hutton L[1], Collerson K[2]
[1]Geological Survey Of Queensland, [2]KDC Consulting-KDC2

TS7 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Laurie Hutton graduated from the University of Queensland in 1972, completing honours the following year. Since then he has been involved in regional geological mapping in Queensland, working in many of the mineralised parts of the state
He was awarded a PhD in 2004.

Laurie acted in the role of director – Exploration Attraction at the Geological Survey of Queensland for two years.

He is a Senior Project Manager (Minerals) where he manages the geological mapping team. He is currently focusing on the Mount Isa Inlier combining mafic geochemistry with basin development and structural evolution for a holistic basin evolution.

Mafic rocks occur at regular intervals throughout the history of the Mount Isa Inlier over about 350 million years. Significant mafic material is injected every 20-30 million years throughout the depositional and deformational history. One implication of this long lasting activity is a high heat flow into the crust resulting in hot crust. The implications of hot crust on the deformational styles will be discussed.

Settings of mafic injection range from intracontinental rifts during the depositional phase of the Inlier to compression during several phases of the Isan Orogeny. Geochemical associations vary from tholeiitic to alkaline and from continental rift tholeiites (upper mantle melting), mid ocean ridge basalts to alkaline assemblages related to deeper mantle melting and accompanied by carbonate rich fluid phases. The geochemistry is modified by subsequent metamorphism and fluid alteration episodes making an understanding of primary igneous geochemistry and ages highly interpretive.

The Soldiers Cap Group records a transition in an evolving passive margin setting progressing to rupture of the continental crust. Mafic geochemistry similarly records a transition from crustally contaminated tholeiites to primitive MORB compositions. This transition also hosts several mineral deposits including the giant Cannington orebody. Mineral systems models for Cannington are presented which are consistent with the interpreted geology.

An understanding of the crustal setting of the eastern succession is important to better understand mineral systems for IOCG mineralisation in the region. Mafic magmatism is commonly postulated as an avenue for getting Cu and Au from deep crustal settings to the upper crust.

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Investigation of the large-scale conductivity structure of the Mount Isa Province from broadband magnetotelluric data

Simpson J[1,2], Donchak P[1], Heison G[2]
[1]Geological Survey Of Queensland, [2]University of Adelaide

TS2 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Janelle Simpson has worked as a geophysicist with the Geological Survey of Queensland for eight years. She is passionate about better integration of geology and geophysics, particularly in the field of inversion. She has worked on a variety of projects including depth to basement studies, regional geophysics acquisition, 3D modelling, and potential field inversion. In 2018 she completed her Ph.D. with the University of Adelaide. Her project focused on inversion and interpretation of magnetotelluric data.

Northwest Queensland's deep electrical structure is dominated by the presence of the Carpentaria Conductivity Anomaly. Despite several studies identifying the feature, its form and underlying cause remain poorly understood. This study uses existing broadband MT (BBMT) data across northern Queensland to provide new insight into this enigmatic feature.
Available BBMT data were subsampled to approximately 10 km station spacing, with sites unaffected by static shift preferentially selected. Data were standardised to 15 points over a range of 5 s to 2000 s. Impedance data was inverted with data errors set at 10 % for Zxy and Zxy and 7% for Zxx and Zyy. Inversion was conducted using the ModEM 3D inversion code.
In addition to the impedance inversion, a tipper only inversion was run using the same mesh. These inversions used the same frequency range and data errors were set to 10% on Tx and Ty. Tipper only inversion was used to investigate the location of large-scale features while the impedance inversion aimed to resolve internal structure of the CCA.
The new inversion modelling refines the location of the CCA and also provides an indication of the complex three-dimensional nature of the feature. The conductivity feature broadly corresponds to the eastern margin of the Mount Isa Province and may be associated with suturing.

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Geotourism – Opportunities for Future Development in Australia

Robinson A[1]
[1]*Geological Society of Australia*

TS4 - 5.1 Geology in Society: geotourism and geoheritage, Room R8, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
An exploration geologist by profession, Angus established his business, Leisure Solutions®, in 1993 and is now engaged in ecotourism/geotourism activities as an eco-certified tour operator. In recent years he has served as inaugural Chair of the Geotourism Standing Committee of the Geological Society of Australia. Angus is also the designated spokesperson on geotourism for the Australian Geoscience Council. Over the past two decades, Angus has been engaged in executive roles relating to technology park development and hi-tech industry association work. In earlier years he has enjoyed various executive roles in major tourist attractions and in an alpine conservation/recreation area.

Whilst the potential for geotourism, a totally holistic field of 'nature based' tourism, was first recognised in Australia in 1996, the concept was only conceptualised locally by the convening of a Global Geotourism Conference in 2008, with the subsequent establishment in 2011 of a geotourism constituency group, now known as the Geotourism Standing Committee of the Geological Society of Australia. In 2008, the then Kanawinka UNESCO Global Geopark was established in Victoria and South Australia, but its status was not ratified by Australian Governments in Council in 2009. Since then work on two Pre-Aspiring UNESCO Global Geopark nominations located in Far North Queensland (Etheridge) and Central West NSW (Warrumbungle) has commenced, but subsequently abandoned owing to objections from graziers for the Etheridge project, and concern from the Geological Survey of NSW about potential mineral resource sterilisation for the Warrumbungle project, even though UNESCO global geoparks do permit both mineral exploration and mining. Nevertheless for both projects, alternative geotourism development strategies are now being put in place, because it has been accepted by local government agencies that geotourism can nurture both regional development and new job creation. In addition, there has been a range of geotrail projects, some of which have been actively supported by State Government Geological Surveys, offering exciting new opportunities for geotourism growth. These projects are being actively supported by State based Geotourism sub-committees in South Australia, Tasmania and Victoria, and through collaborative activity with the Australian Institute of Geoscientists in Western Australia.

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Space-based hazard monitoring for Australia and Melanesia using Interferometric Synthetic Aperture Radar

Parker A[1], Garthwaite M[2], Filmer M[1], Featherstone W[1]
[1]Curtin University, [2]Geoscience Australia

TS3 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Amy specialises in the use of satellite radar imagery (InSAR/SAR) to monitor, measure, and understand natural and man-made hazards. Her research has included the 2010 M 7 Haiti earthquake, atmospheric corrections of InSAR data, the Cascades Volcanic Arc, volcano monitoring in Papua New Guinea, and urban subsidence in Australian cities caused by groundwater extraction. Amy completed her PhD at the University of Bristol, UK, in 2015. She sits on the steering committee of Earth Observation Australia and is an Australasia Outreach Coordinator for Women in Earth & Environmental Science Australasia.

Satellite remote-sensing provides the tools necessary to facilitate hazard monitoring over vast and/or remote areas. Interferometric Synthetic Aperture Radar (InSAR) is one such technique, using the phase difference between pairs of satellite radar images to produce high-resolution (~10s metres) maps of ground displacements. The use of SAR and InSAR over Australia has been somewhat limited compared to other regions globally. This may be attributed to: the success of optical data given relatively abundant cloud-free atmospheric conditions; historically poor data coverage from SAR satellites; and few proven successful case studies to raise awareness around these techniques. However, ad hoc applications of SAR data are yielding new insights into hazards, both natural (e.g. seismicity) and man-made (e.g. subsidence induced by resource extraction). Here we describe two such case studies. The first demonstrates the effects of groundwater extraction and recharge in the Perth Basin, Western Australia. The second documents the use of InSAR to carry out the first systematic geodetic survey of volcanoes in Papua New Guinea. This regional-scale survey contributes to the assistance offered by Australia for volcano monitoring in Papua New Guinea, and provides baseline information against which future changes can be measured. The use of InSAR for hazard monitoring within and by Australia will continue to improve with the European Space Agency's Copernicus program, which now provides the first comprehensive and spatially complete coverage of SAR data via Sentinel-1.

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The information content of geophysical data: Less can be more in seismic inversion.

Sambridge M[1]
[1]*Australian National University*

Biography:
Malcolm Sambridge is currently a Professor in the Research School of Earth Sciences at the Australian National University. His research contributions have been in geophysical inverse problems across the Earth Sciences and in particular seismology. His research involves the development and application of techniques for geophysical inference; seismic wave propagation; imaging of the internal structure of Earth; robust inference from Earth science data; computational geophysics and numerical algorithms.

Advances in digital data acquisition together with cost reductions have resulted in rapid growth in our ability to record, collect, process and transmit data at rates never before seen in the history of science. Nearly a decade ago Gantz (2010) estimated the global rate of data collection to be increasing at 58% per year, which amounted to 1250 billion gigabytes, more bytes than the number of stars in the universe. In the geosciences, this has led to renewed focus on practices of data management and engineering. Significant effort is devoted to data being findable, accessible, interoperable and reusable. This begs the question `how much of this data do we actually use?' And perhaps more importantly how much of it do we need to answer a particular question? Does every new byte add new information? Or is it a case of diminishing returns? Geophysical data is often collected for a single or small range of purposes, and so answers to such questions will inevitably depend on the particular application. In this presentation we examine the information content of geophysical data used for subsurface imaging. As an exemplar, we consider broadband seismic waveforms and ask how much of it is really needed to constrain shallow shear wave seismic structure in the upper crust. Guided by ideas from the field of Compressed Sensing of time series we reach some rather surprising results that may suggest a rethink in how we make use of our ever-expanding Earth bytes.

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Tectono-metamorphic evolution of the southern Thomson Orogen

Doublier M[1], Brown D[2], Cross A[1], Fraser G[1], Hegarty R[3], Purdy D[2], Zwingmann H[4]

[1]Geoscience Australia, [2]Geological Survey of Queensland, [3]Geological Survey of New South Wales, [4]Kyoto University

TS8 - 3.1.7 Studies on the Thomson Orogen, Room R2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

After a Master in structural geology at the University of Giessen Michael did a PhD at University of Frankfurt, working on the Montagne Noire Gneiss Dome and surrounding sediments in Southern France combining structural geology with low-grade petrology and K-Ar geochronology. In 2007 he joined the Geological Survey of Western Australia, working on the regional geology of the eastern and central Yilgarn Craton. In July 2013 he joined the Mineral Systems Branch at Geoscience Australia working broadly in the areas of structural geology and tectonics.

Despite its resources potential, the geological evolution of the Thomson Orogen and its relationship with other parts of the Tasmanides of eastern Australia is not well understood. This is mainly due to poor exposure, as it is largely covered by the Eromanga and underlying sedimentary basins. Interpretation of potential field and seismic data with information from sparse outcrop, drill holes, and a large dataset of U-Pb, Ar-Ar and K-Ar geochronology suggests that the southern Thomson Orogen does not represent a homogenous entity. Several structural domains have been identified. These can be distinguished by differences in: i) structural orientation, (ii) geographic distribution, (iii) timing of major faults, and, to varying degrees, also by: (iv) the evolution and spatial orientation of structural elements such as folds, minor faults and fractures, (v) broad lithological trends, (vi) stratigraphy, and (vii) structural style. The two largest domains are the fault/shear dominated Western Structural Domain (WSD) and the fold dominated Eastern Structural Domain (ESD). The ESD is more strongly affected by Late- to post-Devonian thrusting than the WSD, and contains the spectacular, megascopic Wyuna Megafold—a possible orocline. Ar-Ar and K-Ar geochronology on sheet silicates reveals that the southern Thomson Orogen has been strongly affected by Bindian (~415 – 410 Ma) deformation, which contrasts with the Lachlan Orogen to the south where late Benambran (~450 – 430 Ma) deformation prevails.

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The Inversion Laboratory –inference, inversion and tools for the community

Sambridge M[1], Valentine A[1], Hawkins R[1]
[1]*Australian National University*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Malcolm Sambridge is currently a Professor in the Research School of Earth Sciences at the Australian National University. His research contributions have been in geophysical inverse problems across the Earth Sciences and in particular seismology. His research involves the development and application of techniques for geophysical inference; seismic wave propagation; imaging of the internal structure of Earth; robust inference from Earth science data; computational geophysics and numerical algorithms.

The ANU Inversion Laboratory at the Research School of Earth Sciences, is an initiative to advance research into geophysical and geochemical inferences algorithms. Inversion is the term often given to the process where we want to learn about something that we can not directly measure, for example an Earth property at depth, or a process that occurred in the past, both of which are not accessible to direct observation. The geosciences is rife with examples of such inverse problems, from near surface geophysics to planetary scale geodynamics. In practice indirect measurements must be used to answer questions about the target often based on multi-faceted, multi-disciplinary datasets.
The aim of the Inversion lab is twofold: Firstly to develop leading edge inversion methodology and algorithms, utilizing advances in mathematical methods, computation, statistics and data science, and apply them to geoscience problems; and secondly to make advanced inference and data analysis computer software available to the geoscience community. ILab researchers have produced unique software packages which are freely distributed to the scientific community for research and education; with others contributed by colleagues from round the world for various classes of inversion problem. Some software is specific to particular classes of data set while others take the form of generic software libraries. More than 20 such packages are available from the iLab, software portal (www.iEarth.edu.au). This presentation will showcase some active research directions in ILab such as probabilistic sampling, nonlinear optimization, Bayesian inference, uncertainty quantification and machine learning.

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From Geosystem to Mineral System: Contextualising Ore Deposits

Begg G[1,2], Griffin W[1], O'Reilly S[1], Hronsky J[3]
[1]CCFS/GEMOC, Macquarie University, [2]Minerals Targeting International PL, [3]Western Mining Services PL

TS3 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Graham Begg has over 30 years in the mining and minerals exploration sector, and a PhD in tectonics and epithermal deposit geology from Monash University. Since 2002 he has also spearheaded collaborative research at Macquarie University, aimed at systematic multi-disciplinary mapping of the architecture and geodynamic evolution of the continental lithospheric mantle and crust, with the aim to facilitate a breakthrough in greenfields exploration discovery. The outputs contribute towards the commercial Global Lithospheric Architecture Mapping (GLAM) product, a framework for area selection in the resource sector marketed by his consultancy Minerals Targeting International (MTI).

A Mineral Systems approach to understanding ore deposits involves consideration of the processes that are directly (spatially and temporally) involved in deposit formation. Increasingly we understand that large Mineral Systems operate at the scale of the entire lithosphere (e.g. Griffin et al., 2013), and are influenced by global geodynamic processes (e.g. Begg et al., 2017). The latter dictate lithospheric architectural and tectonic settings, availability of metal sources, and act as temporal triggers for the Mineral System. We will see that there is a near-universal dependence on lithospheric architecture and geodynamic conditions; these are the key elements in the formation of porphyry copper deposits, for example. In addition, magmatic Ni-Cu systems also rely on supercontinent cycles and core-mantle boundary processes, whilst gold deposits rely on low-degree partial melting processes in the mantle. Advances in geoscience over the last 20 years have given us the opportunity to revolutionise our understanding of the continental lithosphere. We are now in a unique position to couple a Mineral Systems approach with a new understanding of lithospheric architecture and geodynamic history, and forge a new frontier in Greenfields discovery.

REFERENCES:
Griffin, W.L., Begg, G.C. and O’Reilly, S.Y. (2013). Continental-root control on the genesis of magmatic ore deposits. Nature Geoscience. Vol. 6, pp. 905-910.
Begg, G.C, Hronsky, J.M.A., Griffin, W.L. and O’Reilly, S.Y., Chapter 1 - Global- to Deposit-Scale Controls on Orthomagmatic Ni-Cu(-PGE) and PGE Reef Ore Formation, In Processes and Ore Deposits of Ultramafic-Mafic Magmas through Space and Time, Elsevier, 2018, Pages 1-46, ISBN 9780128111598, https://doi.org/10.1016/B978-0-12-811159-8.00002-0.

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Laboratory weathering of ore-bearing sulphide minerals: origin of soil-gas anomalies

Plet C[1], Noble R[1], Anand R[1]
[1]CSIRO Mineral Resources

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Chloe is a CSIRO posdoctoral fellow. She has a BSc and MSc in Geosciences from Universite Pierre et Marie Curie (France) and a PhD in Organic Geochemistry from Curtin University, where she studied carbonate concretions, their formation processes and preservation potential for organic matter and fossils. She has a particular interest in cross-disciplinary research.
In her current position at CSIRO, Chloe studies gas production associated with the weathering of ore deposits and aims to improve the use of gases for mineral exploration through cover.

Mineral resources contribute significantly to the economic wealth of Australia with an increasing demand to identify new mineral deposits. However, thick cover (>20 m) blankets much of the Australian landscape, restricting the use of conventional, near-surface geochemical exploration techniques for which efficiency is limited to shallow deposits. In addition, drilling these “geochemically-blind” areas is expensive; as such, development of novel and improved exploration techniques is of great interest.
Previous research on soil-gas pathfinder compounds was conducted in the 1980s but was limited due to analytical resolution. More recently, laboratory and field experiments have had some positive results locating mineralised deposits through cover, but application to mineral exploration requires an improved understanding of gas formation and migration processes. In this research, we aim to develop a foundational understanding on gases produced during the weathering of ore bodies. Ore-bearing minerals and their barren equivalent will be subjected to rapid weathering (heating and oxidizing conditions) in the laboratory. The gases produced will be analysed using gas chromatography.
These analyses will constitute the initial phase of a larger research effort, applying the use of soil-gas analyses in natural mineral deposit environments, to improve the reliability of soil-gas anomalies as pathfinders for the detection of undercover mineral deposits.

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Shale, tight and deep coal gas assessment of the Cooper Basin, Australia

Lech M[1], Wang L[1], Hall [1], **Owens R[1]**, Bailey A[1], Palu T[1], Cathro D[1], Evans T[1]
[1]*Geoscience Australia*

Biography:
Ryan Owens is a geoscientist in Geoscience Australia's Resources Division, Energy Systems Branch. He graduated from the Australian National University in 2007 with a BSc in Geology (Hons). Subsequently he worked in mineral exploration before undertaking a PhD in paleoceanography at the Research School of Earth Sciences, ANU. Ryan joined the Energy Systems Branch in 2015 after completing the Geoscience Australia graduate program and has since been involved in the northern Houtman Sub-basin prospectivity study and the geological and bioregional assessments program.

Geoscience Australia, in collaboration with Geological and Bioregional Assessment Program partners, is improving the understanding of the Cooper Basin's unconventional gas resource potential, and investigating the potential impacts on groundwater, surface water and related water-dependent assets from developing these plays.
The Cooper Basin is Australia's premier onshore conventional hydrocarbon-producing province, but is currently underexplored for unconventional gas resources. Chance of success (COS) mapping was applied, as part of the regional-scale tectonostratigraphic conceptualisation and prospectivity analysis, to map the distribution of the basin's key unconventional plays, including shale gas and tight and deep coal gas for key formations within the Gidgealpa Group. COS criteria identified favourable physical properties, such as lithological compositions, formation depths and extents, source rock and reservoir characteristics and rock mechanics. Mapping and integrating these characteristics have defined the overall chance of success for the individual plays. These maps identify the most prospective areas, in particular the Nappamerri, Patchawarra and Windorah troughs.
The precompetitive COS maps can be used to further target unconventional exploration in underexplored regions of the Cooper Basin, and assist in encouraging exploration investment in the basin. Furthermore, the regional-scale prospectivity assessment can inform any potential for relationships with aquifers in the overlying Great Artesian Basin, and provide the conceptual framework to better understand the potential impacts of shale, tight and deep coal gas development on water and the environment.

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The Northern Australia Geochemical Survey - a potential method for discovering undercover mineralisation

Main P[1], Bastrakov E[1], Wilford J[1], Czarnota K[1], Wygralak A[2]
[1]*Geoscience Australia,* [2]*Northern Territory Geological Survey*

TS7 - 3.1.1 Effective exploration and discovery under cover, Room R2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Philip Main is geochemist working in the Mineral System Branch at Geoscience Australia. He is currently working on the Northern Australia Geochemical Survey, a low-density surface soil project. Philip has a BSc (Hons) from the University of Queensland and has been working at Geoscience Australia since 2014.

Given more than 80% of prospective rocks across Australia are covered by a veneer of younger materials it is imperative that we develop methods to use this material to explore what lies beneath. The Exploring for the Future (EFTF) Northern Australia Geochemical Survey (NAGS) tests the utility of low-density geochemical mapping for mineral exploration, whilst establishing an important environmental background data set, to guide future development and agriculture between Tennant Creek and Mount Isa. The survey targeted overbank stream sediments from large (~500 km2) catchments, over ~505,000 km2, an area highly prospective for copper and basin hosted mineral deposits.

Metal distribution from the survey shows strong regional and geomorphic control with elevated metal contents around Mt Isa and the black soil plains. In order to isolate potential anomalies related to mineralisation we have applied principle component analysis as well as machine learning. This analysis reveals a robust copper Mobile Metal Ion (MMI) anomaly north of Elliot in the Northern Territory. This anomaly is not present in the total digestion data, indicating it is sourced from copper ions adsorbed on the surface of clays, and may indicate anomalous copper is migrating through cover, or from areas up-stream. Our approach could be applied elsewhere to isolate local anomalies from regional/geomorphic controls on metals distribution.

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Paleoceanography and monsoonal history of the Japan Sea over the last 460,000 years

Gallagher S[1]

[1]*The University of Melbourne*

TS7 - 1.3 Marine Geoscience - The evolving oceans/IODP, Room R1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Through my varied consulting and research career, I have had diverse experience in Carboniferous to Recent microfossils, sedimentology & stratigraphy globally, this is the foundation for my successful research at Melbourne University. My most significant contribution to stratigraphy & micropalaeontology is in the application of detailed microfossil analyses to solve stratigraphic problems and to interpret palaeobathymetry & palaeooceanography. I have been heavily involved in IODP activities in the last 10 year and was co-chief on IODP Expedition 356 off northwest Australia in 2015

The Japan Sea is under the direct influence of the Asian monsoon, a system that transports moisture and heat across southeast Asia during the boreal summer, and is a major driver of the Earth's ocean-atmospheric circulation. Foraminiferal and facies analyses of a 460 kyr record from IODP Expedition 346 Site U1427 in the Japan Sea reveal a long term record of nutrient flux and relative oxygenation that varied significantly due to sea level and East Asian monsoon intensity. The East Asian summer monsoon (EASM) was most intense during MIS (Marine Isotope Stage) 5e, 7e, 9e and 11c highstands when the Tsushima Warm Current flowed into an unrestricted well mixed normal salinity Japan Sea. Whereas East Asian winter monsoon (EAWM) conditions dominated glacial phases of MIS 2, 4, 6 and 8 when sea level minima restricted the Japan Sea resulting in low salinity and oxygen conditions in the absence of Tsushima flow. Reduced oxygen stratified, low salinity, higher productivity oceanic conditions characterise terminations TV, TIII, TII and TI when East China Sea Coastal Waters breached the Tsushima Strait prior to Tsushima Current inflow. Comparisons of Site U1427 marine proxies with Chinese loess, cave and Lake Biwa (Japan) proxy records suggest intensification of EASM conditions during low to high insolation transitions whereas the strongest EAWM prevailed during the lowest insolation periods or during high to low insolation transitions.

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Fingerprinting mantle plume activities in the oceanic realm through time

Doucet L[1], Gamal El Dien H[1], Li Z[1], Cox G[2], Mitchell R[1], Kirsher U[1]
[1]Earth Dynamics Research Group, Curtin University, [2]Centre for Tectonics Resources and Exploration (TRaX), The University of Adelaide

TS1 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
PhD in 2012 University of Lyon
2012-2013 Lecturer at University de St Etienne (France)
2013-2016 Research Fellow FNRS & University Libre de Bruxelles
I'm studying the formation and evolution of the Earth lithosphere using petrology, major, minor and trace elements distribution (including water) in the rocks as well as they radiogenic (Hf, Nd, Os) and stable isotopes (O, Zn, Fe).
The main goal of my research is to understand the Earth long term cycles by studying global element transfert that occur during igneous processes.

Large igneous provinces (LIP) are the manifestations of mantle plume activities, i.e. the rise of hot deep mantle materials. Mantle plumes play crucial roles in Earth's tectonic and geodynamic evolution, climatic changes, and mass extinction events. Two competing theories exist about the origin and operation of mantle plumes: (1) the "fixed" model where plumes (or superplumes) are anchored to the core deep in the mantle, and (2) the "dynamic" model where the formation and evolution of plumes and superplumes are link to large scale mantle convection and supercontinent cycles. The current global LIP record appears to show a cyclic nature following that of the supercontinent cycle. However, this LIP record is predominantly a continental record due to the destruction of oceanic LIPs (O-LIP) as part of the oceanic crust for much of Earth's earlier history. Establishing the O-LIP record will enable us to evaluate if LIP intensity in the oceanic realm has remained semi-constant over geological time as some have suggested or followed similar cycles to the continental LIP record. Here we show that O-LIP basalts possess distinct elemental and isotopic compositional distributions that allow us to statistically discriminate O-LIP volcanic rocks from MORB, arc basalts, and continental-LIP basalts. We applied such a filter system to identify O-LIP from the global ophiolite records. Together with the geotectonic and age variations for each such record, we have started to establish a GIS-based global O-LIP record.

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Neoproterozoic sedimentation and Cambrian metamorphism in VanDieland

Moore D[1], Keays R[1], Betts P[1]
[1]*Monash University*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
David Moore has spent many years in industry and the public service providing geological interpretations that integrate the geology with potential field and seismic data. More recently, he completed a PhD on the pre-Carboniferous connections between Victorian and Tasmanian geology, part of which necessitated subdividing western Tasmania into regions with different tectonic histories. The present study attempts to reconcile the Neoproterozoic history of adjacent regions where quite different sedimentary and metamorphic rocks are present.

Prior to the breakup of Rodinia, VanDieland (western Tasmania and associated regions) lay between Laurentia and East Antarctica. The earliest breakup event recorded appears to be the intrusion of mafic dykes and high temperature-low pressure granites on King Island at about 760 Ma. Sedimentation started shortly thereafter. In the Smithton Basin in the Rocky Cape Zone of north-western Tasmania and a second region ~100 km to the southeast, similar sequences are present—a basal conglomerate, followed by a dolomite-chert-black shale unit, then Maranoan diamictite. The Smithton Basin sequence continues upward to shallow to intermediate depth sedimentary rocks and rift tholeiite basalt, and thence to a late Ediacaran dolomite. Deep water turbidite rocks and 730 Ma dolerites of the Burnie Zone lie between the two shallow water sequences, which suggests that the initial extension was concentrated in this area. Younger sedimentation in the Burnie Zone indicates shallowing water depths before returning to deeper water near the end of the Ediacaran, implying a second period of extension.
The Arthur Complex forms the boundary between the Rocky Cape and Burnie zones. This area of Tyennan (Cambrian) blueschist metamorphism includes many unusual lithologies; forward modelling suggests the presence of mafic rocks at depth, rather than the previously suggested granites. We propose that the unusual rocks result from the metamorphism of a sequence that contained Neoproterozoic hematite-rich and evaporite-rich rocks that were metamorphosed in the Tyennan Orogeny. A modern analogue prior to metamorphism might be the Gulf of California region.

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Machine learning: A route to better geoscience models?

Valentine A[1], Sambridge M[1]
[1]Research School Of Earth Sciences, The Australian National University

TS5 - 1.1.2 Optimisation and uncertainties in Earth models, Hall C, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Andrew Valentine completed his DPhil at the University of Oxford under the supervision of John Woodhouse---focussing on global seismology, particularly efforts to quantify and improve the accuracy of tomographic images. He then spent several years as a postdoc in Jeannot Trampert's group at Universiteit Utrecht, The Netherlands, applying machine learning concepts to a range of geophysical problems. In 2016 he joined ANU as Fellow in Seismology and Mathematical Geophysics, and recently received a Discovery Early Career Research Award from the ARC. Andrew's core research focus is the mathematics of inversion and inference, and applications across the spectrum of geoscience.

In order to understand the Earth and its systems, we wish to build, refine and interpret models that can explain observed datasets. Doing so can be challenging: computational costs are often significant, data quality is usually variable, and the available information may not illuminate all aspects of the system under consideration. In these circumstances, we continue to explore new avenues in inverse theory—the mathematics of model-building—and seek strategies for making more effective use of the resources available to us.

In recent years, the terms 'machine learning', 'data science' and 'artificial intelligence' have become commonplace: these concepts underpin a huge fraction of modern technology and commerce. They are enabled by a substantial body of fundamental research in mathematics and statistics, aimed at addressing a question that is familiar to geoscientists: "How do we extract useful information from complex, noisy datasets?". In this talk, I will discuss how this research translates into the Earth Sciences, and show how some of these concepts and tools are enabling new approaches to long-standing geophysical problems.

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Detrital zircon age, oxygen and hafnium isotope systematics record rigid continents after 2.5 Ga

Iaccheri L[1,2], Kemp A[2]
[1]University of Witwatersrand, [2]University of Western Australia

TS6 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Completed my Master degree in petrology in Modena, Italy in 2000. I worked as geotechnical engineer in Italy until the end of 2005 when I moved to Munich, Germany. I joined as researcher the Radiogenic isotope lab at the Ludwig-Maximilians-University (LMU). At the end of 2010 I went back to industry, working as exploration geologist for KNAUF, Iphofen (Germany). In Feb 2013 I moved to Perth, Australia, where I started my PhD project the University of Western Australia, which I completed in 2017. Last October I joined the School of Geociences at the University of Witwatersrand as researcher.

The Neoarchean-Paleoproterozoic boundary is marked by fundamental changes in the composition of the mantle, crust and atmosphere-hydrosphere. The evolution of Earth's deep interior and its exterior are linked, but the causes of the transitions are cryptic. The comparison of the isotopic signatures of magma sources before and after 2.5 Ga may provide insight into the processes driving the secular changes. Here, we present new oxygen and Hf isotope data from detrital zircon grains hosted by Paleoproterozoic metasedimentary rocks of the North Australian Craton, which record three magmatic events at 2.7 Ga, 2.5 Ga and 1.87 Ga. Scattered zircon εHf (+6 to -10) coupled with mantle-like δ18O at 2.7 Ga indicates both new crustal addition and the reworking of older materials. At 2.5 Ga, a range in zircon εHf (+7 to -12) and δ18O (5 to 7‰) reflect reworking of diverse infracrustal and supracrustal components with limited depleted mantle inputs. The εHf array contracts at 1.87 Ga (+3 to -8) and is coupled with heavy δ18O (7 to 9.5‰), indicating reworking of clay-rich supracrustal sources. We attribute the contraction of the zircon εHf array at ca. 1.87 Ga to the melting of a range of Neoarchean crustal components, where the disparate Hf isotope signatures of these were homogenised by sedimentary processes. The shift in magma sources after 2.5 Ga implies a change in the mechanical behaviour of the lithosphere, from soft to rigid. This may have contributed to the transition in the composition of the crust at the Neoarchean-Paleoproterozoic boundary.

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The Development of a National Rock Garden in the Nation's Capital

Smith M[1], Pillans B, Bain J
[1]*National Rock Garden Trust Inc*

TS5 - 5.1 Geology in Society: geotourism and geoheritage & 5.6 Diversity in the Geosciences, Room R8, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Michael Smith is the Chair of the Finance Subcommittee of the Steering Committee of the National Rock Garden Trust Inc and a director of the National Rock Garden Trust Inc. He is employed as General Manager Exploration at Austpac Resources NL and has over 40 years experience in mineral exploration for a wide range of commodities in Australia and internationally. He is a Registered Professional Geoscientist in Geophysics & Mineral Exploration. His society affilliations are FGSA, FAIG and Honorary MASEG.

The National Rock Garden (NRG) will be a globally unique facility providing a stimulating display of large iconic rock specimens adding a unique educational facility near existing scientific establishments. The NRG.is located on the western foreshore of Lake Burley Griffin below the National Arboretum.

The NRG was launched in 2010, officially gazetted as a national monument in 2011 and eight Federation Rocks displayed in 2013 during the Centenary of Canberra celebrations. Two rocks were added in 2016 and 2018. The Federation Rocks, and a growing list of additional specimens, will help potential sponsors and donors to appreciate the longer-term goals of the NRG, as we will need to raise substantial funds to develop the whole site.

Our vision for the NRG is an accessible facility celebrating the geological heritage of Australia by displaying numerous outstanding rocks in a park-like setting. Each rock will have a plaque, to explain its significance, and there will be digital linkages to deliver information for each rock at various technical levels. A primary consideration, in choosing the rocks, is that they will tell interesting stories of national significance that will appeal to a wide public audience, especially school children.

Landscape architects Taylor-Cullity-Lethlean developed a 2014 masterplan with the 'wow' factor to further excite people about rocks. Key elements include: entry structure, enclosed education pavilion (allowing children to receive an initial overview of the purposes of the NRG), rock gallery, amphitheatre, time wall, gorges and geological walks. Architects Tonkin-Zulaikha-Greer supplied design/costing of the education pavilion.

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Mantle stress perturbations during the seismic cycle of oceanic transform faults

Chatzaras V[1], Tikoff B[2], Kruckenberg S[3], Titus S[4], Teyssier C[5], Drury M[6]

[1]University Of Sydney, [2]University of Wisconsin-Madison, [3]Boston College, [4]Carleton College, [5]University of Minnesota-Twin Cities, [6]Utrecht University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Dr. Vasileios Chatzaras is Lecturer in Geology in the School of Geosciences at the University of Sydney. He joined the University of Sydney in 2018, following 5 years of postdoctoral research experience in USA (University of Wisconsin-Madison, Boston College) and Europe (Utrecht University). His research interests include the links between lithospheric rheology and plate tectonics, transient deformation in plate boundaries, formation and evolution of the oceanic lithosphere, tectonic evolution of metamorphic terranes, as well as regional tectonics of eastern Mediterranean and southwest Pacific.

Studying lithosphere as an integrated system is critical for understanding the dynamics of faulting and the seismic cycle. Mantle strength is thought to control the tectonic loading of major fault systems. In the oceanic lithosphere, geological studies have been unable to provide direct evidence of earthquake-related deformation at ambient upper mantle conditions, while our understanding of the seismic cycle of oceanic earthquakes is limited by the scarcity of offshore geodetic observations near major structures. We have studied the Bogota Peninsula shear zone, New Caledonia, a unique exposure of an oceanic transform fault exhumed intact from upper mantle depths. We document micro-slip zones that formed at temperatures of 800°C during transient events of elevated stress within the fault zone. Transient creep along the micro-slip zones is induced by flow stresses of 22–48 MPa, which are up to four times higher than the stresses related to steady state creep in the oceanic transform fault. Olivine crystallographic preferred orientations indicate that melt-assisted slip may have taken place in the micro-slip zones. These data suggest that creep along the micro-slip zones occurred during transient events of elevated stress, associated with earthquake-related deformation in the upper mantle. The observed structures and estimated stresses exhibit that both seismic and aseismic slip along oceanic transform faults occur at significantly lower stresses compared to those suggested by theoretical lithospheric strength profiles (>100 MPa). Our data provide an explanation for the normal static stress drops (2–20 MPa) associated with ordinary frictional sliding in oceanic transform faults.

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Emplacement and unroofing of the Ladakh batholith: implications for the evolution of the trans-Himalayan magmatic belt

Zhou R[1], Aitchison J[1], Lokho K[2], Sobel E[3], Seward D[4], Stojanovic D[1], Feng Y[1], Zhao J[1]

[1]School of Earth and Environmental Sciences, The University of Queensland, [2]Biostratigraphy Group, Wadia Institute of Himalayan Geology, [3]Institute of Earth and Environmental Science, University of Potsdam, [4]School of Geography, Environment and Earth Sciences, Victoria University of Wellington

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Renjie Zhou joined the Earth Science faculty at The University of Queensland as a lecturer in 2018. He studies orogenic systems through basin analysis and multi-system geochronology and thermochronology. He currently works in the Himalayan and central Andean mountains and has collaborative projects in Eastern Australia. Renjie Zhou specializes in thermochronology, particularly in the fission track methods, with current laboratory activities on both fission-track and laser ablation dating methods.

The trans-Himalayan magmatic belt is a 2500 km long zone that hosts melts generated along plate boundaries in the course of Tethys Ocean closure and India-Eurasia collision. During the ongoing collision, the trans-Himalayan batholiths were uplifted and exhumed to the surface as multiple stages of dike intrusion took place. This study focuses on the Ladakh batholith of NW India, one of the most prominent mountain ranges in the western Himalaya. To the west, the Kohistan intra-oceanic arc developed during the Early to Late Cretaceous. To the east, the Gangdese arc is dominantly continental and dated to as young as the Eocene. We report results from field and petrographic observations, zircon U-Pb geochronology and Hf isotopic analysis, zircon and apatite fission-track thermochronology, and apatite U-Th/He thermochronology from granodiorites and intruding dikes from the southern Ladakh range. A phase of dike intrusion was identified based on zircon U-Pb ages of ~40 Ma with $\varepsilon Hf(t)$ values of ~2-12. Zircon fission-track ages of ~ 50-55 Ma and ~30-40 Ma were obtained for plutonic rocks and intruding dikes, respectively. Finally, ~25-30 apatite fission-track ages were obtained with bimodal track length distribution, implying a phase of re-heating to the ~120-60 °C temperature range. To our knowledge, this study provides the youngest reported zircon U-Pb age from the Ladakh batholith, refining its history of igneous activity. A suite of low-temperature thermochronometers from both dikes and granodiorites provide an excellent means for constraining the emplacement depth for the dikes and the overall exhumation history of the Ladakh range.

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Provenance study and the first radiometric age constraints on the Indus molasse in the India-Eurasia collision zone

Zhou R[1], Atichison J[1], Lokho K[2], Sobel E[3], Stojanovic D[1], Feng Y[1], Zhao J[1]

[1]School of Earth and Environmental Sciences, The University of Queensland, [2]Biostratigraphy Group, Wadia Institute of Himalayan Geology, [3]Institute of Earth and Environmental Science, University of Potsdam

TS7 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Renjie Zhou joined the Earth Science faculty at The University of Queensland as a lecturer in 2018. He studies orogenic systems through basin analysis and multi-system geochronology and thermochronology. He currently works in the Himalayan and central Andean mountains and has collaborative projects in Eastern Australia. Renjie Zhou specializes in thermochronology, particularly in the fission track methods, with current laboratory activities on both fission-track and laser ablation dating methods.

Continental deposits in the Indus-Yarlung Tsangpo suture zone contain critical information regarding the India-Eurasia collision and rise of the Himalaya. In NW India, the Indus Group, a suite of ~NW-SE striking and fault-bounded sedimentary units, outcrops along the Indus River, defining the Indus suture zone that separates the Indian Plate to the south and the Lhasa Block and Karakoram Terrane to the north. The Indus molasse outcrops along the north edge of the Indus Group and is in contact with the Ladakh batholith. We report field and laboratory investigations into the Indus molasse focusing on several key issues that are in debate or under-explored, including its radiometric age, contact with the Ladakh batholith, and sediment source regions. Our work clarifies that the contact between the molasse and batholith is primarily depositional but might be locally faulted. In our study area, an inferred ~SW-dipping thrust fault carries the finer grained Temisgang Formation onto the top of the molasse. Detrital zircon U-Pb dating reveals three major age ranges: ~75-85 Ma [εHf(t): ~ 5 to 15], ~45-70 Ma [εHf(t): ~ 3 to 17], and ~23-25 Ma [εHf(t): ~ -2 to -10]. The youngest age population, with a weighted mean age of 23.7 Ma, provides the first radiometric age constraint on the Indus molasse and revises the previous thought for an Eocene deposition. Multiple provenance data, including clast compositions, zircon and apatite geochronology and compositions, allow us to further explore the sources of the molasse in the context of continent-continent collision and mountain growth.

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Groundwater and Critical Zone Science: Innovation and Transformation

Lawrie K[1], Brodie R[1], Symington N[1], Christensen N[2]
[1]Geoscience Australia, [2]Aarhus University

TS5 - 3.3.2 New groundwater technologies and approaches & 3.3.5 Groundwater science for policy development and decision making, Room R5, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Ken Lawrie is Director, Groundwater Science Innovation, in Geoscience Australia. Ken has a PhD in structural and economic geology from Glasgow University, and over 35 years' experience internationally in geoscience research for the minerals, environmental and petroleum sectors. Ken joined Geoscience Australia in 1995, and since 1998 has led multi-disciplinary teams developing innovative geoscience approaches for more rapid and cost-effective mapping, characterisation, assessment, monitoring and management of Australia's groundwater systems.

Our ability to understand, predict and manage complex Earth systems and dynamics is being transformed by a range of new high-resolution satellite, airborne, ground and borehole geophysical sensors, and supercomputing research infrastructure. These are complemented by novel mathematical and statistical approaches, including machine learning, that are critical for data acquisition, processing, fusion, analysis and quantitative modelling of Earth systems in a 'big data' environment. These advances in the research ecosystem are transforming science workflows, and are an important catalyst for significant science innovation through inter-and trans-disciplinary methods. These advances are already delivering important new insights into critical zone processes, including the crustal and mantle influences on Australia's landscapes and hydrological systems. This talk will highlight how this new research ecosystem is being applied to the understanding of Australia's hydrological systems and tectonic/landscape evolution more broadly, and will discuss some of the knowledge and research opportunities that will enable the re-envisioning of Australia's water supplies.

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Decadal Plan for Geoscience: Our planet, Australia's future - A decade of transition in Geoscience

O'Reilly S[1]
[1]*Macquarie University*

TS1 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Professor Suzanne O'Reilly, AM, FAA, FGSAus, FMSA, DHC(Lyon), is Distinguished Professor at Macquarie University Director of the ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS; www.CCFS.mq.edu.au) and the associated GEMOC National Key Centre and an ISI Highly Cited Researcher. Her research (>350 refereed papers) spans basalt geochemistry, the composition and evolution of the upper mantle, the relationship between the continental crust and lithospheric mantle, and integration of information across the discipline boundaries of geophysics, geochemistry, tectonics and geodynamics. Recent research includes global dynamics and the relationships between lithospheric evolution in different tectonic regimes, mantle fluids and mineralisation.

Context: The overarching challenge for geoscience in the coming decade is to develop predictive power about how our planet will behave, how it will respond to our actions, and where to explore for critical resources. In solving this first-order challenge, geoscience will develop enormous capabilities with regard to key societal issues: food and water sustainability, our future mineral/energy resources, and our ability to deal with geohazards. It will increase our ability to maintain the safety, security, wealth, and well-being of Australia.
To achieve this ambitious goal we must take a strategic approach to geoscience research. The strategy should lead to increased investment in infrastructure, strengthening of traditional geo-skills, better capability in numeracy, and better integration skills. By addressing research questions of much larger complex-system scope, geoscience will be able to solve predictive problems that were previously intractable.
The process and result: This second Decadal Plan for Geoscience was prepared by the Australian Academy of Science National Committee for Earth Science; it presents the outstanding strategic imperatives for Geoscience for the next decade, identifies the key challenges, and identifies necessary approaches and critical infrastructure. The formulation of this Decadal Plan has relied on wide exposure at different steps through the process, including town-hall sessions at conferences, workshops and GSA Meetings. An early survey elicited over 700 responses, which were crucial in shaping the Plan. An exposure draft that was widely circulated in late 2017 informed a revised version. Finally, focus group meetings in early 2018 resulted in the final Plan.

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A New Technique in Dating Proterozoic Shear Zones: In-situ Rb-Sr dating of Umm Farwah Shear zone, Arabian Shield using LA-QQQ

Redaa A[1], Ahmed A[2], Collins A[1], Farkas J[1]
[1]The University Of Adelaide, [2]King Abdulaziz University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Ahmad Reda is a lecturer at King Abdulaziz University. He received a MCs degree from King Abdulaziz University in 2014, and he is now a PhD candidate at the University of Adelaide. His PhD project aims to develop in-situ dating technique of Rb-Sr and K-Ca by using Triple quadrupole inductively coupled plasma mass spectrometry ICP-QQQ.

Rb-Sr dating system is a powerful geochronological tool to constrain the time of magma crystallisations and the time of metamorphism that associating regional tectonic event. A new development of triple quadrupole inductively coupled plasma mass spectrometry (QQQ-ICP) technique made the in-situ Rb/Sr dating possible, and it was applied, in this study, to constrain timing of the Au-bearing Umm – Farwah Shear Zone by dating a greisen deposit and a sheared diorite unit allocated within the shear zone. The shear zone is extended about 200 km N – S along the southern part of the Arabian Shield, Saudi Arabia. An Agilent 8900 ICP-QQQ attached with an ASI RESOlution ArF 193µm excimer laser system was used to analyse the Rb and Sr isotopes. The N_2O gas (5% total flow) was used for online chemical separation, and about 99% of the Sr shifted to SrO+. The size of laser spots was 74 µm, and the ablation period was 84 seconds. The obtained Rb-Sr isochron age of the greisen deposit is 649 ± 36 Ma whereas the age of the diorite unit is 653 ± 39 Ma. These ages reflect the timing of the shear zone formation as the greisen deposits generally associate the fluid, and in this case, the metamorphism can be the source of fluid. In addition, the acquired age of the diorite may represent the resetting age during the metamorphic event. In conclusion, the in-situ Rb-Sr dating technique using the LA-QQQ is feasible for dating Proterozoic mineralised shear zone.

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Antipodean fugitive terranes in Laurentia and how Proterozoic Australia built the American west

Gibson G[1], Champion D[2]
[1]Australian National University, [2]Geoscience Australia

TS6 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
George Gibson graduated from the universities of Edinburgh and Otago where he undertook petrological and structural studies on high grade metamorphic rocks. After several years as an academic at the universities of Melbourne and Southern Queensland, he joined Geoscience Australia where he served as project leader for the Broken Hill Exploration Initiative and Predictive Mineral Discovery CRC on Mount Isa. He is a former theme leader (Geodynamics) for UNESCO's IGGP and for the last four years he has been a visiting fellow at ANU. He is a member of the geological societies of London, America, Australia and New Zealand.

Variably deformed basinal sequences of late Paleoproterozoic-early Mesoproterozoic age and shallow to deep water origin occur widely throughout northern and southern Australia and preserve a common 160 Myr history of intracontinental rifting, bimodal magmatism and low pressure-high temperature metamorphism linked to subduction retreat and lithospheric thinning in a backarc extensional environment. Backarc extension occurred in the overriding plate of a west-dipping subduction zone and progressed from west to east, culminating in the separation of one or more magmatic arcs from Proterozoic eastern Australia. A comparable history of backarc extension and bimodal magmatism has been reported in the 1800-1640 Ma Mojave, Yavapai and Mazatzal terranes of southern Laurentia. As with their Australian counterparts, bimodal magmatism in these three terranes was accompanied by low pressure-high temperature metamorphism and took place in an upper plate subduction-related setting, strongly suggesting that Laurentia was either proximal to eastern Australia at this time and shared a common convergent plate margin or that these three terranes have Australian affinities and originally split off from eastern Australia. Near-identical Nd model ages (2.2-2.4 Ga) for continental basement beneath these terranes and eastern Australia are consistent with either interpretation as is the observation that basement is intruded ≥ 1840 Ma granites. Basaltic rocks in eastern Australia were emplaced into progressively deeper water from 1790-1655 Ma and most likely evolved in a western Pacific-style marginal marine basin that mirrors depositional and tectonic conditions in basins hosted by the Mojave terrane. An Australian origin for at least this terrane is inferred.

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Long lived supercontinent Nuna revised – updated paleomagnetic constraints from Australia

Kirscher U[1], Mitchell R[1], Liu Y[1], Li Z[1], Cox G[2], Pisarevsky S[1]
[1]Curtin University, Perth, [2]University of Adelaide

TS2 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Undergraduate and PhD at LMU, Munich, Germany
since 2016 post-doc at Curtin University Perth

We present new paleomagnetic results from two sets of Australian sills with intrusion ages coinciding with the proposed formation and breakup periods of the supercontinent Nuna. Paleomagnetic analysis yield two well defined paleopoles for the ~1.8 Ga Hart Dolerite and the ~1.3 Ga Derim-Derim sills. Comparison with other paleopoles from Nuna, mainly from Laurentia and the North China Craton (NCC), reveals a high degree of similarity, which led us to construct a common apparent polar wander path (APWP) for an updated core of Nuna between 1.8-1.7 Ga and 1.3 Ga, consisting of Laurentia, Siberia, Baltica, proto-Australia and the NCC. A striking feature of this APWP is an overall steady but slow rotational movement of the supercontinent. Superimposed, a much more rapid and irregular polar wander is visible. Based on the most recent paleomagnetic pole list, the breakup time for Nuna can be constrained between ~1.3 and ~1.2 Ga, manifested in relative motion between Laurentia, Australia and North China. We suggest an initial proto-SWEAT connection between Laurentia and Australia between 1.8 and 1.75 Ga, followed by a modified Nuna configuration for the 1.63 –1.3 Ga period. Nuna likely remained intact till ca. 1.3 Ga, when a broad intracontinental basin, bounded by Australia, the NCC and potentially Siberia, existed. Anisotropy of magnetic susceptibility suggests that the same magmatic event likely produced the Derim-Derim Sills and the Galiwinku dykes in Australia, and the Yanliao large igneous province in the NCC, originated from underneath the broad intracontinental basin.

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Geotourism and the Digital Age

Moule K[1]
[1]*Global Gbm*

TS5 - 5.1 Geology in Society: geotourism and geoheritage & 5.6 Diversity in the Geosciences, Room R8, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Ken is a geologist with a background in Mineral Exploration, specialist experience in computer applications in mining and a passion for Geotourism.

We hear of Uber and Airbnb, but sometimes forget these are just two examples of how the digital revolution is transforming our economy. The revolution destroys traditional business models while creating opportunities for those who embrace change. Our challenge is to position Australian Geotourism as one of the great winners of this age.

The internet builds informed consumes who research their passions from their lounge rooms. E-commerce empowers them to bypass the middleman and transact directly with their chosen service provider. In tourism, that levels the playing field against heavily promoted capital-intensive attractions like theme parks and mega resorts in favour of low key encounters with nature.

In this globalised world, success comes to those suppliers whose product is either cheaper than the competition or unique. Relative labour rates and capital scarcity make it difficult for rural Australia to compete with those fancy hotels in Asia. But we can deliver unique experiences in spades and leverage those to attract visitors, create employment and drive our economy.

With our enormous land areas, geological diversity and exotic wildlife we have more geotourism potential per head of population than any nation on earth. Our challenge is to capitalise on these unique resources.

This presentation will explore the tools of the digital age to develop Australia's geotourism potential. We will look at unique opportunities to harness social media and to consolidate internet presences across our multiple geotourism projects to create the critical mass we need to demonstrate leadership in world tourism.

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Interactions between tectonics and surface processes during rifting and passive margin development: The structural evolution of the North West Shelf

Beucher R[1], Moron S[1], Moresi L[1], Farrington R[1], Salles T[2], Rey P[2], Brocard G[2], Giordani J[2], Mansour J[2]
[1]The University of Melbourne, [2]The University of Sydney

TS1 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Romain Beucher is a research associate at the University of Melbourne where he works on the interaction between tectonics and surface processes as a member of the ARC Research Hub for Basin Geodynamics and Evolution of Sedimentary Systems (Basin GENESIS Hub) . He holds a PHd in Geology / Geophysics from the University of Grenoble where he studied the Neogene evolution of the European Alps using tectonic analysis, low-temperature thermochronology and seismotectonic analyses. Romain is an experienced user / developer of geodynamics and surface processes numerical models which he uses to understand the structural evolution of geological systems.

We present numerical experiments coupling a 3D lithospheric-scale thermo-mechanical model (Underworld) with a plan-form 2D surface processes model (Badlands) to investigate the interactions between tectonics and surface processes during rifting and the development of passive margins. Numerous studies have emphasized the roles of the composition and thermal state of the lithosphere on the style of extension. However, while the prevalence of sediment deposits and evidence of the removal of several kilometres of material onshore point to the importance of surface processes across passive margins, very few attempts have been made to model and quantify how erosion, transport and deposition processes modulate the evolution of rift systems.

Our models show that the topography is strongly controlled by the rheology of the lithosphere and its integrated strength with depth. However, efficient erosion resulting from high erodibility and/or favourable climatic conditions can counter the tectonic uplift. Transfers of mass from sub-aerial domains to basins significantly influence the stress field across faulted domains both syn- and post- rifting. It also delays the development of new faults as existing faults stay active for longer and accommodate more displacement.

We show that the interaction of tectonics, erosion and sedimentation account for the complex structural evolution of the North-West Shelf Australia, from distributed to localized extension. We propose that changes in topographic gradient due to sedimentation can trigger flow in the lower crust from below the basin. This can strengthen the lithosphere and result in more localized extension though time, explaining the observations made in the NWS.

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New insights into volcanic eruption triggers from trace element zoning in clinopyroxene

Ubide T[1], Kamber B[2]
[1]The University of Queensland, School of Earth and Environmental Sciences, [2]Trinity College Dublin, Department of Geology

TS6 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Teresa Ubide is a Lecturer in Igneous Petrology/Volcanology at the University of Queensland (Brisbane, Australia). She completed her BSc, MSc and PhD studies at the University of Zaragoza (Spain, 2013) and VU University Amsterdam (The Netherlands) and held a Research Fellowship at Trinity College Dublin (Ireland, 2014-2016) before moving to Australia in July 2016. She combines detailed petrological observations with state-of-the-art analytical techniques to better understand how magmatic systems work. She is particularly interested in constraining why, where and when volcanic eruptions start

Crystals formed prior to volcanic events represent unique archives of magmatic histories and provide valuable timescales of eruptive processes. Clinopyroxene crystallises at a broad range of depths and magmatic water contents, and slow chemical diffusion preserves protracted magma histories. High-resolution trace element maps of clinopyroxene, obtained with laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), provide detailed insights into eruption triggers and timescales. This contribution focuses on Mount Etna (Sicily, Italy), one of the most active volcanoes on Earth, with enhanced eruptive activity since the 1970s.

Clinopyroxene zoning in lavas spanning 40 years of eruptive activity (1974-2014) reflects punctuated episodes of invasion of primitive, undegassed magma into resident crystal-melt mushes, recorded as zones enriched in chromium and other transition metals. Statistical analysis of zoning shows that magma was not effectively stirred. Instead, fresh injections appear to have triggered mobilisation and eruption from a main reservoir at ca. 10 km depth. Considering clinopyroxene growth rates, the time elapsed between recharge and eruption may be as short as ca. 2 weeks, in agreement with previous minimum estimates from diffusion chronometry in olivine as well as earthquake and gas monitoring data.

Trace element zonation distinguishes between injections of mafic magma and regular recharges with more evolved magma, which often fail to tip the system to erupt. High Cr clinopyroxene zones can be used to reconstruct past eruption triggers and inform responses to geophysical signals of volcanic unrest, potentially offering an additional approach to volcano hazard monitoring in basaltic to intermediate systems.

Why are we still mining coal?

Green D[1]
[1]*Green Exploration & Mining Services PL*

TS6 - 3.2.2 Energy from coal, Room R2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
David has worked as a coal geologist in Queensland industry for more than 35 years, of which 22 years has been running his own consulting business. This included working for various companies in exploration, tenure and data management, resource evaluation and working at operating mines, as well as undertaking geological reviews of projects in Indonesia, Mongolia, and Canada.

For the last 3 years he has been the Coal Geoscience Manager with the Geological Survey leading a team evaluating the current and future coal resources in Queensland.

David is also the current Chair of the Bowen Basin Geologist's Group.

In today's society, coal has been demonised and has a poor image. Fossil fuels are blamed as a major cause of climate change. Coal mining is presented as a destroyer of land, water and livelihoods. So why do we still mine it?

Coal is essential to create steel and still provides nearly 40% of the world's energy. Yet there is a general lack of understanding about the scale of coal use, the different types of coal, the economic benefits, and the developments made to improve its performance and reduce its environmental impact.

All countries need steel for infrastructure development. There is currently no alternative to the use of metallurgical coal for making steel.

There are still hundreds of coal fired power stations under construction globally and more ready to be started. These new electricity generators are more efficient, have reduced emissions and will operate for more than 50 years. Whilst there is some replacement of coal power generation with renewables, developing nations still see coal as the most economic and reliable means to deliver electricity to hundreds of millions of people who currently have none.

Increased development of underground mining will reduce surface impacts and improvements in rehabilitation methods will enable improved future land use.

New technologies may require carbon and other minerals which may exist within coal measures.

Coal mining will be needed for many decades to come to provide the essential elements to develop and maintain our modern way of life.

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Characterising wetlands and groundwater dependent ecosystems in Australia's north using Digital Earth Australia

Dunn B[1], Lymburner L[1], Newey V[1], Evans T[1], Carey H[1], Lai E[1], Dixon-Jain P[1]
[1]*Geoscience Australia*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Bex Dunn is an early career landscape scientist at Geoscience Australia, where she is currently working on Digital Earth Australia (DEA), identifying new methods to combine Earth Observations data streams with other gridded datasets to quantify the dynamics of land cover, surface water and the coastal zone.

Digital Earth Australia (DEA) is a key piece of public data infrastructure that uses images and information recorded by satellites orbiting our planet to detect physical changes across Australia in unprecedented detail. Landsat 5, 7 and 8 'analysis-ready' data are currently available within DEA, where the raw satellite data have been corrected and orthorectified to enable easy interrogation of data across sensors. Geoscience Australia is developing techniques for analysing the data within DEA to identify wetlands and groundwater dependent ecosystems across northern Australia. These techniques include summarising observations of 'wetness' acquired over 30 years and linking these observations to gridded rainfall measurements to identity waterbodies and wetlands that persist during periods of low rainfall.
These wetness summaries have been shown to correspond with known spring complexes in the Carmichael River catchment in Queensland, and have been used to improve the understanding of groundwater discharge processes within basalt provinces in the Upper Burdekin region in Queensland.

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The response of the Great Barrier Reef to major environmental changes: lessons from geologic past.

Webster J[1]
[1]*University Of Sydney*

TS6 - 1.3 Marine Geoscience - The evolving oceans/IODP, Room R1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Jody Webster's research in sedimentology and stratigraphy focuses on carbonate sedimentology, climate change, and tectonics and it tends to take him to all the beautiful places in the world (e.g. the Great Barrier Reef, Tahiti, Hawaii, Papua New Guinea, Seychelles, Brazil).

Jody is particularly interested in coral reef and carbonate platform systems, both modern and ancient, and their associated sedimentary systems; as tools to address fundamental questions in paleoclimate variability and tectonics, and in turn the influence of these factors on the geometry, composition and evolution of these sedimentary systems.

Predicting how the Great Barrier Reef (GBR) will respond in the face of future global climate changes is both poorly constrained and controversial. This relates to our incomplete understanding of how reef systems respond to environmental changes but also the lack of baseline data — particularly on centennial to millennial time scales. The recent declines in coral coverage across much of the GBR, combined with the potential from year-on-year mass coral bleaching, has brought these issues around reef resilience into sharp focus. The study of fossil coral reefs that grew over past 130,000 ka can provide unique insight about how reef systems respond to abrupt and major environmental changes. Working with the International Ocean Discovery Program (IODP), we collected fossil coral reef cores on Expedition 325 from the edge of continental shelf of the GBR, in water depths between 50 to 130 m. Analysis of these and other cores collected from the GBR is now revealing exciting information about past sea level and climate changes but also crucial new insights into how the reef responded to these perturbations. In this seminar, I present a synthesis of all available geomorphic, sedimentologic, biologic, geochemical and dating information and discuss the nature and timing of the reef initiation and demise events, while documenting the corresponding changes in coral-algal assemblages, vertical accretion rates and paleoenvironmental conditions at each stage of the GBR's development.

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Palaeomagnetic rotations in the Tasmanides

Musgrave R[1,2], Job K[3,4], Roach M[3], Meffre S[3]
[1]Geological Survey of NSW, [2]Institute for Frontier Geoscience, University of Newcastle, [3]University of Tasmania, [4]Westgold Resources

TS2 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Bob Musgrave is a senior research scientist at the Geological Survey of NSW, with interests in palaeomagnetism applied to tectonics, magnetic petrophysics, and potential-field interpretation ad modelling. His career spans palaeomagnetic research throughout the western Pacific, more than 25 years of involvement with IODP, and academic positions at La Trobe and Monash universities. Bob set up and manages the PALM palaeomagnetic and petrophysical laboratory at the University of Newcastle.

Several recent tectonic models for the Tasmanides have invoked vertical-axis rotations, expressed either as oroclines or as more localised rotations of blocks or terranes. Palaeomagnetic declination records rotation, but few reliable palaeomagnetic data are available from the Tasmanides, and their interpretation is disputed. A joint study by the University of Tasmania and the Geological Survey of NSW aims to test models of oroclinal and terrane rotation in the Lachlan and Delamerian orogens, and having established the larger framework, also identify and quantify local tectonically driven block rotation. A pilot study in Tasmania, examining proposed oroclinal curvature in the Cambrian to early Devonian Dundas–Fossey Trough, recognised a characteristic remanence carried by magnetite, which was overprinted by a steeply inclined, normal polarity component carried by hematite. Declination of the characteristic remanence correlates with regional strike, thus passing the palaeomagnetic orocline test, and additionally suggests an earlier phase of rotation during the mid-Cambrian. The overprint appears to have been acquired during the same late Cretaceous heating and uplift event that has been invoked as the cause of similar widespread overprints in eastern Australia, and may be linked to a proposed origin for opal in the Great Artesian Basin. First results from a pilot study in the east Riverina area in the Lachlan Orogen have indicated a similar record of remanence in magnetite overprinted by hematite in Bendoc Group siltstone. A mean direction from the Bendoc Group and Temora Volcanics indicates little post-Ordovician rotation in the southwestern part of the Macquarie Arc.

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UNCOVER Australia: a trillion dollar prize

McFadden P[1]
[1]*Australian Academy of Science*

TS1 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Phil McFadden, AO, FAA had a long career in frontline geophysics research and is an author of the standard postgraduate level textbooks on geomagnetism on palaeomagnetism. During his position of Chief Scientist at Geoscience Australia, he led the team initiated and designed the Australian Tsunami Warning System. He subsequently became a national leader in promoting the importance of Geoscience knowledge, research and applications for societal benefit. Among many other voluntary activities, he drives the Australian Academy of Science UNCOVER Australia initiative, provides strategic advice to scientific organisations and to government on research and innovation, and is a photography enthusiast.

Global demand for non-bulk minerals to support high-tech industries and the renewable energy transition is projected to explode over the coming decades. Based on known reserves and current exploration technologies, Australia will not be able to meet existing demand (worth at least a trillion dollars by 2030) let alone capitalise on its growth.

We urgently need to look deeper, to the three-quarters of Australia that is covered and inaccessible to existing prospecting technologies. The one-quarter of our continent that is uncovered has generated hundreds of billions of dollars and provided jobs in exploration, mining and the associated services industries. The remaining three-quarters of our continent is our unclaimed prize.

The Australian geoscience community has united to meet this shared challenge with the sense of urgency that it demands. UNCOVER Australia is a nationally coordinated, collaborative refocussing of geoscience research and data acquisition effort across the exploration and mining industry, government agencies and the geoscience research community, that also seeks disruptive innovation from other sciences. Working with AMIRA, it has developed an Industry Roadmap identifying the targeted geoscience research and data acquisition needed to unlock Australia's hidden resource potential.

Past public investment in surface-mapping yielded spectacular results that allowed industry to develop our mineral riches. The remaining three-quarters of our continent—a trillion dollar prize—represents a new and different smart-prospecting mode to a genuine knowledge-based, science-driven exploration process.

This is an opportunity Australia cannot afford to miss.

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Access to hazard and risk information to underpin decision-making

Sexton J[1], Hazelwood M[1], Hay R[1], Edwards M[1]
[1]*Geoscience Australia*

TS2 - 4.4.3 Geoscience data delivery & 4.4.2 Understanding the Surface, Room R7, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Jane Sexton joined Geoscience Australia in 2005 to work collaboratively with Australian Government agencies to manage tsunami risk. Since then, Jane has contributed to the development of a range of modelling tools that can be used for natural hazard risk management. Prior to starting with Geoscience Australia, Jane worked with the Defence Science and Technology Organisation (DSTO) applying a variety of modelling approaches to support defence acquisition and operations projects

Understanding risk is a key tenet of the National Disaster Resilience Strategy and inherent to this is the discoverability, accessibility and availability of authoritative risk data and information. Access to this data and information is critical to support decisions relating to land use or infrastructure planning and is required both before decisions are made and at a future date when investment is required to mitigate any created or residual risk. The communities affected by these decisions also require the risk data and information so they can understand the hazard and risk and make decisions accordingly.

Here, we showcase a suite of risk data and information developed by Geoscience Australia that can support land use and infrastructure planning decisions. Since 2009, GA has released all data and information using the Creative Commons Attribution Licence (now using CC BY 4.0 International). This recognises the investment made by the Australian Government in the development of the data and information and the value it can serve to a range of stakeholders in government, industry, academia and the public.

We contrast this approach with the case-study of the National Flood Risk Information Project where procurement practices of flood hazard and risk data and information have failed to deliver on the requirement to improve the community's understanding of flood hazard and risk. We show how these challenges can be overcome so that decisions (for example in land use and infrastructure planning) can be made to minimise risk to the Australian community.

Reassessing the potential threat of submarine landslide tsunamigenesis for Fiji's capital (Suva), from existing coastal boulder evidence

Lau A[1], Terry J[2], Ziegler A[3], Pratap A[4], Harris D[1]
[1]School of Earth and Environmental Sciences, The University Of Queensland, [2]Department of Environmental Sciences, Zayed University, [3]Department of Geography, National University of Singapore, [4]School of Geography, Earth Sciences and Environment, University of the South Pacific

TS4 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Annie Lau is a Lecturer in Physical Geography at the School of Earth and Environmental Sciences (SEES) in the University of Queensland after receiving her PhD from Singapore (NUS) in 2016. She is interested in Quaternary climatic and environmental changes, coastal geomorphology and the sedimentary signatures of natural hazards. Her work focuses on coastal changes in high-magnitude storm and tsunami events, as well as the use of sedimentary deposits to reconstruct millennial-scale coastal hazard history and climate variability for guiding emergency and coastal management decisions in Asia-Pacific.

Wave transported coastal boulders are one of the proxies that improve our understanding of both tsunamis and tropical cyclones for predicting potential future hazard impacts. While many boulder fields formed in modern high-energy events have been analysed in depth to provide analogues for interpreting earlier counterparts, there remains a lack of research on deposits produced by landslide-generated tsunamis in particular. Here we present for the first time detailed characteristics of a reef-top boulder field created by a major local submarine landslide tsunami near Fiji's capital city, Suva (the 1953 Suva tsunami). Examination of large reef-derived boulders revealed that the 1953 tsunami flow velocity exceeded 9 m/s at the reef edge. Prior research has demonstrated how headward retreat of the submarine Suva Canyon was a response to repeated earthquake occurrence in the past. Our new results suggest that tsunamis and subsequent storms appear to have produced and remobilised boulders. This highlights the lingering vulnerability of this Fijian coastline to high-energy waves generated either in the presence or absence of submarine failures and/or earthquakes. The boulder distribution confirms that shorter-than-normal-period tsunami waves generated by submarine landslides would create a boulder field resembling typical storm boulder fields, due to relatively short transport distances. The Suva boulder field can be used as a reference set in identifying possible prehistorical local submarine landslide tsunami occurrences elsewhere. It will be particularly useful for comparison with other tropical Pacific island coasts where submarine slope failures are relatively common but associated past hazards not well documented.

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Cambrian Series 3 and 4 faunas from Northern Victoria Land, Antarctica: a summary

Jago J[1], Cooper R, Bentley C
[1]University Of South Australia

TS5 - 2.6 Geobiology & 2.8 Earth, life and ores, Room R1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Jim Jago is an Adjunct Professor, School of Natural and Built Environments, University of South Australia. His main research topics are the Cambrian biostratigraphy of Tasmania, Antarctica and South Australia.

Cambrian Series 3 and 4 faunas from Northern Victoria Land, Antarctica: a summary
J.B.Jago, School of Natural and Built environments, University of South Australia, Mawson Lakes, SA 5095, Australia; R.A.Cooper, Institute of Geological and Nuclear Sciences, PO Box 30368, Lower Hutt, New Zealand; C.J.Bentley, 30 Albert Street, Clare, SA 5453, Australia

The best preserved and most extensive Cambrian Series 3 (middle Cambrian) and Cambrian Series 4 (Furongian, late Cambrian) fossiliferous successions from Antarctica occur in Northern Victoria Land. Almost all the fossil localities are found within the Bowers Supergroup, which outcrops within the Bowers Terrane, a fault-bounded northwest-southeast oriented strip in Northern Victoria Land. The great bulk of the fossils occur within the Spurs Formation. The fossil assemblages are dominated by agnostoids and trilobites with most ranging in age from Drumian to Paibian, although one fauna is of Jiangshanian age. Over 40 agnostoid taxa and over 100 taxa of trilobites have been recorded from the rocks of the Bowers Supergroup. The youngest fauna occurs within the adjacent Robertson Bay Terrane, where a limited fauna of trilobites and conodonts from within a limestone olistolith have a very late Cambrian or early Ordovician age.

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Whole Earth harmonics

Mitchell R[1], Kirscher U[1], Cox G[2], Ernst R[3], Collins W[1], Spencer C[1], Pisarevsky S[1], Doucet L[1], Li Z[1]
[1]Curtin University, [2]University of Adelaide, [3]Carleton University

TS1 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Dr Ross Mitchell earned his PhD from Yale University, did a postdoc at the California Institute of Technology, and is presently a research fellow at Curtin University working in the Earth Dynamics research group. He is trained in palaeomagnetism and studies Earth history and the supercontinent cycle. He has predicted the arrangement of future supercontinent "Amasia" based on his "orthoversion" model of the supercontinent cycle.

Cycles are common in nature and the expanse of Earth history may be no exception. Already commonly discussed are Wilson cycles of ocean basins and supercontinent cycles of continent assembly and dispersal. Nonetheless, quantitative testing for rigorous periodicity has not been demonstrated. Here we collect proxies from a range of depths (core, mantle, and crust) and conduct fast Fourier transforms with Monte Carlo noise simulation for significance testing. Bandpass filtering allows us to characterize and compare similar cycles from different proxy depths, where phase relationships carry implications for the dominance of top-down or bottom-up mantle convection. Four statistically significant cycles are present in all proxy depths, including the Wilson cycle (310 ± 40 Myr), the supercontinent cycle (625 ± 126 Myr), and two longer supercycles. Amplitude modulation of shorter cycles by longer cycles strengthens the argument for the existence of such long wavelength cycles. Possible mechanisms for the supercycles are discussed.

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The Roots of Settlement: how nature's provision has created an opportunity in urban geotourism

Dent B[1]
[1]*Red Earth Geosciences*

Biography:
Boyd first studied applied geology in the early 1970s and specialised in Engineering Geology with a particular interest in landslides: later he was the Engineering Geologist for the NSW Public Works Department where his focus was dam geology (another passion). In the decade from 1994 he completed his MSc in Hydrogeology and Groundwater Management then a PhD in Hydrogeology. He holds a Certificate in Marketing Practice and more recently attained a Certificate IV in Tourism. He works as an independent consultant building on his esoteric specialty - the geoscience of cemeteries, as well as interests in geoscience and communities.

Colonel Light sited Adelaide on a flat plain between sea and hills, around the River Torrens, embracing the concept that the physiography of the place encouraged its location. Captain Phillip landed at Sydney Cove in the estuary of the Tank Stream in the ria of Port Jackson because the physiography hosted a safe harbour and a fresh-water stream. While Captain Stirling crossed the Swan River bar at Fremantle, sailed into the estuary and established Swan River Colony (Perth) on the favourable coastal plain.

The Parramatta River (Sydney) was drowned about 20000 ya; it became the basis of Australia's first settlement which then struggled to survive on infertile, skeletal soils developed on a competent, erosion-resistant quartz sandstone. The Adelaide Plain hosted thick 'Bay of Biscay' soils which were to become problematic for all future building works. Settlers in Perth had plenty of groundwater supplies but also plenty of sand which didn't satisfactorily support agriculture.

As a major necessity, these settlements developed quarries to use the local stone for housing and important building construction. Development in Adelaide was hampered by an absence of plentiful timber supplies and in concert with Sydney, by a lack of reliable surface water. Perth's development further suffered from river transport and port difficulties.

Local geological knowledge, in context, can be used by all geoscientists whether intrepid explorers working in remote locations or mine sites or working around urban centres. All can be professional ambassadors to foster Geotourism and Geoheritage knowledge and appreciation for the community.

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A genetic model for the Central Gawler Au Province and it's relationship to the Gawler IOCGs

Payne J[1,3], Wade C[2,3], Morrissey L[1,3], La Flamme C[4], Barovich K[3], Reid A[2]
[1]School of Natural and Built Environments, University Of South Australia, [2]Geological Survey of South Australia, [3]Department of Earth Sciences, University of Adelaide, [4]Centre for Exploration Targeting, University of Western Australia

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Justin Payne is a Senior Lecturer at the University of South Australia. His research is focused on the use of isotope geochemistry, geochemistry, geochronology and geology to unravel the evolution of the continents with a particular focus on the Proterozoic of Australia.

The Central Gawler Gold Province (CGGP) has been defined to include a series of Au and other precious metal deposits in the central and southern Gawler Craton that are interpreted to have formed at ca. 1590 Ma. The Province was defined in part due to differences in deposit style to the Olympic Cu-Au province along the eastern margin of the Gawler Craton. As part of this study we suggest that the boundaries of the CGGP should be modified to only include deposits with a similar style of mineralisation as opposed to including all Au, Ag and Pb-Zn deposits that appear to differ from the Olympic Cu-Au province Fe-oxide-Cu-Au deposits. Budd and Skirrow (2007) highlight the role of mafic dykes in the CGGP but could not conclusively link the mineralisation to the dykes due to both orogenic and intrusion-related characteristics in the studied Tarcoola deposit. This study builds upon previous studies to include samples and/or data from a total of nine different deposits and prospects with varying host rocks for the mineralisation. At all but one of these deposits/prospects, mafic dykes or intermediate Gawler Range Volcanic dykes are present with mineralisation commonly concentrated along or proximal to the dyke margins. Stable and radiogenic isotopic data suggest that the mafic dykes are integral to mineralisation but that the signature and, to some extent, style of mineralisation varies as a result of the host rock to the dykes and the mineralisation.

Budd, A. R. and Skirrow, R. G., 2007. Economic Geology, 102.

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The terminal deposits of rivers in drylands

Amos K[1], Mann S[1]
[1]*The University Of Adelaide*

TS7 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Kathryn is a Senior Lecturer at the Australian School of Petroleum, University of Adelaide. M
Her expertise is in clastic sedimentology, research focusing on understanding the controls behind processes of sediment transport and deposition in a range of environments, based on the study of modern environments and the rock record. A key driver for this research is the application of improved understanding about depositional systems to the interpretation of ancient successions. Kathryn obtained her PhD in 2004 from the University of East Anglia, UK.

In dryland settings, the terminal deposits of rivers are complex and diverse. These typically form where a river flows into a lake/playa, but can also occur within a fluvial system. Dryland fluvial termination deposits have been described using many names, which can be confusing: terminal fans, floodouts, interdune fluvial terminations, fluvial distributary systems, terminal distributary systems, fan deltas, and terminal splay complexes. This is significant, as drylands represent c.50% of the global land area at present, and dryland endorheic basins have been prevalent throughout geological history, their deposits of economic importance as hydrocarbon reservoirs. We address this problem by presenting a review of published literature, and new observations from five deposits in two localities: Kati Thanda (Lake Eyre) and Yamma Yamma, central Australia. We propose that non-marine terminal fluvial deposits can be usefully classified based on river discharge and lake level: Type 1) perennial rivers terminating into perennial lakes, Type 2) ephemeral rivers terminating into perennial lakes, Type 3) ephemeral rivers terminating on a landform which is not a lake, and Type 4) ephemeral rivers terminating into ephemeral lakes, which are wet (4A) or dry (4B). Although relatively common in drylands globally, Type 4 deposits are understudied compared to their Type 1, 2, 3 and marine counterparts, and have been shown to have a highly variable sedimentology, lateral extent and architecture. The aim of this review and classification is to enable an improved basis for future description, comparison and interpretation of both modern and ancient dryland fluvial termination deposits.

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Current and potential uses for geothermal energy in Australia

Larking A[1], **Beardsmore G[1]**, Bendall B[1], Bolton G[1], Pujol M[1], Ricard L[1]
[1]*Australian Geothermal Association*

TS3 - 3.2.4 Sustainable energy sources & 3.2.6 Using geoscience to address social licence concerns for energy projects, Room R5, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Dr Graeme Beardsmore is a Director of the Australian Geothermal Association, a Senior Research Fellow at the University of Melbourne, Chairman of the Resources and Reserves Committee of the International Geothermal Association, Vice Secretary of the International Heat Flow Commission, and Technical Director of geothermal consulting company Hot Dry Rocks Pty Ltd. He earned his PhD from Monash University in 1996 and has since focussed on exploring for and assessing the economic potential for geothermal energy in Australia.

Domestic interest in geothermal energy in 2016 justified the incorporation of the Australian Geothermal Association, a professional society with members across industry, academia and government. Current economic and social drivers favour energy efficient heating and cooling, low emissions process heat, and low emissions base load power. AGA represents the full range of geothermal technologies to meet these goals, including ‘ground source heat pumps' (GSHP), industrial heat supply, recreational bathing / wellness, and geothermal power.
The economic argument for GSHPs is close to a tipping point in Australia, but we are behind other industrialised nations where GSHPs are a standard feature of every new HVAC system.
Geothermal energy can provide clean, sustainable and affordable industrial heat at a stable price. Direct use of geothermal water for space and aquatic centre heating is expanding, especially in the Perth Basin, while Peninsula Hot Springs spa in Victoria continues to expand utilising natural geothermal water. Other current consumers of geothermal energy include an abattoir and barramundi farms.
Australia witnessed a boom and bust cycle of investment in geothermal power generation from the early 2000s to early 2010s. The geothermal sector learned many valuable technical and business lessons, and economic power generation remains a focus for many. Profound changes in Australian energy markets suggest that the benefits of geothermal power for low greenhouse gas emissions and grid stability might one day be factored into the relative price of geothermal electricity. If, and when, that happens, expect a renaissance in geothermal power projects.

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Geoscience Australia's contribution to the AusLAMP program: Results from NSW, Victoria and Northern Australia

Kirkby A[1], Duan J[1], Jiang W[1]
[1]*Geoscience Australia*

TS5 - 3.1.6 New frontiers in ore system research, Hall E2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Alison joined Geoscience Australia in 2008 after completing her MSc in Geology at the University of Auckland, and joined the Geothermal Section in 2009. In 2013, she commenced a PhD at the University of Adelaide, working with Graham Heinson on the resistivity characteristics of fractured rocks as imaged by the magnetotelluric method. After completing her PhD in 2016, she joined the MT and Seismic section. She is currently responsible for the development of the MTPy software package for MT data analysis and the modelling and interpretation of new MT datasets, and their integration with other geoscience data.

The Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP) is an Australia-wide program to map the electrical resistivity structure of the Australian lithosphere in three dimensions. The aim of the program is to deliver long-period magnetotelluric data on a 0.5 degree (~55 km) grid across Australia. Data and models produced from this program will provide new insight into Australia's lithospheric architecture and tectonic processes, and help to reduce exploration risk.

Geoscience Australia is a key player in the delivery of the AusLAMP program, which is now around 30 % complete.

Geoscience Australia has recently released AusLAMP data from Victoria, which completes data collection in this state. To date, a further 100 sites have been collected in NSW and 155 in the Northern Territory, the latter as part of Geoscience Australia's Exploring for the Future (EFTF) program.

This presentation will show new data and models from each of these key areas. The implications of these results for our understanding of the deep resistivity structure of the Australian lithosphere and for mineral systems targeting will also be discussed.

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Automation of cover sequence geochemistry within a modern mineral exploration environment

Tiddy C[1], Giles D[1], Hill S[2], Baudet E[3], Brotodewo A[4], Custance K[5], Hill R[5], Normington V[5], Plavsa D[6], Stoate K[5], van der Hoek B[1], Wolff K[5]

[1]DET CRC, MinEx CRC, FII, University of South Australia, [2]Geological Survey of South Australia, [3]DET CRC, FII, University of South Australia, [4]MinEx CRC, FII, University of South Australia, [5]DET CRC, University of Adelaide, [6]FII, University of South Australia

TS1 - 3.1.1 Effective exploration and discovery under cover, Hall E2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Caroline Tiddy is a Senior Research Fellow within the Future Industries Institute at the University of South Australia. Over the last 8 years Caroline's research has been conducted as part of the Deep Exploration Technologies CRC. This research, plus more, now continues with MinEx CRC.

Over the last eight years there has been a concerted effort within the Deep Exploration Technologies Cooperative Research Centre (DET CRC) and associated collaborative projects to assess how cover sequence materials can be used in mineral exploration. The work presented here is a brief overview of results that have come from research undertaken within the Gawler Craton, which is host to Proterozoic basement rocks that preserve significant mineralisation (e.g. iron oxide-copper-gold (IOCG)) and that are extensively overlain by younger cover sequences. This research includes: investigation into mechanical and chemical dispersion of geochemical signatures within Permian glacial cover sequences; effects of deep weathering processes on geochemistry and suitability of sample media within the Lower Cretaceous Cadna-owie Formation and Bulldog Shale; element deportment within mineral phases preserved within the cover sequence; geochemical discrimination of pedogenic- and marine-carbonates and preservation of geochemical signatures related to proximal IOCG mineralisation; and the expression of Au and Cu mineralization within biogeochemical samples. The key factor in the success of using all these sample media types (cover sequence materials, surface sampling, biogeochemistry and specific mineral phases) has been in defining background chemistry. Without understanding background chemistry, the ability to positively identify true elevated or anomalous concentrations is compromised to the point where false anomalies may appear to be an attractive target or a target may be missed.

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Archean sulphur identified in Mesoproterozoic skarn deposits associated with the Olympic Dam iron oxide–copper–gold (IOGC) event

Morrissey L[1], LaFlamme C[2], Payne J[1], Raimondo T[1]

[1]School of Natural and Built Environments, University Of South Australia, [2]Centre for Exploration Targeting, University of Western Australia

TS8 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Dr Laura Morrissey completed her PhD in metamorphic geology at the University of Adelaide in 2016 and is now a post-doctoral researcher at the University of South Australia. Her PhD research focused on the use of metamorphic geology to investigate the role of melting and high temperature processes on the preserved geological record of orogenic events as well as the role of melting in mineral deposit formation. She is now working on an ARC Linkage Project investigating the formation of the diverse range of deposit types associated with the Hiltaba–Gawler Range Volcanics magmatic event.

The Gawler Craton in South Australia is host to the c. 1595–1570 Ma Hiltaba Suite and Gawler Range Volcanics (GRV) Large Igneous Province. In the eastern part of the Gawler Craton, the Hiltaba–GRV magmatic event was associated with the formation of giant hematite-dominated IOCG deposits (e.g. Olympic Dam, Prominent Hill). The Hiltaba–GRV magmatic event also formed a diverse series of smaller deposits and prospects that include Fe–Au skarns, shear-hosted Au, Pb–Zn and Ag, pointing to complexity in fluid and metal sources during this event. These smaller deposits and prospects may hold key information about the processes that drove mineralisation.

New multiple sulphur isotope data from two skarn systems is used to explore whether there was a similar driver and source for skarn mineralisation in the eastern and central Gawler Craton. Both prospects are hosted in Paleoproterozoic sedimentary rocks that are inferred to overlie Archean basement. The Weednanna prospect in the central Gawler Craton shows an appreciable Δ33S anomaly, with values of +0.17 to +0.33‰. This suggests sulphur may be sourced in part from Archean supracrustal rocks, consistent with ‘crustal’ δ34S values of +6.3 to +9.2‰ for pyrite. In contrast, there is no Δ33S anomaly in samples from the Punt Hill prospect in the eastern Gawler Craton. Pyrite and chalcopyrite in K-feldspar-altered pelite have δ34S of +2.5 to +4.4 ‰, whereas chalcopyrite in clinopyroxene–fluorite skarn has δ34S values of -0.1 to +0.7 ‰. These data suggest a complex fluid evolution during skarn mineralisation at Punt Hill.

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Development of the Global Paleomagnetic Database and new global paleogeographic animation for 2000-1600 Ma

Pisarevsky S[1]

[1]*Earth Dynamics Research Group, ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS) and The Institute for Geoscience Research (TIGeR), Department of Applied Geology,Curtin University*

TS2 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

Sergei Pisarevsky obtained his MSc in geophysics from Leningrad State University in 1976, and PhD in geophysics from the same University in 1983. He moved to the Tectonics Special Research Centre at the School of Earth and Geographical Sciences of the University of Western Australia (UWA) in 1998. In 2007 he moved to the University of Edinburgh and returned to UWA in 2010. He works in Curtin University since 2011. Particular research areas include: paleomagnetism, Precambrian geology, plate tectonics and *global palaeogeography.*

The Global Paleomagnetic Database has been updated and contains now 9864 paleomagnetic poles from 4073 publications. The online interactive version of the new database is to be installed in the website of the Earth Dynamic Group in Curtin University this year. The wealth of new paleomagnetic data results in new generation of plate tectonics reconstructions. As an example, I shall demonstrate a new global paleogeographic animation for the 2000-1600 Ma. This time interval time in Earth's history was marked by worldwide orogenic events. These events were associated with the assemblies of the Laurentia, Baltica, Siberia, Australia, North China, and Kalahari cratons, and accretionary growth of others. The Statherian period (1.8–1.6 Ga) was characterized by the final assembly of the supercontinent Nuna. Recent 1.9–1.8 Ga paleogeographic reconstructions demonstrate that Nuna, and even its building blocks such as Laurentia, did not assemble before 1.86–1.87 Ga. The three segments of Baltica – Fennoscandia, Sarmatia and Volgo-Uralia – did not amalgamate into a single entity until 1.8–1.75 Ga. There are several lines of evidence suggesting that the final assembly of Nuna occurred during the ~1.6 Ga collision of Australia with Laurentia. Three segments of Baltica - Fennoscandia, Sarmatia and Volgo-Uralia - did not amalgamate into a single entity until 1.8-1.75 Ga. A recent detailed study of the Svecofennian orogeny in Fennoscandia does not support the SAMBA model, and suggests instead that Amazonia was not connected to Baltica.

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Exploring for the Future – new innovative groundwater data and information for Northern Australia

Neumann N[1], Lawrie K[1], Sundaram B[1]
[1]*Geoscience Australia*

TS2 - 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Narelle Neumann is currently leading Geoscience Australia's Groundwater Branch, which undertakes geoscience investigations across Australia to provide advice in support of Government priorities and to inform the sustainable development of groundwater resources. She joined Geoscience Australia in 2001, and has worked on a wide range of regional projects across Australia focused on the collection and interpretation of diverse geoscience datasets to understand the geology and resource potential of Australia. She has a PhD from the University of Adelaide.

The Australian Government's White Paper on Developing Northern Australia identified the untapped potential and close proximity of this region to significant trading markets presents a unique opportunity to drive economic growth and investment. However, there are major gaps in our knowledge of the mineral, energy and groundwater resource potential of this area. Geoscience Australia's Exploring for the Future program, in collaboration with State/Northern Territory government agencies, and other key government, research and industry partners is addressing these gaps to improve confidence in resource potential, lower technical risk and encourage further investment. Now halfway through this four-year, $100.5 million program, a diverse and innovative range of geoscience activities are improving government, industry and community understanding of the potential of mineral, energy and groundwater resources in Northern Australia. The groundwater component of this program is applying new innovative approaches, tools and pre-competitive data to map and characterise the location, quality and quantity of groundwater resources across selected key regions. The collection, interpretation and delivery of these hydrogeological, geophysical, geospatial and remote sensing datasets will inform government, industry and public decision-making for potential irrigated agriculture, mineral and energy development, and community water supply.

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Australia's mineral inventory – identified resources, trends, distribution and resource life

Britt A[1]

[1]*Geoscience Australia*

TS3 - 3.4 Resources sustainability – responsible investment and management, Room R2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:

Allison graduated from the Australian National University in 1994 after completing her thesis on regolith and geochemistry near Mount Isa. She began her professional career with CSIRO Exploration & Mining working on gold geochemistry in the Yilgarn as part of the first CRC LEME. This was followed by six years overseas working as a share trader, scientific English editor and contract geologist. Allison returned to Australia in 2008, initially working with the uranium group at Geoscience Australia before moving into mineral resources and advice, specialising in the annual inventory of Australia's mineral resources.

The Australian Government has been assessing the nation's mineral inventory since 1975. Aggregated identified resources of all major, and many minor, commodities have grown enormously over this 40-year period. Despite this growth, trends over the last decade for most major commodities are sideways or down. Only black coal, mineral sands and uranium have continued growth in resources considered commercial or potentially commercial. Production for most major commodities has also increased over the past 40 years although, again, some commodities have seen sideways or downward trends in recent years.

Australia has some of the largest identified resources in the world but only world-class discoveries attract the funding necessary for development. This has resulted in much of Australia's minerals inventory being attributable to a relatively small number of deposits.

A simple calculation of reserve life at operating mines shows that gold, diamonds, iron ore, silver, mineral sands and bauxite all have a reserve life of less than 15 years. However, mining companies typically replace depleted ore by upgrading Measured and Indicated Resources and, in turn, upgrade Inferred Resources to higher categories. Thus, resource life at operating mines is considerably larger than reserve life. A yet larger, long-term view, of resource life can be derived by using all identified mineral resources, regardless of operational status. When these deposits are included in the calculation, Australia has the potential to supply major commodities to the world for centuries, with the exception of gold and diamonds which have a significantly shorter future.

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Decoding Earth's rhythms: Modulation of supercontinent cycles by longer superocean cycles

Li Z[1], Mitchell R[1], Spencer C[1], Ernst R[2], Pisarevsky S[1], Kircher U[1], Murphy B[1,3]
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TS1 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
BSc Peking Uni 1982; PhD Macquarie Uni 1989. Macquarie Uni (1989-1990), Uni WA (1990-2006); Curtin Uni (2007-present).
Currently an ARC Laureate Fellow and a John Curtin Distinguished Professor, and a Co-Leader of IGCP 648. Research interests include palaeomagnetism and global paleogeography, global to regional tectonics, and global geodynamics.

The supercontinent cycle of episodic assembly and breakup of almost all continents on Earth is commonly considered the longest period variation to affect mantle convection(Anderson, 1982; Bleeker, 2003; Li and Zhong, 2009; Zhong et al., 2007). However, global zircon Hf isotopic signatures and seawater Sr isotope ratios suggest the existence of a cycle twice the duration of the supercontinent cycle(Spencer et al., 2013). Here we propose that since ~2 billion years ago the superocean surrounding a supercontinent, as well as the circum-supercontinent subduction girdle, survive every second supercontinent cycle. This interpretation is in agreement with global palaeogeography and supported by variations in passive margin, orogen, and mineral deposit records that each exhibits two periodic signals at 500–700 and 1000–1500 million years. We suggest that supercontinents assemble alternatingly through dominantly extroversion(Murphy and Nance, 2003) (the previous supercontinent turned inside-out through the destruction of the Panthalassa-type superocean) after a more complete breakup, and dominantly introversion (survival of the superocean) after an incomplete breakup of the previous supercontinent, giving rise to the two harmonic cycles. Coexistence of the two supercycles may reflect an oscillatory feedback system between supercontinent assembly tectonics and mantle thermal state and structure. Our model provides a conceptual framework toward a paradigm shift in understanding how Earth's internal engine works, which is testable with increasing resolution of global palaeogeography in deep time and more realistic 4D geodynamic modelling.

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Recognising base level shifts in the Upper Jurassic Walloon Coal Measures of the Surat Basin, Australia

Wainman C[1], McCabe P[1]
[1]Australian School of Petroleum, University Of Adelaide

TS2 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Carmine C. Wainman is a Postdoctoral Fellow at the University of Adelaide in Australia. He completed his PhD in 2018 at the same University and received his M.Sc. (integrated) degree in geology from the University of Southampton, United Kingdom in 2012. Before commencing his PhD, he worked for the RSK Group and *Woodside Energy. His research focuses on Middle to Upper Jurassic coal-bearing strata in eastern Australia and the evolution of Upper Cretaceous strata in the Bight Basin on Australia's southern margin.*

The Upper Jurassic Walloon Coal Measures (WCM) of the Surat Basin is Australia's premier source of coal seam gas. Improving reservoir models for developing resources in the WCM is hindered by the correlation of strata in a poorly defined lithostratigraphic framework and by interpretation of the formation as a single depositional environment. This can have implications for locating aquifers and gas sweet spots in the basin.

Recently obtained U–Pb tuff dates from the WCM in the western Surat Basin have identified a major unconformity during the Kimmeridgian with a 4.5 Ma time gap between tuffs spread ~20 m apart. This demonstrates that there were two episodes of peat (coal) accumulation. Above the unconformity are incised valley fills that transition from fluvially to tidally-influences facies indicated by dinoflagellate cysts and tidal sedimentary structures such as double mud drapes. A relative fall in sea level that created the unconformity was probably due to local tectonism as eustatic sea level was rising during the Kimmeridgian. A marine incursion into the basin from the north following the depositional hiatus during the Kimmeridgian was likely associated with a highstand of eustatic sea level during the early Tithonian.

These findings will help establish an improved sequence stratigraphic understanding of the WCM and help elucidate the evolution of other fluviolacustrine systems.

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SA3D – Multi-Scale 3D Mineral System Maps

Van Der Wielen S[1]
[1]*Geoscience Australia*

TS7 - 3.1.2 Making better exploration decisions through an integrated geoscience approach & 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Simon van der Wielen is a geoscientist with more than 18 years' experience that span industry, government and academia. He uses data integration and 3D modelling techniques to better understand mineral systems and geological processes.

SA3D model integrates geophysical, geochemical, geological and mineralogical data in three dimensions and covers the entire state of South Australia to a depth of 250 km. The model incorporates HyLogger spectral mineralogy, petrophysics, whole rock geochemistry, isotopes, new gravity, magnetic, and magnetotelluric inversions with existing deep crustal reflection seismic surveys and seismological velocity models into a fully integrated 3D model. The model is a significant new contribution to the understanding of South Australian geology and mineral systems.

This is the first time a model of this size, complexity and completeness of data types has been produced for South Australia. The SA3D model is a valuable research and exploration tool that enables users to visualise, query and interpret the state's vast archive of geoscientific data in a full 3D environment. The SA3D model is designed to be readily updateable and will incorporate new datasets when they become available.

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Inferring Formation Boundaries through Bayesian Geophysical Inversion

Scalzo R[1], Olierook H[2], Kohn D[3], Chandra R[4], Muller D[4], Farabaksh E[4], Houseman G[4], Clark C[2], Cripps S[1]
[1]Centre for Translational Data Science, University Of Sydney, [2]School of Earth, Ocean, and Planetary Sciences, Curtin University, [3]Sydney Informatics Hub, University Of Sydney, [4]School of Geosciences, University of Sydney

TS3 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Richard Scalzo completed his PhD in Physics at the University of Chicago in 2004 He held postdoctoral fellowships at Berkeley Lab, Yale University, and ANU before joining the staff of the University of Sydney's Centre for Translational Data Science (CTDS) in 2015. Dr. Scalzo's research focuses on probabilistic modeling in the natural sciences, including non-parametric Bayesian inference, Monte Carlo Markov chains, and learning or emulation of sensor response kernels and/or complex forward models.

Accurately localizing the boundaries between geological units is fundamental to numerous geological applications, including plate reconstructions, defining stratigraphy, and mineral and petroleum exploration. Traditional approaches employ a mix of quantitative and narrative scientific techniques that, though sound in principle, may make it difficult to optimally weight constraints from different sensors. Here, we use an updated version of the Obsidian software suite to provide a principled framework for joint inversion of geological and geophysical datasets, inferring surface and subsurface geology based on sensor data and prior expert knowledge using Bayesian statistical techniques. A parametrized three-dimensional world model describing the geometry of geological units within a modeled volume forms the basis for forward-model computations of predicted sensor data, which are then compared with geological field observations to produce a posterior probability for each possible configuration. Obsidian is designed for use on large distributed computing systems, and employs parallel-tempered Markov chain Monte Carlo to explore multi-modal posterior distributions. The quantitative fusion of prior geological knowledge with sensor data allows predictions of uncertainty in the three-dimensional positioning of geological boundaries. Quantitative outputs provide a risk-minimized tool for new exploration ventures, be it for camp-scale mineralization, defining plate-scale boundaries or any scale in between.

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Innovative Government Geoscience to Drive New Discoveries: an Integrated Approach to Defining Australia's Resource Potential

Heap A[1]
[1]*Geoscience Australia*

TS5 - 3.4 Resources sustainability – responsible investment and management & 3.5 Technology integration, Room R2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Andrew Heap is Chief of Resources Division at Geoscience Australia. He graduated 1st class Honours in Earth Sciences from University of Auckland after which he completed his PhD at James Cook University. Dr Heap has over 17 years experience in leading pre-competitive geoscience research within the Australian Government, including as a senior leader in Geoscience Australia, with responsibility for energy and mineral resources, carbon capture and storage and marine geoscience programs. Dr Heap has responsibility for building a national prospectus of energy and mineral exploration opportunities across Australia through the design and delivery of innovative scientific studies and technologies.

Minerals and energy resources contribute around $200 billion annually towards Australia's export income, and the water-dependent agricultural sector contributes a further $41 billion. To ensure a continuing contribution from the resources sector, Australia needs to be internationally competitive as only the most economic deposits will receive investment. Many parts of Australia lie under cover, which presents both a challenge and opportunity for exploration. Opportunities exist in all areas of the search space, with continued discoveries in brownfields regions, through to untapped frontier greenfields.

Northern Australia holds many areas of unknown resource and agricultural potential. To improve government, industry and community understanding of the potential of mineral, energy and groundwater resources, Geoscience Australia is conducting the Exploring for the Future program. In collaboration with State/Northern Territory government agencies, and other key government, research and industry partners, this program is addressing gaps in geoscience knowledge in Northern Australia to improve confidence in resource potential, lower technical risk and encourage further investment. Innovative techniques are being used to gather new data and information on an unprecedented scale.

The acquired knowledge will provide critical information to support evidence-based decision making to manage those resources and broader community development. A key element of the program is an integrated approach to understanding the geological framework and resource potential to encourage explorers to undertake further activity, and drive new resource discoveries that will provide the inter-generational economic base for developing infrastructure and sustaining communities across Australia.

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Stable and radiogenic strontium isotope systematics in hypersaline coastal environments: constraints for paleo-hydrology in the Coorong, South Australia.

Shao Y[1], Farkaš J[1], Tyler J[1], Gillanders B[1], Chamberlayne B[1], Haynes D[1]
[1]*University of Adelaide*

TS5 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
I have arrived Australia since 2013 after high school in my hometown; here I completed my Bachelor of Science with Honours in Geology in the University of Adelaide. During the past 4 years, I knew my supervisors and built my confidence in researches. I have been working on Sr and Ca isotope systematics in the Coorong region since my Honours year, and I am passionate to continue on this topic and learn new things and getting new experience, so I decided to continue my Ph.D. I hope to add new aspects to climate evolution and surface cycles of the earth.

Strontium (Sr) isotopes have been widely used in large-scale ecosystem and hydrological studies. Specifically, the 87Sr/86Sr is commonly used for tracing radiogenic processes such as water source mixing, while the newly employed stable 88Sr/86Sr (noted as δ88/86Sr) is sensitive to isotope fractionation processes such as carbonate formation. Combining the two isotope signatures in carbonate sediment archives and ambient water adds potential to reconstruct paleo-hydrology in carbonate-producing coastal environments. Importantly, the stable 88Sr/86Sr has been applied in recent years in coastal environments with fresh to marine salinity conditions, very few studies were conducted in hypersaline environments. The Coorong hydrological system, located ~100 km southeast to Adelaide, represents a unique 'natural laboratory' to calibrate novel and traditional isotope tracers in due to its unique geomorphology and large salinity gradient in water bodies ranging from fresh to hypersaline (from ~0 PSU to ~120 PSU). This study aims to assess the radiogenic and stable Sr isotope ratios (i.e., 87Sr/86Sr and δ88/86Sr) in the Coorong lagoon waters, inorganic carbonates and bivalve shells Arthritica helmsi from sediment cores, and hence explore the potential of these isotope tracers to be used to reconstruct the paleo-hydrology in the Coorong throughout the recent thousands of years.

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Constraints on Archean tectonic processes from seismic reflection surveys in the Canadian Superior and Australian Yilgarn cratons

Calvert A[1], Doublier M[2]
[1]Simon Fraser University , [2]Geoscience Australia

TS3 - 1.1.4 Crustal evolution of Archean Cratons, Hall A, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Andy Calvert is Professor of Geophysics at Simon Fraser University in British Columbia, Canada. He is an exploration seismologist, who has worked on active source data from a broad range of tectonic settings. He was involved in three major transects of the Canadian Lithoprobe geoscience program, and from 2007-2014 led Geoscience BC's multidisciplinary Nechako project to evaluate the hydrocarbon potential of basins in central British Columbia. He holds a doctorate in geophysics from the University of Cambridge and a BA in Mathematics from Oxford University, and previously worked in the hydrocarbon exploration industry with Western Geophysical, Schlumberger, and PanCanadian Petroluem,

Following multi-year seismic acquisition programs in the Yilgarn Craton by Geoscience Australia with the Geological Survey of Western Australia and in the Superior Craton by the Canadian Lithoprobe program, these two cratons are now the best surveyed Archean regions on Earth.

The Superior Craton grew as various island arcs, oceanic plateaux, and micro-continental fragments of Meso-Neoarchean age were accreted to the southern margin of a pre-existing microcontinent (North Caribou superterrane), giving rise to well-developed east-striking belts of granite-greenstone, metasedimentary, and plutonic rocks. Seismic reflection transects reveal a doubly-vergent orogen in the north and in the south listric north-dipping mid-crustal reflection fabrics, which were originally interpreted to represent successive episodes of underthrusting, but are also overlain by a thinned middle crust.

In the Yilgarn Craton, the Youanmi terrane is characterized by a relatively non-reflective upper crust above a pervasive fabric of commonly listric east-dipping mid-crustal reflections that sole out into the upper part of a 2-3 s thick region of subhorizontal lower crustal reflections. We interpret these reflective fabrics as the result of widespread crustal flow during the late stage of craton evolution at ~2.66-2.61 Ga that also produced subsidence of the upper crust.

Seismic lines from both Archean cratons indicate a similar process of crustal collapse, which was much more extensive in the Yilgarn Craton where it can be viewed as continental spreading. In the Superior Craton, pervasive extension is more limited, consistent with its greater crustal thickness and the preservation of many structures related to subduction-driven accretion.

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An interdisciplinary approach to assessing the prospectivity and potential impacts of unconventional hydrocarbon development in the Isa Superbasin of Queensland.

Orr M[1], Bradshaw B[1], Bailey A[1], Wang L[1], Palu T[1], Lech M[1], Hall L[1], Buchanan S[1], Dixon-Jain P[1], Lewis S[1], Sundaram B[1]

[1]*Geoscience Australia*

TS1 - 3.2.3 Petroleum and its co-products, Room R2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:

Meredith Orr has experience in interdisciplinary research gained from her former role as a lecturer at Monash University in a multidisciplinary department. She is a tectonic geomorphologist with a PhD in Earth Sciences from the University of Melbourne and has worked not only within geological and geomorphological discipline areas but also contributed sedimentological analyses to multidisciplinary research in Quaternary environmental change with researchers in palynology and archaeology. She is currently based at the petroleum data repository at Geoscience Australia and is engaged by Geoscience Australia in Stage 2 of the Australian Government's Geological and Bioregional Assessments Program.

Proterozoic basins have often been subject to multiphase tectonic deformation, uplift, metasomatism and metamorphism and are therefore considered to have greater risk to hydrocarbon preservation than Phanerozoic basins. The Isa Superbasin is a large underexplored Proterozoic basin. Geological research in this basin has focussed on mostly outcrop regions, while data acquisition in areas under cover has been limited.

Despite perceived risks to hydrocarbon preservation, multiple gas shows encountered during exploration drilling in the River and Lawn supersequences indicate the potential for future unconventional gas development of the Isa Superbasin in Queensland. Multiphase deformation and alteration affect not only hydrocarbon preservation but the geomechanical properties that exert a primary control over fracture propagation and the relative continuity and interconnectivity of aquifers.

This interdisciplinary study assesses the available geological data, including but not limited to seismic data, borehole logs, and petrophysical and geomechanical data, to characterise unconventional hydrocarbon plays in the northern Lawn Hill Platform and to identify any potential connectivity with productive aquifers. A number of key criteria are developed as part of this study for chance of success mapping, including source rock maturity from burial history modelling. Criteria are adapted from those established in stepwise subsiding basins to account for thermal changes and regional differences during the extended period of post-depositional geological history. The results can be applied as a framework to assess data from future broader exploration in the Paleoproterozoic to Mesoproterozoic regional sequences and identify any potential impacts to be mitigated during unconventional hydrocarbon development.

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Magma production along the Lord Howe Seamount Chain, northern Zealandia

Seton M[1], Williams S[1], Mortimer N[2], Meffre S[3], Micklethwaite S[4], Zahirovic S[1]
[1]University Of Sydney, [2]GNS Science, [3]University of Tasmania, [4]Monash University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Maria Seton is an ARC Future Fellow in the EarthByte Group, School of Geosciences, University of Sydney. Maria was awarded her PhD from the University of Sydney in 2005, was awarded an Australian Postdoctoral Fellowship in 2009 and a Future fellowship in 2013. In 2014, Maria was awarded the Dorothy Hill Award from the Australian Academy of Sciences.

One of the world's most notable intraplate volcanic regions lies on the eastern Australian plate. As well as numerous scattered volcanic centres, the region includes two age-progressive trails offshore (Tasmantid and Lord Howe Seamount chains) and the world's longest continental hotspot trail (Cosgrove Track). While most studies agree that the age-progressive chains formed by the rapid northward motion of the Australian plate over a slowly moving mantle source, the volcanic output along these trails, and their time-varying influence on the sedimentary basins, remain unconstrained. A geophysical mapping and dredging campaign on the RV Southern Surveyor (ss2012_v06), confirmed the prolongation of the Lord Howe Seamount Chain (LHSC) to the South Rennell Trough, ~200 km further north than previously sampled. Radiometric dating of these new samples at 27-28 Ma, with previously published results from the southernmost chain, indicate straightforward northward motion of the Australian plate over a quasi-stationary hotspot as predicted by Indo-Atlantic and Pacific hotspot models. A peak in LHSC magmatism in the late Oligocene, also seen in the Tasmantid and Cosgrove trails, matches a 27-23 Ma slowdown of Australian plate motion. The average magma flux of the Lord Howe hotspot is estimated at 0.4 m3/s, similar to rates of crustal production at the South Rennell Trough prior to cessation of spreading in the mid-Oligocene, supporting a potential genetic relationship to this spreading system. Our results from the LHSC will assist in thermal history modelling in the sedimentary basins of northern Zealandia and our understanding of plate-mantle interactions in the region.

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A new emplacement origin for the world famous, highly Au-endowed, Archean Golden Mile Dolerite, Kalgoorlie, Western Australia

Cas R[1], McMann R[2], Olin P[2], Hayman P[3], Squire R[1], Campbell I[4], Smithies H[5], Sapkota J[5], Wyche S[5]
[1]Monash University, [2]CODES, University of Tasmania, [3]Queensland University of Technology, [4]Australian National University, [5]Geological Survey of Western Australia

TS7 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Ray is an Emeritus Professor at Monash University and Professorial Research Adjunct at CODES, University of Tasmania. He has published 150 peer reviewed papers on the volcanology of modern volcanoes and ancient volcanic successions, including aspects of their mineralised systems, and tectonic and paleoenvironmental setting. He presents an annual professional volcanology short course, that has been attended by ~1,500 industry, geological survey and postgraduate geoscientists. This year's course will be run from 2nd to 8th December, at Merimbula, NSW. Contact ray.cas@monash.edu for details.

The iconic, Archean Golden Mile Dolerite (GMD), host to the world-famous Golden Mile Au deposit at Kalgoorlie, Western Australia, has traditionally being interpreted as a “late” post-lithification sill. However, it has also been considered to be a thick, ponded lava flow, based on occurrence of dolerite clasts in the overlying, deep water, Black Flag Group (BFG) sedimentary rocks, implying that its surface was subject to erosion. Radiometric ages for the GMD coincide with those of the BFG, giving credence to the lava hypothesis. However, new co-funded drill holes demonstrate that in places the GMD consists of several discrete bodies of basalt-dolerite, separated by black mudstone, with gradational contacts between them consisting of jigsaw fit basalt clast to clast rotated breccias with a black mudstone matrix. This is inconsistent with erosion, reworking or resedimentation, but consistent with syn-depositional intrusion of a basaltic sill complex into unconsolidated, water saturated mudstone, quench fragmentation and peperite formation. Internally, the GMD grades from basalt to dolerite, and in the thickest part, to gabbro, as well as containing quartz-feldspar-magnetite granophyre segregations, and a basal cumulate zone, which is all consistent with slow cooling, and in situ internal differentiation of a mafic sill. Such petrological variations are unknown in lavas, even thick ponded lavas. The later orogenic gold mineralisation, is focused around the granophyric textural zones, which provide both chemical (oxidising) and textural (coarse inter-crystal face) permeability and physical trap characteristics for Au bearing mineralising fluids.

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Detrital rutile: a new tool for gold exploration under cover

Mcnaughton N[1], Porter J[1,2], Evans N[2,1], McDonald B[1], Talavera C[1], Doyle M[3]
[1]John De Laeter Centre for Isotope Research, Curtin Univ., [2]School of Earth and Planetary Sciences, Curtin Univ., [3]AngloGold Ashanti Ltd

TS5 - 3.1.6 New frontiers in ore system research, Hall E2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
- Isotope geochemist for 40 years with an ore deposit bent;
- PhD at Uni. Qld, postdoc at Cambridge Uni. prior to academic positions at UWA and Curtin;
- Published on stable and radiogenic isotopes, crustal evolution, REE-phosphate geochronology, 4D evolution of Precambrian terranes;
- Published on gold (>100 publications), base metals (Ni, Cu, Pb, Zn) and fractionated granites-pegmatites;
- *Currently researching a major industry-government sponsored project on rutile as a very distal footprint to hydrothermal gold ores.*

Detrital heavy minerals such as zircon, monazite, xenotime and rutile can be transported >100 km from their eroding source rock because they are sufficiently robust to withstand physical erosion-transport. Rutile can form in a hydrothermal gold ore environment, and importantly, captures a trace element signature that can be used to uniquely fingerprint the ore environment. Further, published examples show that rutile in the regolith overlying a gold orebody faithfully preserve the trace element signature of the orebody. In combination, these features imply detrital rutile grains in regolith and surficial clastic sedimentary cover can (1) indicate the presence of gold prospects/ores below or upstream from the sampling site, and (2) potentially extend the distal footprint of some gold ores to >100 km.
The utility of detrital rutile grains for gold exploration was assessed in clastic surficial sediments from a known Archean gold-mineralised belt in the Yilgarn Craton, but >20 kms from known mineralisation. The cover sequence was sampled from drillcore 4, 5 and 7 metres above the Archean basement contact. Heavy minerals from each sample were separated, mounted in epoxy and polished. Mounts were scanned automatically using TIMA (Tescan Intergrated Mineral Analyser) to identify TiO2 grains, rutile, anatase and brookite were confirmed with EBSD, and a selection of rutiles was analysed in-situ for multiple trace elements using laser ablation ICPMS. A gold fingerprint was found in rutile from the two samples closest to basement, with more abundant grains and a stronger "gold" geochemical signature in the sample 4m above the basement.

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Detrital provenance of the greater McArthur Basin, with implications for Palaeoproterozoic to Tonian tectonic geography of northern Australia.

Blades M[1], Cassidy E[1], Subarkah D[1], Collins A[1], Yang B[1], Payne J[2], Glorie S[1], Farkas J[1], Cox G[1]
[1]Centre for Tectonics, Resources and Exploration (TRaX), Department of Earth Sciences, The University of Adelaide,
[2]School of Built and Natural Environments, University of South Australia

TS6 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Morgan Blades is a tectonic geologist who undertook a PhD at The University of Adelaide where she studied the tectonic evolution of the Arabian Nubian Shield. Her work in this field has taken her to investigating how regional tectonic geology can illuminate global plate tectonic reconstructions. Since 2017, she has been working on the evolution of Proterozoic basins with a particular focus on the northern Australian McArthur Basin

There is still little known about the occurrence, formation and spatial distribution of long-lived cratonic basins, which formed during millions of years of subsidence. Their history spans multiple phases of super continent break-up, dispersal and amalgamation; resulting in the modification of sedimentation rates and drainage within basins. These changing conditions are recorded in the detrital zircon record, providing a tool for understanding the basin evolution and consequently its palaeogeography.
The Proterozoic basin system, informally referred to as the greater McArthur Basin, covers a wide extent of northern Australia, spanning from Western Australia to Queensland. It includes the Palaeoproterozoic to Mesoproterozoic successions of the McArthur and Birrindudu basins and parts of the Tomkinson Province in the south. These basins contain thick sedimentary sequences that were deposited from the Palaeoproterozoic to the Neoproterozoic and have been interpreted to have been interconnected at the time of deposition. LA-ICP-MS detrital zircon U–Pb, Lu–Hf and REE data presented here provide new constraints on the sedimentary successions with in the greater McArthur Basin, to reveal spatial and temporal provenance variations. The basin system initiated straight after the Pine Creek Orogeny and temporally overlaps with Palaeoproterozoic tectonism in the Arunta Province to the basin's south (present coordinates), the Isan Orogeny to its east. Orogenesis at ca. 1.4–1.3 Ga is recorded in the western Musgraves, the east Pilbara, beneath the Nullarbor Plain, the Musgravian Orogeny and subsequent Warakurna large igneous province. This study explores basin provenance with respect to this dynamic basin margin tectonic geography.

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New Tools for Mineral Systems

Hobbs B[1,2]
[1]CSIRO, [2]Centre for Exploration Targeting, UWA

TS5 - 3.1.6 New frontiers in ore system research, Hall E2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Bruce Hobbs' research is in structural geology, the mechanics of hydrothermal systems, modelling of coupled deforming, chemically reacting systems with heat and fluid transport and the thermodynamics of deformed systems at and far from equilibrium. He is co-author of four books on structural geology and the mechanics of fluid/heat transport in porous media and over 200 papers in international journals. His interests are in applying the tools developed for nonlinear dynamical systems over the past 50 years to large data sets on alteration assemblages, deformation and mineralisation in mineralising systems in order to extract information of relevance to metal discovery.

Ore systems are complex systems where interacting processes such as fluid flow, mineral reactions and deformation contribute to ore body formation. The result is generally complicated and predictions of ore grade distribution at both the local and regional scales are difficult. The common approach uses linear methods of pattern recognition such as kriging, weights of evidence and linear correlations which all assume underlying statistical models (such as a Gaussian or log-normal distributions) for the data. Here we discuss a data driven approach that does not rely on underlying statistical models and is capable of integrating all available geoscience data. We treat mineral systems as nonlinear chemical-fluid flow-deformation systems. Such systems can be analysed and described using three interrelated methods. One is purely geometrical and examines the multifractal nature of the mineralisation. The second derives from the dynamics of the underlying processes and results in recurrence plots and their quantification. The third integrates the geometry and the dynamics and is expressed as recurrence networks. All of these methods are highly visual and easily executed for drill-hole data, chemical analyses, geophysical data, and regional distributions of mineralisation and alteration. Such approaches are quantitative and purely data driven with no underlying assumptions of process or statistics although such information can be readily extracted from the analyses. Examples are presented for drill-hole chemical and structural data where quantitative cross correlations are made between data sets at local and regional scales to delineate targets for further exploration and to test proposed models for ore systems.

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Towards a Whole Earth System Reconstruction of the Neoproterozoic

Collins A[1], Blades M[1], Merdith A[2], Donnedieu Y[4], Goddéris Y[5], Williams S[3], Cox G[1], Alessio B[1], Hasterok D[1], Müller D[3]

[1]The University Of Adelaide, [2]Université de Lyon, [3]University of Sydney, [4]Université de Versailles, [5]Géosciences, Environment, Toulouse, Observatoire Midi-Pyrénées

TS5 - 1.1.6 Proterozoic tectonics, Hall A, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Alan Collins is a tectonic geologist who has worked on the tectonic evolution of the Neoproterozoic world for the last twenty years. He has had the fortune to work with a fabulous group of students and colleagues at Adelaide, Perth and overseas that have morphed his research direction into trying to comprehend the links between deep time plate tectonics and the evolution of the planet.

A full-plate topological reconstruction of the ancient earth is a requirement to understand the kinematic evolution of various plates on the planet and integrate preserved geology with the tectonic geography of deep-time. For example, the relics of the complex arc-arc, arc-continent and continent-continent collisions that forms much of north-east and east Africa, all of Arabia, north-west India, Madagascar, southern India, and into Sri Lanka and East Antarctica can be reconstructed to indicate a major plate kinematic reconfiguration at ca. 750 Ma. This is broadly coeval with the start of Neoproterozoic India's southern progress from Tonian polar regions to the tropical margin of western Australia and eventually to collide with Africa to form the largest mountain range known prior to the Himalaya (the East African Orogen).
These GPlates-based reconstructions then form a platform to investigate deep-earth process controls on the wider earth system. The scenario discussed above involves the closure of an equatorial ocean seaway (the Mozambique Ocean), at the same time that the nascent Pacific Ocean opened. The evolution of these oceanic gateways effects climate and nutrient dispersal through changing ocean current patterns. In addition, the creation and destruction of topography can be investigated by integrating thermo-barometric information from the preserved orogens and from detrital phases in successor basins. Together, this creates a work-program to address an Earth Science grand-challenge—creating evolving bathymetric-topographic models for deep time and modelling these plate-ocean-continent configurations to examine nutrient supply and dispersal, climate-controlling chemical fluxes/sinks and their effects on developing the habitable earth.

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Preliminary insights of deep-sea coring of Australia's frontier Bight and Mentelle basins – IODP Expedition 369

Bogus K[4], Expedition 369 Scientists[5], Hobbs R[3], Huber B[2], **White L[1]**

[1]University Of Wollongong, [2]National Museum of Natural History, Smithsonian Institution, [3]Department of Earth Sciences, University of Durham, [4]International Ocean Discovery Program, Texas A&M University, [5]Various

TS6 - 1.3 Marine Geoscience - The evolving oceans/IODP, Room R1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:

Lloyd White is a Lecturer in Geology at the University of Wollongong (2017–). Before moving to Wollongong, Lloyd was based in the UK as a Postdoctoral Research Fellow with the Southeast Asia Research Group at Royal Holloway University of London. He was earlier based in Canberra – first as a Research Geoscientist with Geoscience Australia (2006–2008). He later moved to the Australian National University to commence PhD studies and a postdoctoral fellowship (2008–2012). Lloyd's research focuses on understanding the evolution mountain belts and plate break-up using a mixture of techniques (e.g., structural geology, geochronology, plate reconstructions). Lloyd is a recent recipient of an Australian Geoscience Council Early Career Geoscientists Travel Grant.

International Ocean Discovery Program (IODP) Expedition 369 successfully recovered deep-sea cores from the Bight and Mentelle basins offshore southern and southwest Australia in late 2017. Sediment recovered from each site provides a new perspective on Earth's temperature variation at sub-polar latitudes (~60°S) through the mid-Cretaceous hot greenhouse climate as well as the following period of cooling. This time also marked the final phase of break-up of the Australian, Indian and Antarctic plates. Key goals of the expedition were to:

- characterize how oceanographic conditions changed as the Indian, Australian and Antarctic plates broke apart, as well as due to the later closure of the Indonesian gateway;
- characterize the sequences in the Bight and Mentelle basins for stratigraphic control on the age and nature of pre- and post-break-up stratigraphy;
- obtain a record of Cretaceous oceanic anoxic events (OAEs) to determine the relative roles of productivity, ocean temperature and ocean circulation at high southern latitudes;
- investigate the timing and causes for the rise and collapse of the Cretaceous hot greenhouse climate and how this climate mode affected the climate-ocean system and oceanic biota.

This talk summarises the preliminary results of Expedition 369. This will include a summary of lithological, biostratigraphic, geochemical and physical property data from Hole U1512A in the Ceduna sub-basin, as well as four sites (U1513–U1516) within the Mentelle Basin.

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Identifying and Characterising Mica Minerals with Infrared Reflectance Spectroscopy

LeGras M[1], Laukamp C[1], Lau I[1]
[1]*CSIRO*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Monica LeGras has worked with CSIRO since 2011 after completing a Bachelor of Science (Geology) at the University of New South Wales.

Mica group minerals are a common constituent of many rock types, with variations in their chemical and structural composition indicating the nature of their formation environment, and any subsequent alteration processes. Infrared technologies are more sensitive to light elements than X-ray fluorescence, differentiate mica species more readily than X-ray diffraction, are portable, easy to use and require minimal sample preparation, making them valuable in a wide range of geological applications.

Vibrations arising from the molecular bonds of hydroxylated cations in the octahedral layer of mica minerals, including Al, Mg, Fe2+, Fe3+ and Li, and Si-O bonds in the tetrahedral layer, absorb in the 1200-14500 nm wavelength range of the electromagnetic spectrum. The relative wavelength position and magnitude of the resulting absorption features varies with the type and abundance of different molecules in the crystal. This allows a variety of mica species to be distinguished, and variation in their chemical composition measured. Our work compares infrared reflectance parameters with quantitative geochemical data, which can be used to calibrate infrared data to yield quantitative estimates of mica chemistry.

While not a replacement for very precise quantitative geochemical analysis techniques such as electron probe microanalysis and inductively coupled plasma mass spectrometry, infrared reflectance spectroscopy provides a reliable means both for narrowing sample selection for more thorough analysis, and extrapolating precise quantitative measurements over large datasets.

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Monitoring surface motion from space using Interferometric Synthetic Aperture Radar

Lawrie S[1], Fuhrmann T[1], Garthwaite M[1], Brown N[1]
[1]*Geoscience Australia*

TS2 - 4.4.3 Geoscience data delivery & 4.4.2 Understanding the Surface, Room R7, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
InSAR Scientist working at Geoscience Australia

Monitoring and modelling surface motions caused by natural hazards (e.g. earthquakes, volcanoes) and anthropogenic influences (e.g. urban development, mining activities, groundwater extraction) contributes to a greater understanding of crustal deformation processes, identifying cause-effect relationships from human activities, and development of appropriate risk mitigation strategies.
Interferometric Synthetic Aperture Radar (InSAR) is a technique that utilises radar imagery captured by orbiting satellites to map surface motion patterns at the millimetre to centimetre scale. In this contribution we will demonstrate how InSAR can be used to measure and model surface motion on different spatial and temporal scales using case studies from Australia and the Asia-Pacific region. Our case studies will include: the 2016 Petermann Ranges earthquake in Western Australia, the largest in Australia for 19 years; volcano deformation in Papua New Guinea; urban monitoring in Melbourne; and sub-surface mining activities in New South Wales.
Since the launch of the Sentinel-1 satellite constellation by the European Space Agency in 2014, there have been regular SAR imagery acquisitions over the entire Australian continent (~12 day repeat coverage). This provides Australia with an opportunity to develop national-scale InSAR surface deformation products. Such products could be used to enhance our understanding of the intra-plate tectonic movement of the continent, and identify previously unrecognised deforming regions that are being impacted by either natural hazards or anthropogenic influences. These opportunities will be discussed in the presentation.

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Forecasting in Mineral Systems

Ord A[1], Hobbs B[1,2]
[1]Centre for Exploration Targeting, The University of Western Australia, [2]CSIRO

TS3 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Alison's research is in structural geology, the mechanics of hydrothermal systems, computer modelling of coupled deforming systems with heat and fluid transport and the thermodynamics of chaotic systems. Her interests are in applying the tools developed for nonlinear dynamical systems, particularly multifractal analysis and recurrence plots, to large data sets on alteration assemblages, deformation and mineralisation in mineralising systems in order to quantify and fingerprint various classes of hydrothermal mineralising systems. Her goal is to develop a new paradigm for mineral exploration based on nonlinear dynamics.

The forecasting of mineralisation and structural features is important in hydrocarbon and mineral exploration, mining and geotechnical engineering. Although the distribution of mineralisation, alteration and structural features such as folds, faults and veins may appear irregular and difficult to forecast in advance from observed data we show that such irregularity can be analysed using complexity theory. In particular these data sets can be visualised, quantified and analysed in terms of recurrence plots and recurrence networks. A recurrence plot is a visual generalised autocorrelation function and embodies the dynamics of the underlying physical and chemical processes that produced the data. A recurrence network describes the interconnections between parts of the system and reflects the topology of the underlying dynamics. Both recurrence plots and networks can be quantified with measures that reflect the dynamics of the processes that produced the data set. Both methods are data driven with no assumptions made of the statistics or dynamics of the system. The basis for forecasting lies in this underlying dynamical knowledge where the dynamics are used as training sets for forecasting ore grades, mineralised sites and structural geometry in areas with little or no data. We give examples for recurrence plot and network analyses together with forecasting based on these procedures for ore grades, fold systems and vein arrays with quantitative measures of the uncertainties. Comparisons are made with conventional kriging methods. These procedures are important as non-parametric data driven methods that are essential for visualising and analysing big-data sets arising from nonlinear processes.

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Linking the Neoproterozoic Oxygenation Event to the interplay between global glaciation and the radiation of eukaryotes

Cox G[1], Blades M[1], Kunzmann M[2], Collins A[1], Giles D[3]
[1]University Of Adelaide, [2]CSIRO Mineral Resources, [3]University of South Australia

TS3 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
I am an earth scientist whose research centres around the interaction between solid earth processes (e.g. tectonics) with the redox state of the earths oceans and atmosphere along with climate. I studied economics at Charles Sturt University and both chemistry and geology at the University of Adelaide. This was followed by a PhD at McGill University and a post doc at Curtin University. Currently I am a research associate at the University of Adelaide.

Understanding the timing of the Neoproterozoic Oxygenation Event (NOE) is of importance as much debate surrounds whether the emergence of animals is linked directly to levels of atmospheric pO2, is simply a consequence of the timing of evolutionary advances, related to changes in ecosystem structures, or some combination of the above.
Estimates on the timing of the NOE vary significantly between different isotopic proxies (δ53Cr, Mo and Fe speciation in black shales), likely relating to the sensitivity to rising pO2 and differences in the temporal resolution of the respective datasets. Here we make use of high resolution geochemical analysis focussing on elemental proxies for pO2, on core that spans the Sturtian-Marionan interglacial sequence; Marinoan glacial interval and post Marinoan transgression.
These data reveal that while some increase in pO2 is apparent in the aftermath of the Sturtian glaciation, persistent growth in pO2, occurs in the immediate aftermath to the Marinoan glaciation. This work, in part, supports recent models, which argue for a direct link between snowball glaciations and step changes in atmospheric O2. However, it raises the question as to why this step change is associated with the later Marinoan glaciation rather than the Sturtian glaciation. We suggest that the necessary pre-requisites for the NOE is both extreme glaciation coupled with the rise to dominance of eukaryotes, which occurs during the Sturtian–Marinoan interglacial. We suggest that this interplay between biology and climate is responsible for oxygenation being tied to the later Marinoan glaciation.

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Mapping and characterising springs for understanding groundwater-surface water interactions in the Upper Burdekin Region, north Queensland

Dixon-jain P[1], Dunn B[1], Newey V[1], Ransley T[1], Sundaram B[1]
[1]*Geoscience Australia*

TS1 - 3.3.1 Groundwater challenges and opportunities & 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
tbc

The Upper Burdekin region in north Queensland consists of basaltic, alluvial and fractured rock aquifers. In addition to stock and domestic water use, the basalt aquifers sustain wetlands and provide baseflow to streams. Demand for water in the region is predicted to increase, with potential impacts on water availability for natural ecosystems. Understanding the mechanisms and dynamics of groundwater and surface water system interactions is required for the protection and management of groundwater dependent ecosystems.

The Basalt Provinces in the Upper Burdekin region contain springs in numerous locations. Springs have been identified as both local discharge features, occurring as small seeps, and as regionally significant discharge features that drive permanent flow in many streams, including the Upper Burdekin River. These springs have differing temporal dynamics and hydrochemical signatures that reflect their combination of groundwater sources, positions in the landscape and phenology.

Springs in the Upper Burdekin region have been mapped and characterised by a variety of methods. To complement the more traditional hydrochemical and topographic approaches for understanding groundwater-surface water interactions, remote sensing approaches have also been applied. Remote sensing products provide spatial and temporal datasets that are particularly useful for the current study due to the large area, restricted access and limited availability of time-series hydrological data. Tasselled cap algorithms have been applied to Landsat series spectral data (available through Digital Earth Australia) to identify springs that contribute flow to surface water systems and understand the seasonal response of water in the landscape over multi-decadal time periods.

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150 Myr of episodic metamorphism, magmatism and intraplate deformation catalysed by rehydration and localised weakening of the deep crust

Raimondo T[1], Howlett D[2], Varga J[1], Morrissey L[1], Kelsey D[2], Hand M[2]
[1]School of Natural and Built Environments, University of South Australia, [2]School of Physical Sciences, University of Adelaide

TS7 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
I am a geologist and geochemist who is interested in how mountains form in the centre of tectonic plates, how fluids control the strength of rocks and trigger earthquakes, and how some of the hottest rocks in the world are distributed through southern Australia. In more specific terms, my research focuses on these major themes:
(1) Fluid–rock interaction in the deep crust/shear zones;
(2) Linking geochemical and microstructural records of fluid flow to large scale geodynamics;
(3) Intraplate mountain building (orogenesis);
(4) Heat flow and crustal heat production (geothermal energy).

The intraplate Alice Springs Orogen, central Australia, is characterised by fluid-rock systems that systematically vary in their depth, structural style, fluid sources and magnitude of alteration and deformation. Despite being part of a laterally-continuous anastomosing shear belt, however, the timing of metamorphism, magmatism and deformation associated with fluid-rock interaction is strongly diachronous. Ages obtained from amphibolite-facies schists and associated pegmatite suites span 150 Myr from 450–300 Ma, and are linked to multiple prograde thermal cycles that attest to a prolonged and episodic history of rehydration and reworking.

We focus on kilometre-scale shear zones and voluminous pegmatite intrusions of the Strangways and Harts Ranges, which represent extensive zones of mid-crustal rehydration and localised lithospheric weakening that transect Palaeoproterozoic granulite facies protoliths. Garnet Sm-Nd and monazite, xenotime and zircon U-Pb ages indicate that periods of prograde metamorphism and pegmatite emplacement occurred at c. 450, 420, 380, 360, 330 and 300 Ma. Calculated P–T mineral equilibria models indicate that each prograde metamorphic episode reached similar peak P–T conditions (6.5–6.9 kbar and 575–660 °C). Garnet core compositions indicate that its growth initiated at elevated P–T conditions, and petrographically the samples show no evidence of relict phases or preserved mineral reaction textures. These factors suggest that the protolith did not undergo low-temperature retrogression prior to prograde metamorphism, but rather that metamorphism resulted from fluid-rock interaction at near peak P–T conditions. Palaeozoic reworking was thus catalysed by episodic hydrous input into the metastable Palaeoproterozoic granulite protolith, causing a profound effect on the dynamics of basement reactivation.

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Exploring for the Future: South Nicholson Seismic Interpretation

Carr L[1], **Henson P**[1], Southby C[1], Carson C[1], Anderson J[1], Fomin T[1], Bailey A[1], Costelloe R[1], Champion D[1], Huston D[1], Doublier M[1]
[1]*Geoscience Australia*

TS2 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Lidena Carr is a geoscientist for the onshore energy systems project within the Resources Division at Geoscience Australia. She graduated from the Australian National University majoring in Geology and Human Ecology with a BA/BSc (Hons) in 2004, and began working as a technical officer at the Research School of Earth Sciences (ANU). In 2007 She joined Geoscience Australia with the then ACRES, in 2009 she moved to the then Onshore Energy and Mineral Division to work as a seismic interpreter and basin analyst. Currently she works within the Onshore Energy Section as part of the Exploring for the Future program.

Exploring for the Future is a four year $100.5 million initiative by the Australian Government conducted in partnership with state and Northern Territory government agencies, CSIRO and universities that aims to boost northern Australia's attractiveness as a destination for investment in resource exploration. As part of this program Geoscience Australia's leading researchers will use innovative techniques to gather new pre-competitive data and information, on an unprecedented scale, about the energy, mineral and groundwater resource potential concealed beneath the surface.
A major EFTF deliverable, the acquisition of crustal seismic reflection data in the region between the southern McArthur Basin to the Mt Isa western succession, crossing the South Nicholson Basin and Murphy Province, was completed in August 2017. Prior to this survey the region contained no seismic data and minimal well data. Five seismic lines were acquired in an orientation to best image geological features which had been identified in outcrop and as sub-surface geophysical features. The acquisition was designed to explore both exposed and undercover sedimentary basins to better understand the location and scale of the region’s oil, gas and mineral potential, and to image the crustal architecture. Previously unidentified geological features have been imaged by the new seismic, including a large ?Paleoproterozoic to Mesoproterozoic basin (~5-7 km thick) in the undercover region to the west of Mt Isa. The new data has greatly improved our geological and resource understanding of the region and was initially released in Alice Springs at the Annual Geoscience Exploration Seminar in March 2018

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A biological trigger for cyclic organic carbon enrichment in Mesoproterozoic black shales

Cox G[1], Sansjofre P[1], Blades M[1], Collins A[1], Farkas J[1]
[1]University of Adelaide, [2]Laboratoire Géosciences Océan, Institut Universitaire Européen de la Mer

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
I am an earth scientist whose research centres around the interaction between solid earth processes (e.g. tectonics) with the redox state of the earths oceans and atmosphere along with climate. I studied economics at Charles Sturt University and both chemistry and geology at the University of Adelaide. This was followed by a PhD at McGill University and a post doc at Curtin University. Currently I am a research associate at the University of Adelaide.

Cyclic behaviour in organic matter enrichment within a Mesoproterozoic black shale succession are not associated with maximum flooding surfaces. The combination of δ15N, δ13C, total organic carbon and molybdenum concentrations are used to show that such cyclic behaviour can be explained by the interaction between redox processes and biological metabolisms, specifically, diazotrophy. This supports the hypothesis of Anbar and Knoll (2002) that basin redox, in particular euxinia, influences nutrient concentrations, in particular molybdenum and subsequently bioavailable nitrogen (i.e. Mo-N co-limitation). Such processes can naturally affect primary productivity and organic carbon burial. Considering the link between organic matter export and euxinia, the euxinic redox state is inherently self-limiting.

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Complex Systems Thinking and Mineral Systems

Hobbs B[1,2], Ord A[1]
[1]*Centre For Exploration Targeting, UWA,* [2]*CSIRO*

TS6 - 3.1.2 Making better exploration decisions through an integrated geoscience approach, Hall E2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Bruce's research is in structural geology, the mechanics of hydrothermal systems, modelling of coupled deforming, chemically reacting systems with heat and fluid transport and the thermodynamics of deformed systems at and far from equilibrium. He is co-author of four books on structural geology and the mechanics of fluid/heat transport in porous media and over 200 papers in international journals. His interests are in applying the tools developed for nonlinear dynamical systems over the past 50 years to large data sets on alteration assemblages, deformation and mineralisation in mineralising systems in order to extract information of relevance to metal discovery.

The conventional view of mineral systems as a source-path-trap paradigm is a linear approach that fails to account for interactions (especially long range interactions) across the time and spatial scales involved in ore system formation. Such an approach is reductionist in nature and has been important in developing linear models of mineralisation. The success of such models depends on whether the system is linear or not and is commonly applied to a single ore body rather than the regional system. A complex systems approach examines all possible inputs and outputs for a system of interest and takes into account that there may be feedback loops and strong interconnections between parts (the nodes) of the system at microscopic, local and regional scales. Interactions between parts of a system are quantified using measures such as the connectedness, degree/centrality and clustering of the various nodes in the system. In establishing the connections and strength of coupling between various nodes all relevant geoscience data are integrated. As an example we present a network analysis of the Yilgarn gold-nickel system. This system is viewed as a regional set of nodes at which open flow chemical reactors operate to produce ore bodies of various grades. We examine various models that optimise the ore grades at specific nodes in the system and the implications for mineral exploration. In comparing the Yilgarn with other mineralised systems it appears that so called small world networks are characteristic of highly mineralised systems implying long range spatial connections between deposits.

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Geostatistics for Mining Geology and Grade Control

Shaw W[1]
[1]Ore Control

TS8 - 4.2 Mining geology and geometallurgy, Room R6, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Bill has over 40 years of experience in economic geology including mineral resource and ore reserve estimation, mining grade control, sampling studies and mining project evaluation. He has operational experience in gold and ferrous metals and has audited mineral resources and ore reserves for many commodities to international standards.
He has many voluntary roles including on JORC, VALMIN and IMVAL for the AusIMM and AIG. He is currently the President of the Australian Geoscience Council, on the Executive of UNCOVER AUSTRALIA, was involved in preparing the Australian Academy of Science Decadal Plan for Geoscience, and is the Chair of the AGC Convention (AGCC 2018) to be held in Adelaide during Earth Science Week.

The application of geostatistics to the estimation of Mineral Resources had slow acceptance but it is now the industry standard. Better training of practitioners, better user knowledge and better outcomes resulted in good practices being promoted and poorer ones being abandoned. The mystique of kriging as a 'black box' has now been supplanted by acceptance that it works better than the previous methods. Of course, there is always a requirement for geological knowledge to be integrated, applied and tested in every case.

Mining Grade Control involves identifying the Ore Reserve locally, and then mining it to achieve expected outcomes. Geostatistics was often applied only to analyse specific problems, usually when there was a reconciliation issue. Since the 1990s, as computing power and software has evolved, there has been significant growth in the application of the geostatistical tools of variography, kriging and conditional simulation to this approach of solving problems on mine sites.

The way in which geostatistics was accepted for resource development provides a context for how we can better disseminate the concepts, tools and successes of applications in the mine environment. There is a need for a better understanding of the characteristics of good practices, and for support of these in the context of what works, when and why.

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A ~1600-1580 Ma metamorphic core complex in the northern Gawler Craton

Tiddy C[1], Betts P[2,6], Neumann M[3,4], Murphy F[5], Stewart J[6], Giles D[1], Sawyer M, Freeman H[4], Jourdan F[7]
[1]Future Industries Institute, University of South Australia, Deep Exploration Technologies Cooperative Research Centre (DET CRC) , [2]Monash University, [3]Tectonics, Resources and Exploration (TRaX), Department of Earth Sciences, University of Adelaide, , [4]OZ Minerals Limited, [5]Fractore Pty Ltd , [6]PGN Geoscience, [7]Department of Applied Geology, Curtin University of Technology

TS5 - 1.1.6 Proterozoic tectonics, Hall A, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Professor Peter Betts is an academic in the School of Earth, Atmosphere and Environment and is the Associate Dean of Graduate Research in the Faculty of Science. He has expertise is in structural analysis of regional aeromagnetic and gravity datasets, forward modelling of gravity and magnetic data, regional tectonic and geodynamic analysis, ancient and modern tectonic synthesis. He has a diverse portfolio of research that includes the dynamics of congested subduction, ocean initiation processes in the Red Sea, tectonic evolution of the Australian Plate, mineral system analysis, and geophysics of volcanoes.

The Mount Woods Domain in the northern Gawler Craton has been interpreted to be one of the oldest known metamorphic core complexes on Earth, which impacts on assessing this region for IOCG mineral systems prospectivity analysis and consideration of factors such as crustal depth, association and distribution of intrusive rocks and fault architecture. The core complex architecture developed at ~1600-1580 Ma, during the Hiltaba Event, and has been identified using an integrated approach of geophysics, field mapping, metamorphic petrology and zircon and biotite geochronology. The core of the complex comprises the Mount Woods Metamorphics, which yield a new maximum depositional detrital zircon age of ~1860 Ma and are now the oldest rock package recognised within the domain. These rocks were deformed along thrust structures and metamorphosed to upper amphibolite to granulite facies during the ~1740-1690 Ma Kimban Orogeny. The upper plate comprises the ~1750 Ma Skylark Metasediments, which were extensively intruded by Hiltaba Suite granitic and mafic plutons at ~1595-1575 Ma. Sedimentary and volcanic successions of the Gawler Range Volcanics were deposited into half graben basins that evolved during brittle normal faulting of the upper plate associated with NE-SW extension. The detachment fault juxtaposing the upper and lower plates is defined by the Skylark Shear Zone. The core complex was deformed and exhumed along major faults during the ~1570-1540 Kararan Orogeny. The timing of exhumation is constrained by new $^{40}Ar/^{39}Ar$ biotite cooling ages that show the central Mount Woods Domain cooled past ~300°C at ~1560 Ma.

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Millennial-scale variability in subtropical precipitation observed in Central Queensland speleothem

Welsh K[1], Eickhoff C[1], Nothdurft L[1], Price G[1], Feng Y[1], Webb G[1], Zhao J[1]
[1]*University Of Queensland*

TS4 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Kevin Welsh is Lecturer in Sedimentology and Palaeoclimate in the School of Earth and Environmental Science at the University of Queensland. His main interests are in the use of fossils and geochemical proxies to understand changes in hydrology and sea level in the Late Quaternary.

Australia is the driest inhabited continent with the most spatially and temporarily variable precipitation making it vital to understand the consequences of future climate change on rainfall regimes. However there are significant gaps in our knowledge largely because of a lack of reliable, high resolution and well-dated records of hydrological variability that span the last glacial cycle. The subtropics of Australia are a particularly important area for understanding interactions between climate systems. Several studies indicate that high latitude forcing may influence precipitation in the tropics, and some recent studies from south east Queensland and northern New South Wales indicate a wet or variable Last Glacial Maximum. However, these sites rely on 14C dating of lake and swamp cores, which are less precise during MIS3, and there is a conspicuous lack of continuous records in the northern subtropics meaning that our spatial understanding is very limited. Here we present two overlapping trace element records derived from a well-dated speleothem from Mount Etna, Central Eastern Queensland that we interpret as reflecting variations in precipitation at this site. These records appear to indicate rapid changes in relative precipitation that are coeval with the northern hemisphere Heinrich events and also may indicate a relatively wet Last Glacial Maximum in the Australian subtropics.

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Progress towards deep coring of the Lord Howe Rise, northern Zealandia: a guide to the future of IODP riser drilling

Hackney R[1], Eguchi N[2], Saruhashi T[2], Aoike K[2], Saito S[2], Yamada Y[2], Yano T[2], Nichol S[1], Carroll A[1], Taira A[2], Heap A[1], IODP Proposal 871 Science Team
[1]*Geoscience Australia,* [2]*Japan Agency for Marine-Earth Science and Technology*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Ron Hackney is a Senior Geoscientist at Geoscience Australia and the lead proponent on a proposal for innovative IODP deep riser scientific drilling on the Lord Howe Rise (northern Zealandia). Prior to joining GA 10 years ago, Ron was Junior Professor for Solid Earth Geophysics at the University of Kiel and completed a postdoc at the Free University of Berlin, a PhD at the University of Western Australia, an MSc at Victoria University of Wellington and a BSc(Hons) at the Australian National University. Ron has been Secretary of the Australian Geoscience Council since 2013.

Much has been achieved in 50 years of DSDP, ODP and IODP. However, to date deep riser drilling has played a relatively small role in IODP and its predecessors, albeit a role with considerable impact, especially in the understanding of subduction zone processes gained from CHIKYU drilling into the Japan forearc. More frequent deep riser scientific drilling is arguably a goal for the next 50 years of IODP. Geoscience Australia and JAMSTEC first discussed CHIKYU riser drilling on the remote Lord Howe Rise (LHR) continental ribbon, east of Australia, a decade ago. The resulting decade-long collaboration recognised the importance of the LHR in addressing globally-relevant scientific questions in Cretaceous tectonics and paleoclimate, as well as the limits to life on Earth. A proposal for deep riser drilling on the LHR was approved by IODP in early 2017. Subsequent planning for this ambitious expedition exemplifies the unique challenges faced by scientific riser drilling under IODP. These challenges include a need for comprehensive site surveys that allow a thorough assessment of geohazards, collection of baseline data to support environmental permitting, planning logistical support for remote, long-duration drilling operations, and securing funding for a high-cost expedition. This presentation will provide an overview of the efforts by JAMSTEC, Geoscience Australia and a diverse team of international proponents in delivering new data from the LHR extended continental ribbon that ultimately place IODP on the verge of ground-breaking scientific riser drilling in a remote part of northern Zealandia.

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Use of Industry seismic reflection data for groundwater investigations in the Kimberley region as part of the Exploring for the Future Program

Cathro D[1], Lawrie K[1], Halas L[1], Symington N[1], Christiansen N[2], McMillan M[3], Harris-Pascal C[1], McPherson A[1], Tan K[1]

[1]Geoscience Australia, [2]Aarhus University, [3]Computational Geosciences Inc

TS1 - 3.3.1 Groundwater challenges and opportunities & 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 11:00 AM - 1:00 PM

Biography:

Donna Cathro is a Basin Analyst in the Groundwater Group at Geoscience Australia contributing to projects in the East Kimberley region and Surat-Galilee basins. Prior to joining GA, Donna was a senior geologist with FROGTECH, where she worked on a variety of regional seismic stratigraphic projects and multi-basin SEEBASE™ studies. She obtained a BSc (Hons) from Adelaide University and holds a PhD from the University of Texas at Austin. In her early career, Donna worked at AMDEL Core Services as a sedimentary petrologist and AGSO (now Geoscience Australia) as a seismic data processor and interpreter. Member: AGU, AAPG, PESA.

donna.cathro@ga.gov.au

The Kimberley Region of north-western Australia has been identified as a priority for agricultural expansion by the Australian, Western Australia (WA) and Northern Territory (NT) Governments. The area also has known hydrocarbon and mineral resources, with irrigated agriculture proposed for both upland and lowland landscapes. Geoscience Australia is currently undertaking an inter-disciplinary, multi-physics investigations into the groundwater systems in the Kimberley region including the onshore Ord-Bonaparte Basin to provide a broader regional context for proposed future development in the region.
New data acquisition includes: over 6,000 line-km of airborne electromagnetics (AEM; SkyTEM312FAST); surface nuclear magnetic resonance (SNMR); passive seismic and microgravity; drilling and pump testing; borehole geophysics (induction, spectral gamma, NMR); hydrogeological and hydrochemical investigations; regional soils, geological and morphotectonic mapping; and groundwater system assessment and modelling.

Pre-existing Industry seismic reflection data are often overlooked for groundwater studies and can supply additional regional context and constraints. The project has re-processed ~600 line-km of legacy, multi-survey 2D seismic reflection data acquired in several phases from the early 1980s through to 1997. Reprocessing focussed on targeting the shallow depth section while maintaining imaging at depth. Results vary between surveys and geographically, however, overall, reprocessing has resulted in higher Signal/Noise ratios, and traceable reflections that provide additional details of the shallow subsurface geological architecture, while reflectivity is retained at greater depth. Reprocessed seismic data will be integrated with geological and hydrogeological interpretations from the newly acquired data and provide invaluable constraint to AEM inversions, particularly in areas with complex fault zones.

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MinEx CRC: Addressing future trends and adoption challenges of exploration technology

Bailey A[1], Giles D[2]
[1]MinEx CRC, [2]UniSA

TS8 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Andrew Bailey is a geologist with Australian and International experience across exploration, resource estimation, research coordination, development and mining projects. He has worked in on gold, diamond, nickel laterite, nickel sulphide and iron ore deposits primarily for large corporations, but also in small company settings. He holds an M.Sc and MBA degree and has been coordinating the bid for the MinEx CRC since mid-2017.

MinEx CRC is addressing future trends in exploration technology by delivering; 1) more productive, safer and environmentally friendly drilling methods; 2) new technologies for collecting data while drilling and; 3) exploration data on never before sampled, but prospective, rocks. The three research programs of MinEx CRC have been proposed by our participants are to be delivered by:

- Drilling Technologies, including extending the capability of Coiled Tubing (CT) drilling so that it can drill deeper, is steerable and delivers the highest quality sampling. and developing technologies for optimising the performance and increasing the productivity of conventional drilling techniques.
- Data from Drilling, with technologies for capturing geochemical, petrophysical and seismic data either during drilling or within the drilling workflow, as well as software to enable drilling data to be integrated into 3D geological models in real-time.
- National Drilling Initiative (NDI), employing novel drilling technologies in collaboration with Australia's geological surveys to map the deep cover search space and determine its mineral prospectively.

By undertaking projects proposed by industry, including the geological surveys, adoption challenges are being addressed throughout the planned 10-year life of the MinEx CRC, with >$200m of total resources applied to the three significant programs outlined above.

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New age constraints on stratigraphic units of the South Nicholson Basin, Australia

Lewis C[1], Anderson J
[1]*Geoscience Australia*

Biography:
Chris Lewis completed his undergraduate degree (B.Sc. Hons) at the University of Adelaide in 2009. He joined Geoscience Australia in 2010 and has worked in both the Energy Systems Branch and Mineral Systems Branch with a focus on applying geochronology and isotope geochemistry to both large- and small-scale projects.

The chronostratigraphic record of sedimentary rocks in the South Nicholson Basin is poorly understood. The sedimentary rocks are generally assumed to be time-equivalent to those of the McArthur Basin (c. 1500–1400 Ma). Under the auspices of the Exploring for the Future Programme new geochronological data has been acquired from South Nicholson Group units to constrain the timing of deposition to inform estimations of hydrocarbon plays within the basin.

We present seven new SHRIMP U–Pb zircon datasets, and compare these with existing age data across the South Nicholson and Roper groups, and older stratigraphic units between c. 1650 Ma and c. 1400 Ma across northern Australia within the McArthur Basin and Isa Superbasin.

New zircon ages acquired from tuffaceous intervals suggest part of the Mullera Formation was deposited at or after c. 1366 Ma, more than 100 My younger than existing U–Pb age data from the South Nicholson Basin and suggesting the presence of an unrecognised, major sedimentary hiatus between the Mullera Formation and underlying Constance Sandstone (c. 1578 Ma tuff age). New U–Pb zircon data also suggest parts of the lower Doomadgee Formation of the underlying Fickling Group were deposited at or after c. 1612 Ma.

We also present new detrital age data from the previously correlated Mittiebah Sandstone (NT) and Constance Sandstone (QLD) to compare provenance age spectra. These age data provide an improved understanding of the timing of deposition and detrital signatures for the South Nicholson Basin.

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Sit back, relax and enjoy: GSWA's virtual tours

Goss S[1], Farrell T[1], **Riganti A[1]**, Johnston J[1], Johnson S[1]
[1]*Geological Survey of Western Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Angela Riganti is the Content Manager at the Geological Survey of Western Australia, focussing on design and management of geoscience databases, and innovations in geoscience data delivery. She is an ardent advocate for promoting community awareness of the role of earth sciences in every day's life, and contributes to projects that foster the appreciation of the geology underpinning landscapes, both in the remote and urban environment.

As technological innovations have improved virtual reality capabilities, virtual tours have become commonplace – enticing travelers to research and preview their destinations from the comfort of their armchairs. Equally, virtual geotours should offer previews of geosites of interest to attract potential tourists, provide relevant access and geological information, and afford the opportunity to travel to remote (and often inaccessible) destinations for those unable to make the trip.

Free virtual tours by the Geological Survey of Western Australia (GSWA) offer a unique travel experience to parts of the remarkable geology of the State. They vary from virtual field excursions for experienced professionals (e.g. Mafic–ultramafic intrusions of the Youanmi Terrane, created for a conference field trip) to those designed for amateur geologists or anyone with a passion for finding out more about WA's spectacular geology (e.g. Discovery trails to early Earth in the east Pilbara). Others (e.g. Meteorite impact structures of Western Australia) are progressively built on, with new sites released incrementally. All tours rely heavily on photos, geological maps and other appropriate material, and can include detailed glossaries and references for further reading.

GSWA's web-based virtual tours are best run on Google Earth Pro to maximise users' experience. The Keyhole Markup Language (KML) files are available from the department's e Bookshop (www.wa.gov.au/ebookshop), and can be downloaded to a USB or saved to a local drive on a PC. An in-house app is being developed to allow easy conversion of legacy geological field excursions into online Google Earth virtual tours.

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Unravelling the pre-1860–1850 Ma ‘basement’ history of the Mount Isa Inlier

Lewis C[1], Bultitude R[2], Hutton L[2]
[1]Geoscience Australia, [2]Geological Survey of Queensland

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Chris Lewis completed his undergraduate degree (B.Sc. Hons) at the University of Adelaide in 2009. He joined Geoscience Australia in 2010 and has worked in both the Energy Systems Branch and Mineral Systems Branch with a focus on applying geochronology and isotope geochemistry to both large- and small-scale projects.

The Kalkadoon-Leichhardt Domain of the Mount Isa Inlier has been interpreted to represent the ‘basement’ of the larger inlier, onto which many of the younger, economically prospective sedimentary and volcanic units were deposited. The domain itself is dominated by 1860–1850 Ma granitic to volcanic Kalkadoon Supersuite rocks, but these units are interpreted to have been emplaced/erupted onto older units of the Kurbayia Metamorphic Complex.
This study aims to provide insights into a number of geological questions:
1. What is the isotopic character of the pre-1860–1850 Ma rocks?
2. How do these vary laterally within the Kalkadoon-Leichhardt Domain?
3. What is the tectonic/stratigraphic relationship between the 1860–1850 Ma rocks of the Mount Isa Inlier and c. 1850 Ma rocks of the Tennant Creek region and Greater McArthur Basin basement?
Detrital zircon U–Pb results indicate the presence of 2500 Ma detritus within the Kurbayia Metamorphic Complex, suggesting that the Kalkadoon-Leichhardt Domain was a sedimentary depocentre in the Paleoproterozoic and potentially had sources such as the Pine Creek Orogen, or, as some authors suggest, potential sources from cratons in northern North America.
Existing Hf and Nd-isotopic data suggest that the ‘basement’ units of the Mount Isa Inlier have early Proterozoic model ages (TDM) of 2500–2000 Ma. Oxygen and Hf-isotopic studies on samples from this study will allow us to test these models, and provide further insights into the character and history of these ‘basement’ rocks within the Mount Isa Inlier, and northern Australia more broadly.

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Northeast-Australian collisional tectonics during the assembly of Nuna unravelled by multi-method petrochronology

Pourteau A[1], Li Z[1], Collins W[1], Norsdvan A[1], Volante S[1], Li J[1], Smit M[2]
[1]Curtin University, [2]University of British Columbia

TS7 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
2007–2016: Doctoral study and post-doctoral appointments at the University of Potsdam, German on Tethyan subduction-related tectonics in the East Mediterranean.
Since Feb 2016: Research Fellow in the Earth Dynamics Research Group at Curtin University working on Proterozoic tectonics in NE Australia

Northeast Australia ca. 1.65–1.50 Ga orogenic events have previously been ascribed to a collision with western Laurentia. However, these events are characterised by low–P/T metamorphism rather than medium–P/T metamorphism associated with crustal thickening expected during continental collision.

Recent work showed that the Proterozoic Georgetown Inlier of NE Australia has a Laurentian affinity prior to ca. 1.65 Ga, and an Australian affinity by ca. 1.5 Ga (Nordsvan et al., 2018), suggesting a ca. 1.65–1.5 Ga suture within Queensland.

Here we report for the first time, synchronous prograde metamorphic history across this suture, precisely dated at ca. 1.60 Ga using the garnet Lu–Hf method. We interpret the prograde medium–P/T metamorphism in the Georgetown Inlier as recording lower plate burial and crustal thickening, and coeval low–P/T metamorphism in the Mount-Isa Inlier as related to basin inversion.

Zircon U–Pb–Hf isotopic data for felsic igneous and migmatised sedimentary rocks from NE Australia show a decreasing trend from ca. 1.65 to 1.5 Ga. This gradual isotopic enrichment, at a higher rate than in crustal growth models, and the lack of subsequent juvenile magmatism are interpreted to reflect collisional and post-collisional processes in an internal orogen.

These results shed light on the 1.7–1.5 Ga evolution of the converging plate boundary between Australia and Laurentia, and further indicate the final assembly of the Nuna supercontinent took plate at 1.6 Ga.

Reference

Nordsvan et al., Geology, 2018, doi:10.1130/G39980.1

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A global full-plate reconstruction model for the last 2.0 Ga

Wu L[1], Li Z[1], Pisarevsky S[1]
[1]Earth Dynamics Research Group, ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS) and The Institute for Geoscience Research (TIGeR), School of Earth and Planetary Sciences, Curtin University

TS2 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr. Lei Wu is a research associate in the Earth Dynamics Research Group at Curtin University. Dr. Wu received his PhD in geophysics from the University of Alberta, Canada. His research interests involve geophysics, data mining, seismology and paleomagnetism.

Kinematic reconstruction of global plates provides a key framework and surface boundary condition necessary for understanding the Earth's 4D history, and for resolving mantle thermochemical evolution, surface dynamic process and global climatic changes. Here we present the first global full-plate reconstruction model for the last 2.0 Ga, using freeware GPlates. We first critically modified recently published post-1.0 Ga global full-plate models through (1) applying paleomagnetic constrains using our latest compilation of paleomagnetic database, (2) removing true polar wander corrections to reflect paleogeographic evolution in the spin axis reference frame instead of the speculated mantle reference frame, (3) examining the "orthoversion" assembly model of supercontinents, and (4) utilising multiple geotetonic constraints. Paleopoles from clastic sedimentary rocks were corrected with a common flattening factor of 0.6 to correct the inclination shallowing effect. To ensure the quality of paleomagnetic data, paleopoles were first selected by applying a cut-off quality factor of 4 based on the Van der Voo seven-criterion and then further scrutinized to remove those affected by remagnetization and/or local rotations. Although the Precambrian part of the plate model is necessarily more speculative than the Phanerozoic part due to less robust geological and geophysical constraints for numerous time intervals, our model will facilitate further testing and improvements by the community when more critical data and databases become available in future.

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Computer vision techniques for extracting geological lineaments from optical remote sensing data

Farahbakhsh E[1], **Chandra R**[1,2], Olierook H[3], Scalzo R[2], Clark C[3], Muller R[1,4]
[1]School of Geosciences, University of Sydney, [2]Centre for Translational Data Science, University of Sydney, [3]School of Earth and Planetary Sciences, Curtin University, [4]Sydney Informatics Hub, University of Sydney

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Dr. Rohitash Chandra is USyd Research Fellow at the Centre for Translational Data Science and School of Geosciences at the University of Sydney. His research interests are in areas of deep learning, neuro-evolution, Bayesian methods, solid Earth Evolution, reef modelling and mineral exploration.

The extraction of geological lineaments from digital satellite data is a fundamental application in remote sensing. Accurately locating geological lineaments such as faults and dykes are important because of their correlation with hydrothermal mineralization. A wide range of successful applications have utilized computer vision and image processing techniques, but these are rarely used for mineral exploration. The diversity of computer vision techniques and image processing algorithms, and lack of a standard procedure for extracting geological lineaments is a significant obstacle. Here, we provide a semi-automatic procedure for extracting geological lineaments using computer vision and image processing techniques. We employ a combination of edge detection and line extraction algorithms for extracting geological lineaments using optical remote sensing data. Image processing algorithms are also used for reducing dimension, removing noise and enhancing the lineaments. Moreover, the efficiency among three dimension reduction algorithms and two convolutional filters are compared in terms of enhancing the lineaments. We test the proposed procedure on Landsat 8 data of a mineral-rich portion of the Gascoyne Province, Western Australia, and compare this to lineaments defined from geological mapping by the Geological Survey of Western Australia. The highest correlation of geological lineaments between computer vision and geological mapping is achieved by applying the image with maximum eigenvalue resulted after running minimum noise fraction algorithm and extracting lineaments using a directional filter. Extracted and mapped lineaments show strong correlation with known sites of hydrothermal mineralization.

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Characterisation of New Caledonian nickel laterite using hyperspectral imaging

Ramanaidou E[1], Fonteneau L[2], Sevin B[3], Foucher W[4]
[1]CSIRO Mineral Resources, [2]Corescan Pty Ltd, [3]Direction de l'industrie des mines et de l'énergie de la Nouvelle-Calédonie, [4]Nickel Mining Company

TS2 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Erick Ramanaidou is the Commodity Research Leader for iron ore and lateritic Nickel in the Discovery Program in CSIRO Mineral Resources. Erick is based at the Australian Resource Research Centre (ARRC) in Perth, Western Australia. In the last 30 years, Erick has been involved with iron ore deposits from Australia, Sweden, Brazil, South and West Africa. He is co-chairman and editor of the International Iron Ore Conference since 2002. Erick has also studied lateritic nickel deposits in Australia, Brazil and New Caledonia.

In New Caledonian nickel laterites, the ore types are classified using a visual recognition of minerals by the exploration and mine geologists. As part of a larger strategy for mine automation, the nickel companies have been testing a hyperspectral imaging system as an objective technique for automated classification of their ore types.
All the samples were measured by the Corescan Hyperspectral Core Imager Mark III and all results were validated by classical XRF analyses, by Minalyze XRF automated system and X-ray diffraction (XRD).
A comparison between all the chemical analyses shows excellent correlations. The X-ray diffraction results confirm the presence of olivine, pyroxene, amphibole, chlorite, serpentine, talc, quartz, goethite, hematite, maghemite/magnetite, brucite, stevensite, chromite, kaolinite, falcondoite, pyroaurite and comblainite.
The mineralogical results derived from the hyperspectral imaging display a good correlation with the XRD-derived mineralogy. A hyperspectral classification was developed and correlates well with the classification of the ore types used by the mining companies with the exception of very weathered samples as the spectral signature of the primary minerals such as olivine and pyroxene is no longer present.
The implementation of a hyperspectral imaging system in New Caledonia would provide the nickel laterite mining companies with an objective and automated tool for the classification of the ore types. Such a system could be adapted and implemented for all nickel laterite deposits.

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Initiation of the Canning Basin: extensional magmatism in the middle Cambrian?

Haines P[1], Wingate M[1], Maidment D[1], Zhan Y[1]
[1]*Geological Survey Of Western Australia*

TS2 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Peter Haines holds BSc (Honours) and PhD degrees in geology from the university of Adelaide. He currently holds the position of Senior Petroleum Geologist with the Geological Survey of Western Australia (Division of Geoscience and Resource Strategy, Department of Mines, Industry Regulation and Safety). He has worked extensively in sedimentary basins in Western Australia, including the Canning Basin.

The tectonic event (Samphire Marsh Extension) that initiated the Canning Basin is traditionally viewed as relatively gentle rifting in the early Ordovician, coincident with deposition of the oldest marine sediments of the Nambeet Formation. However, undated fluvial sedimentary rocks underlie the marine succession in some wells. Furthermore, basement-penetrating wells are on relative basement highs, with seismic evidence of potentially older sediments filling early-formed rift grabens. Flood basalts and dykes of the c. 510 Ma Kalkarindji Large Igneous Province are extensive to the northeast (Antrim Plateau Volcanics) and south (Table Hill Volcanics) of the Canning Basin. Geochronology of basement granitic rocks from deep wells reveals an igneous crystallization age of 654 ± 3 Ma from Goldwyer 1 and 505 ± 4 Ma from Samphire Marsh 1. The former is similar to ages reported for granitic rocks of the O'Callaghans Supersuite (678-607 Ma) near Telfer mine south of the basin, but the latter is much younger than any known magmatic events in the area, with the exception of the Kalkarindji LIP. The short period separating mafic-felsic magmatism beneath and surrounding the Canning Basin, and initiation of sedimentation in rift grabens, suggests that middle Cambrian magmatism may reflect an early phase of extension related to initiation of the basin. Marine incursion to the basin may thus be relatively late in the rifting process. The timing is similar to c. 520 Ma bimodal magmatism related to an early stage of the extensional Larapinta Event in central Australia.

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Resolving the source parameters of shallow crustal earthquakes in Australia: examples from three earthquakes in the Musgrave Province

Hejrani B[1], Tkalčić H[1]
[1]The Australian National University

TS1 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
I am a seismologist and I am interested in mathematical Geophysics. I have a B.Sc. in pure mathematics and a M.Sc. in Geophysics. I obtained my PhD degree in Earth imaging in 2014, from Aarhus University, Denmark.
Currently, at the Research School of Earth Sciences, at The Australian National University, I am developing a semi-automatic system to calculate the source parameters of earthquakes within the Australasian region.

Routine calculations of earthquake source parameters are usually performed using synthetic data simulated in a 1D layered Earth at low frequencies (< 0.025 Hz). However, at low frequencies, as the seismic source becomes shallower, the ground motion due to a vertical dip-slip mechanism becomes very small (zero at the surface).
The amplitudes of synthetic waveforms for vertical dip-slip mechanisms increase at higher frequncies. This requires an estimation of Earth structure in 3D and a simulation of the wave propagation within it, which is computationally expensive but feasible for limited volumes of the Earth. Here, we present the estimation of the source parameters of three shallow events occurred in the Musgrave Province: the 20 May 2016 Mw 5.9, the 9 June 2013 Mw 5.3 and the 23 March 2012 Mw 5.4 event. Using a 3D model AuSREM, we simulate waveforms at 0.01 – 0.15 Hz for seven stations operated by Geoscience Australia. AuSREM was made possible to a large extent through the analysis of waveform data collected using the ANSIR pool of instruments.
For the Mw 5.9 Petermann Ranges earthquake in 2016, our solution shows a thrust mechanism dipping NE at 30 degrees at depth 1 km, which is in a very good agreement with the known surface rupture reported for this event.
These results, in conjunction with further developments of AuSREM, give a hope to extend the limits of full waveform simulation to the earthquakes as small as Mw=3.0 within the Australian continent.

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Emerging machine learning approaches for mineral prospectivity mapping through space and time

Muller D[1], Scalzo R[1], Olierook H[2], Chandra R[1], Butterworth N[2], Farahbakhsh E[1], Clark C[2], Cripps S[1]
[1]The University Of Sydney, [2]Curtin University

TS3 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Dietmar Müller received his undergraduate degree from the Univ. of Kiel, Germany, and his PhD in Earth Science from the Scripps Institution of Oceanography, La Jolla/California in 1993. After joining the University of Sydney he built the EarthByte Research Group, pursuing the collaborative development of open-source software and virtual globes. One of the fundamental aims of the EarthByte Group is geodata synthesis through space and time, assimilating the wealth of disparate geological and geophysical data into a four-dimensional Earth model. Dietmar currently directs the ARC Basin Genesis Hub as well as the Sydney Informatics Hub.

We review several emerging machine learning approaches to aid mineral exploration. The first two case studies are focussed on a common area in the Gascoyne Province in the Capricorn Orogen of Western Australia. The Gascoyne Province is largely covered by sedimentary and regolith cover, making it especially important to use cost-effective methods to improve our understanding of its geology and ultimately promote mineral exploration investment. Both machine learning methods exploit the association of mineral deposits with crustal faults. The first approach uses computer vision techniques to learn the association between mineral deposits and geological lineaments in Landsat 8 data. The second approach fuses geological field observations with geophysical data, particularly magnetic and gravity anomalies, to create a probabilistic map of the three-dimensional structure of geological boundaries. In a third case study we apply a Gaussian classifier methodology to develop iron ore prospectivity mapping for the Yilgarn and Pilbara cratons. Our fourth case study is based on spatio-temporal analysis of mineral deposits, enabled by the pyGPlates Python library. Efficiently extracting subduction zone characteristics for age-coded ore deposits allows us to unravel the tectonic environments of Pacific-rim porphyry copper-gold deposits along the Andes since the Late Cretaceous. Future pyGPlates applications will integrate tectonic reconstructions with high-resolution high-performance computer simulations and statistical model analysis and optimisation for the development of an “experimental planet”. These linked technologies have the potential to reveal the big picture of how crustal and deep-Earth processes interact, and thus the intricate pathways in the planet’s geological development.

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Transdimensional Bayesian tomography of the core-mantle boundary layer from ScS-S measurements

Mousavi S[1], Tkalčić H[1], Masters G[2], Hawkins R[3]

[1]Australian National University, [2]Scripps Institution of Oceanography, University of California San Diego, [3]Lyon University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

I have a BSc. in Physics (Azad University, Tehran, Iran, 2006), a MSc. in Geophysics (Tehran University, Iran, 2010) and a PhD in seismology (Leipzig University, Germany, October 2016). I've been working at ANU since October 2016 until October 2017 as a research assistant and thereafter as a post-doctoral fellow.

Knowing the structure of the core-mantle boundary (CMB) is crucial to the understanding of the whole mantle dynamics, and yet it remains a much debated and ongoing challenge in geophysics. The CMB is the largest compositional discontinuity within the earth that separates liquid outer core from the solid but slowly convecting mantle. It contains significant heterogeneities on different spatial scales and a wide range of physical and chemical features such as partial melting and seismic anisotropy.

A clear challenge for research in seismological, theoretical and computational geophysics is globally incomplete coverage of station and earthquake locations. The major limitation of deep earth tomography has been the explicit parameterization of the region of interest which faces inherent problems of either over-smoothing the data or allowing for too much noise. Here, we apply a recently developed method based on trans-dimensional and hierarchical Bayesian imaging where strict parameterization and explicit regularization are not imposed.

We develop a new S-wave speed model of the CMB by using ScS-S differential travel times measured through waveform correlation and Bayesian transdimensional inversion to further understand and characterize heterogeneities in the CMB. We use a globally collected dataset of ScS-S differential travel times augmented by the data from specially targeted source-receiver geometries including the ANSIR deployments to cover the gaps in spatial coverage. Apart from the shear wave speed model, we present the model uncertainty, and we focus on the similarities and differences between the S-wave and the existing P-wave speed tomographic models of the lowermost mantle.

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Is Mount Isa a zoned carbonate replacement system?

Lilly R[1], Taylor R[2]
[1]University Of Adelaide, [2]Roger Taylor Consulting

TS2 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Richard Lilly is currently the Mount Isa Mines embedded research fellow at the University of Adelaide. The role involves coordinating a range of minerals industry related research projects, lecturing economic geology and coordinating the National Exploration Undercover School (NExUS).

He completed his PhD (Cardiff University, UK) and worked with Rio Tinto and Chevron before joining Mount Isa Mines (formally Xstrata Copper) exploration in 2007 based in Mount Isa, Queensland.

In his role as senior exploration geologist he instigated and co-supervised a wide range of applied research projects, before returning to an industry funded academic role in 2015.

As a globally significant resource of both Pb-Zn and Cu, the Mount Isa mineral system (including the George Fisher Pb-Zn-Ag deposit) has been the recipient of a great deal of academic study during its 95+ year mine life. The interpretation of rock, ore and associated alteration textures and their relative timing and mode of formation have changed considerably over the years. The textural difference between the strata-bound nature of the Pb-Zn (Ag) ores and the large non-conformable breccia hosted epigenetic Cu ores, and their close spatial association has been the main cause of debate over the timing and genesis of the deposit.

A recent review of the ore deposit model, with a focus on ore textures and mineral chemistry, has updated the proposed model of formation. Paragenetic work indicates that only one stage of ore-related sulphides is present. Sulphides display a consistent paragenetic sequence, with the earliest being a fine-grained pyrite (Pyrite-1), followed by coarse-grained hydrothermal pyrite (Pyrite-2) that commonly forms coarse euhedral crystals. Paragenetically later sphalerite, galena, pyrrhotite and chalcopyrite, which have co-precipitated during additional brecciation and alteration events, are the last hypogene sulphide stages to have formed. Importantly Cu-Pb-Zn (Ag) mineralisation post-dates deformation of the host rock.

Current evidence points to Mount Isa being a zoned carbonate replacement system; a model that compliments all previous epigenetic ore models and which was originally proposed by W. Perkins (1997). The updated model has strong implications for the origin of other NW Queensland sediment hosted Pb-Zn (+Cu) systems and regional exploration.

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The National Exploration Undercover School (NExUS)

Lilly R[1], Heinson G[1]
[1]University Of Adelaide - Mount Isa Mines

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Richard Lilly is currently the Mount Isa Mines embedded research fellow at the University of Adelaide. The role involves coordinating a range of minerals industry related research projects, lecturing economic geology and coordinating the National Exploration Undercover School (NExUS).

Richard completed his PhD (Cardiff University, UK) and worked with Rio Tinto and Chevron before joining Mount Isa Mines (formally Xstrata Copper) exploration in 2007 based in Mount Isa, Queensland.

In his role as senior exploration geologist he instigated and co-supervised a wide range of applied research projects before returning to an industry funded academic role in 2015.

The National Exploration Undercover School (NExUS) is an initiative to provide world-class training in mineral exploration. The three week summer school is funded by the Minerals Council of Australia (MCA) and run by the University of Adelaide. Students from the full range of Australian Universities, along with early career professionals in industry and government geological surveys can apply for entry. Numbers are limited to 30 placements so attendance at NExUS is considered competitive and prestigious.

NExUS is centred on addressing the four key themes identified by the UNCOVER program being the major knowledge areas to improve the success rate of world-class mineral system discoveries, particularly for areas of extensive and deep cover. The primary outcome of the program will be students who understand the challenges and opportunities of mineral exploration in Australia into the future, and have knowledge of the tools required to address these problems.

The program is a mixture of classroom, laboratory and drill core activities in the first week, hosted at the South Australia Drill Core Reference Library. The second week was based in the Adelaide Hills and focused on practical mineral exploration (geochemistry, geophysics) in partnership with Hillgrove Resources at active exploration targets. The final week is based on the Yorke Peninsula with Rex Minerals at the Hillside deposit and other field locations.

NExUS is an exciting new program for the Australian tertiary education sector and we look forward to reporting the 2016-17 outcomes and plans for NExUS 2018 and beyond.

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Quantitative Geodynamics of Mt Isa & McArthur Basins - Implications for Giant Sediment Hosted Mineral Systems

Czarnota K[1]
[1]*Geoscience Australia*

TS4 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
tbc - Dr Karol Czarnota is the Section Leader for Mineral Prospectivity at Geoscience Australia.

Despite over two decades of focused research into the McArthur and Mt Isa basins there is a lack of consensus regarding the relationship between the contained giant world-class sediment hosted ore deposits and the geodynamic processes which led to their formation. By combining results from past geological mapping, sequence stratigraphic assessments, dating and reflection seismic profiling within the Exploring for the Future program we quantitatively assess the subsidence history of these basins and apply a conjugate gradient inversion scheme to invert for strain rate history. The results show systematic variation of subsidence across northern Australia with peak strain rates of ~10-15 per second, comparable to GPS derived strain rates in continental areas currently under extension. We the resulting temporal variability in strain rate to rationalise the myriad of qualitative structural event histories proposed for this region. We find a coincidence between periods of peak basin subsidence and extensional strain rate. Given this relationship we explore the fluid budget of these basins resulting from compaction and devolatilisation and challenge the commonly held view that these giant basin hosted ore deposits are a consequence of multi-pass fluid flow resulting from thermal convection of basin brines. Furthermore, the subsidence trends of these basins together with mafic rock geochemistry imply that the thick lithospheric keel beneath these basins, imaged using passive seismic tomography, originated after these basins were initiated.

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Multiple point source simulation for large earthquakes within the Australasian region

Hejrani B[1], Tkalčić H[1]
[1]The Australian National University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
I am a seismologist and I am interested in mathematical Geophysics. I have a B.Sc. in pure mathematics and a M.Sc. in Geophysics. I obtained my PhD degree in Earth imaging in 2014, from Aarhus University, Denmark.
Currently, at the Research School of Earth Sciences, at The Australian National University, I am developing a semi-automatic system to calculate the source parameters of earthquakes within the Australasian region.

Large earthquakes usually surprise us. The rupture patterns for events with moment magnitude larger than 7.5 could be quite complex, especially for shallow events which are the most destructive ones. Therefore, a quick, accurate and reliable estimation of the complexity of the large earthquakes is critical for Early Warning Systems and the seismic hazard studies.
Here, we present the first step towards a semi-automatic multiple point source simulation for earthquakes with moment magnitude larger than 7.5. We use a 3D crust and mantle model AMSAN19, which covers the Australasian region, to simulate seismic wave propagation at frequencies < 0.033 Hz on the continental scale. The refinement of this model will be possible through the use of ANSIR pool and a large volume of waveform data that has recently been collected in Australia. We use the implementation of the reciprocity theorem to reduce the volume of synthetic calculations. We then apply an iterative de-convolution method to retrieve multiple point sources, supported by the seismic data.
Our multiple point source solution for the 1 April 2007 Mw 8.1 Solomon Islands earthquake reveals two separate ruptures with ~ 25 seconds delay. This is in agreement with detailed studies of this event where two rupture patches separated by a volcanic island have been observed.
The multiple point source inversion of large earthquakes using the state-of-the-art tomographic models of the Earth provides a powerful tool and early constraints on the rupture complexity as well as the direction of the rupture propagation.

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How seafloor weathering drives the slow carbon cycle

Dutkiewicz A[1], Muller D[1]
[1]The University Of Sydney

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Adriana Dutkiewicz is a senior lecturer in geology at the University of Sydney, specialising in sedimentology. Her current research is focused
on the synthesis of large sedimentological and geochemical data sets to provide new insights into fundamental processes underpinning the
composition of marine sediments, ocean chemistry, and resource formation on a global scale through time.

Long-term fluctuations in atmospheric CO_2 concentrations are thought to be driven by supercontinental cycles that operate on timescales of 100s of millions of years. Here we explore whether these fluctuations may be caused by changes in the capacity of the oceanic crustal carbon reservoir. Carbon, mainly in the form of calcite cements, accumulates in the upper 300 m of the ocean crust due to the long-term alteration of the crust by low-temperature hydrothermal fluids, resulting in a gradual loss of porosity. The majority of the calcite cement forms within 20 Myr of crustal accretion, with about 20% continuing to precipitate in crust aged 20–50 Myr, and shows a strong dependence on bottom water temperature. Using all available records of crustal CO_2 from ocean drilling sites, and a global bottom water temperature curve based on published paleo-ocean bottom water temperature estimates, we calculate the volume of crustal carbon sequestered from the Triassic to the present. In order to produce paleo-oceanic crustal CO_2 grids, we utilise a global bottom water temperature evolution curve based on published paleo-ocean bottom water temperature estimates. We compute the CO_2 content of oceanic crust through time and its subduction history by tracking the age and paleo-ocean bottom water temperature for any given parcel of ocean crust. Our results show that seafloor spreading rates as well as the combined storage, subduction and emission of oceanic crustal and mantle CO_2 fluctuate with a period of 26 My that is also evident in the long-term atmospheric CO_2 curve.

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Welcoming diverse groups to the classroom - how tiny changes can create big outcomes

King P[1], Holland K[1], Eggins S[1]
[1]*Research School of Earth Sciences, Australian National University*

TS7 - 5.2 Prediction, process, place: Geomorphology & 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Penny King is a Senior Fellow at ANU and her group studies the processes that affect planetary surfaces, crusts and oceans - especially on Mars and Earth. She oversees the mineralogy facilities at ANU and her group use experimental, field and thermodynamic approaches to understand rocks. Penny teaches the introductory earth systems course at ANU and actively promotes diversity and inclusion initiatives at ANU. Over the last few decades, she has worked and taught at four universities in three countries.

Many studies show that equitable and inclusive environments improve outcomes for organisations by creating a more holistic approach, more creative solutions and increased profits. Such diverse environments are also powerful in the classroom for improving teaching and learning, especially for underrepresented groups. We have found (or likely rediscovered!) that being mindful of diversity issues is the single most critical step in trying to increase diversity and inclusion in the classroom. Making an explicit effort to welcome diversity impacts students, demonstrators and teachers who in turn become attentive of these issues and thus influence our workplace: creating a big impact.

Tiny changes in our first year Earth Systems course include: using inclusive language (we, us etc.); starting the year with a 'Welcome to Country'; showing that students have different levels of preparation (e.g., in chemistry, spreadsheets etc.) as evidence that we need to work together; requiring name tags for both students and staff; presenting different perspectives (conflicting interpretations); indicating that learning is a journey and that there are no dumb questions; showing students what we do in our lives; highlighting minority scientists and indigenous art in course content; providing glossaries; meeting with minority students and in some cases integrating them into groups with Australian students; creating assignments that reward individual creativity; providing multiple toilet stops on field trips; hiring a diverse cohort of demonstrators and lecturers (e.g., Mandarin-speaking) and showing them what we are doing. We receive feedback that these efforts make a difference, but have not formally examined the outcomes.

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New insights into the centre of the Earth from the detection of inner core shear waves

Tkalčić H[1], Pham T[1]
[1]The Australian National University

TS3 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Hrvoje Tkalcic is an Associate Professor in the Seismology and Mathematical Geophysics group at the Australian National University. He obtained his PhD from the University of California at Berkeley in 2001. He uses seismology and mathematical geophysics tools to understand the internal workings of our planet. His recent projects focus on developing new approaches in lithospheric and mantle imaging and studying seismic sources. He is a manager of the Warramunga Seismic and Infrasound Array. He has authored over 75 research papers and an academic book on the Earth's inner core, which was published by the Cambridge University Press in 2017.

More than seventy-five years ago, the Earth's core was hypothesized to be solid in the centre as a result of a liquid–solid phase change in iron, which implies that shear waves in its solid part (seismic J–phase) should exist. Some claims of such observations have been made, but the J–phase has remained elusive until the present day. According to some researchers, the compressional body waves that convert to shear waves during passage through the inner core (a.k.a. PKJKP) were termed "the holy grail of body wave seismology". We have employed recent advances in the global correlation wavefield to detect the presence of the J-phase unequivocally. We identify arrivals of PKJKP in a correlation pair with another core phase, PKIKPPKIKP over a range of angular distances. This allows us to determine, with unprecedented precision, the shear wave speed reduction of 2.5±0.5 % with respect to the Earth reference model PREM.
Coupled with a strong attenuation, this is evidence for a "soft inner core", which explains the absence of PKJKP waves in the seismic wavefield and has significant implications for geodynamics and mineral physics studies. There is much work to do towards improving the quality of the globally stacked correlograms, especially at short angular distances. An addition of the Australian permanent and temporary regional networks such as those deployed using the ANSIR pool should make the global correlogram clearer, thus further improving the clarity of the time and amplitude readings of the J–phase related features.

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Future of teaching and training in Geoscience

McLaren S[1], Hergt J[1]
[1]University Of Melbourne

TS3 - 5.5 Planning the future of Geoscience & 5.1 Geology in society: geotourism and geoheritage, Room R8, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Sandra is a geologist with research interests in a wide range of earth science fields. She completed her PhD at the University of Adelaide in 2001 and subsequently held postdoctoral appointments at the University of Melbourne and the Research School of Earth Sciences at the Australian National University. She recently completed an ARC Australian Research Fellowship at the University of Melbourne (2009-2017) and is currently employed as a Senior Lecturer in Structural Geology and Tectonics in the School of Earth Sciences. Her main research interest is in understanding the long term evolution of the Australian continent.

The Decadal Plan for Australian Geoscience recognises that geoscience education and training into the future require investment in programs for both primary and secondary education levels and University level courses. Indeed, weakness in Australia's education system for geoscience is a major threat to the ongoing capacity of geoscience to serve the nation effectively. The lack of geoscience-qualified school teachers is a unique problem facing primary and secondary schools. The absence of geoscience education at these levels has the natural consequence of young people entering tertiary education without being familiar with the science, and so impacting on their tertiary choices. On the other hand, Australia has an extraordinary archive of geological and environmental change and our natural laboratories mean we should be well placed to effectively teach geoscience to all levels. Recent availability of large topographic, photogrammetric, geological and geophysical datasets, as well as smaller scale imaging tools (such as UAVs) mean that geoscience can be made more accessible and has the potential to capture the imagination of students and teachers alike. The Decadal Plan recognises the excellent work and inspiring programs already available in some areas, but notes the urgent need to expand and improve the reach of these programs nationwide. Moreover, the generic skills required to master geoscience at tertiary level are useful across a broad range of careers, particularly in high-level management and decision making. The breadth of employment opportunities outside the resources sector must be highlighted.

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Engagement in earth science teaching – twitter use in undergraduate structural geology and tectonics classes

McLaren S[1]

[1]*University Of Melbourne*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:

Sandra is a geologist with research interests in a wide range of earth science fields. She completed her PhD at the University of Adelaide in 2001 and subsequently held postdoctoral appointments at the University of Melbourne and the Research School of Earth Sciences at the Australian National University. She recently completed an ARC Australian Research Fellowship at the University of Melbourne (2009-2017) and is currently employed as a Senior Lecturer in Structural Geology and Tectonics in the School of Earth Sciences. Her main research interest is in understanding the long term evolution of the Australian continent.

Student engagement with their courses is a great predictor for academic success. Traditionally, earth science courses have high levels of engagement that arise from shared experiences on field trips and the generally small class sizes. In 2018 I trialed using twitter to improve engagement among students in 2nd and 3rd year structural, metamorphic and tectonic courses, and particularly to help boost engagement prior to field classes and other cohort building experiences. Although few students engaged with the twitter posts (by commenting or retweeting) most regularly checked posts on the course hashtag and followed the course related content posted. Feedback was positive and students enjoyed this additional component of their course. They were particularly interested to see the wide reach of their own work (practicals, field trip content) as evidenced by likes and retweets from across the twitter community. As well as improving engagement amongst current students, posts were shared by the University official accounts and added to geoscience visibility. Searching for and tweeting potentially useful content also improved my own engagement with teaching, an added benefit.

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Calibrating HyLogger-3 reflectance spectra using Minalyze XRF data

Pendock N[1]
[1]*Corelog Analytics*

TS1 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Neil Pendock is an applied mathematician with over 30 years experience developing algorithms and software for the processing of remotely sensed data.

Hyperspectral core logging finds many applications in geology, geometallurgy and optimization of mining production. One of the main limitations of the technique is the qualitative nature of interpretations of the reflectance spectra. Recently XRF and XRD core loggers have been introduced which bring a new quantitative dimension to hyperspectral core logging.

The South Australian drill core reference library consists of over 30 several boreholes which have been logged by both the HyLogger-3 reflectance profiler and the Minalyze XRF system.

We chose one borehole to investigate the practicality of calibrating HyLogger-3 data from XRF. By spatially registering the two data sets, we may average our HyLogger-3 spectra into a non-negative matrix H and likewise the XRF data is represented by a non-negative matrix X. The calibration is simply the estimation of a matrix S

$H = SX$

We may interpret X as a matrix of spectral abundances, so if we require S to be non-negative, we have the standard linear unmixing problem where in place of the usual estimation of spectral abundances given a library we need to solve the transpose problem of estimating a spectral library from unmixing abundances.

This may be done using many approaches from linear algebra and in particular by non-negative matrix factorization. S now calibrates H from X and there are several other useful spin offs for XRF data too including interpolation to an increased spatial resolution and even the transformation of X from a 1D spatial profile to 2D if H is a corelog image.

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The Australian National Virtual Core Library – accessing geological information from the upper 1–2 km of our Earth's crust

Laukamp C[1]
[1]*CSIRO*

TS1 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Carsten Laukamp is a senior research geoscientist with CSIRO Mineral Resources in Perth, where he's the leader of the Mineral Footprints Team and the National Virtual Core Library Project. Carsten explores the use of proximal and remote reflectance spectroscopy, geochemistry and geophysics for tracing hydrothermal alteration signatures through cover.

The Australian National Virtual Core Library (NVCL), part of AuScope's national earth science infrastructure program (http://www.auscope.org.au/nvcl/), comprises about 3000 drill cores from across the Australian continent. The prime objective of the NVCL is to provide internet access to the vast resource of geological information from the upper 1 – 2 km of our Earth's crust that is stored in drill core libraries and core sheds. High-resolution RGB imagery, hyperspectral and associated geoscience data are available to the research community via AuScope's data infrastructure and discovery portal (http://www.auscope.org.au/auscope-grid/), the Australian Geoscience Portal (http://portal.geoscience.gov.au/gmap.html) and directly from the State and Territory Geological Surveys.
This paper presents recent research projects, which demonstrate the manifold geoscience questions that can be addressed by using NVCL data. For example, NVCL-derived hyperspectral data are used for characterising mineral footprints associated with hydrothermal ore deposits, identifying alteration mineral assemblages in bed- and cover rocks. The availability of mineralogical data from across the Australian continent allows the comparison of geological provinces and mineral deposit styles beyond state and territory boundaries. Furthermore, the high-resolution RGB imagery is used for lithological classification and textural analysis, which can be easily tested having a data set of 3000 drill cores readily available. A combination of the RGB imagery, with mineralogical, geochemical and/or geophysical data is evaluated for objective, automated mapping of bedrock lithologies, alteration minerals and regolith stratigraphy. Numbers of drill cores and data types available through the NVCL are steadily increasing, providing researchers with new information to discover the geology of Australia.

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Characterising the phenology of irrigated crops using Landsat and Sentinel 2 data

Krause C[1], Lymburner L[1], Li F[1], Oliver S[1], Sixsmith J[1]
[1]*Geoscience Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Claire Krause has a PhD in Palaeoclimatology, focusing in stable isotope geochemistry and paaleoclimate modelling. She took a graduate position at Geoscience Australia in 2016, and currently works in the Digital Earth Australia program as a remote sensing scientist.

Digital Earth Australia (DEA) is a key piece of public data infrastructure that uses satellite imagery and information to detect physical changes across Australia in unprecedented detail. 'Analysis-read data' from Landsat 5, 7 and 8 are currently available within the DEA platform. The raw satellite data have been corrected and orthorectified to enable easy interrogation of data across sensors. The first Sentinel 2 spectral satellite was launched in 2015, and data from this platform has been made available to Australia under an agreement between the European Space Agency (ESA) and Geoscience Australia. Processing of the Sentinel 2 data archive is underway, and will soon be made available via DEA.

Mapping the extent of irrigated crop across Australia is an important data requirement for water and land management, and economic reporting. The availability of Sentinel 2 data (currently only within a testing environment) will have a huge impact on the quality of such a crop product. Here we will present some initial results demonstrating the combination of Landsat and Sentinel 2 imagery to track annual cropping cycles. The combination of satellite sensors improves the likelihood of capturing cloud-free imagery of key phenological stages, including the maximum spatial crop extent for the cropping season. While this presentation will focus on the application of this new DEA capability on agricultural monitoring, the workflow demonstrated is also applicable to forestry, water and flood monitoring, and capturing land use changes.

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Quantifying the fit of paleogeographically-constrained mantle flow models to present-day dynamic topography and lower mantle structure

Flament N[1]
[1]*University Of Wollongong*

TS5 - 1.1.2 Optimisation and uncertainties in Earth models, Hall C, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
N. Flament joined the School of Earth and Environmental Sciences at the University of Wollongong, Australia in 2016. He obtained a PhD in Earth Sciences from École Normale Supérieure de Lyon, France and The University of Sydney, Australia in 2010.From 2010 to 2016 he worked as a postdoctoral research associate and post doctoral fellow at The University of Sydney. He has been an ARC DECRA Fellow since 2016. His main research interests are in global geodynamics and in the role of deep-Earth processes on the evolution of Earth's surface.

Earth's large-scale topography and lower mantle structure are linked to past tectonic motions and mantle flow. The amplitude of dynamic topography and lower mantle structure predicted by paleogeographically-constrained mantle flow models both depend on the depth- and temperature-dependence of viscosity, making it possible to gain insights in the properties of the solid Earth.

Here, I compare the results of global convection models driven by tectonic reconstructions to independent residual topography models and tomography models. The physics approximation (Boussinesq or extended Boussinesq), boundary conditions and governing parameters were varied across a series of model cases. The correlation between dynamic topography and residual topography models at degrees one-three ranges between 0.4 and 0.5 and the fit (accuracy) to lower mantle structures between 0.4 and 0.8. The volume of lower mantle slabs predicted by Extended Boussinesq models is comparable to that imaged by tomography models. The best-fit model cases considered either 150 Myr of tectonic motions, a moderately dense basal layer (+1.9%), or weak temperature- and pressure-dependence (EηLM = 100 kJ mol-1 and ZηLM = 1 cm3 mol-1) of lower mantle viscosity.

The fit to constraints does not significantly deteriorate when increasing initial model ages to 410 Ma, reflecting that seismic tomography models preserve 200-250 Myr of lower mantle convection history, and suggesting that paleogeographically-constrained mantle flow models should be compared to time-dependent surface geological constraints such as paleo-environments and thermochronology.

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Record of the First Day of the Cenozoic in the Chicxulub Impact Structure

Gulick S[1], Bralower T[2], Ormo J[3], Hall B[4], Grice K[5], Schaefer B[5], Lyons S[2], Morgan J[6], Artemieva N[7], Kaskes P[8], de Graaf S[8], Whalen M[9], Goto K[10], Christeson G[1], McCall N[1], Collins G[6], Claeys P[8], Goderis S[8], Freeman K[2], Expedition 364 Scientists

[1]University Of Texas at Austin, [2]Pennsylvania State University, [3]Centro de Astrobiologia (INTA-CSIC), [4]Enthought, Inc, [5]Curtin University, [6]Imperial College London, [7]Planetary Science Institute, [8]Vrije Universiteit Brussel, [9]University of Alaska - Fairbanks, [10]Tohoku University

TS1 - 2.3 Mass Extinctions, Room R1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:

Dr. Sean Gulick is a Research Professor at The University of Texas at Austin where he has been since completing his post-doctoral fellowship in 2001. He has participated or led >25 marine geology and geophysics expeditions. Current projects include tectonic and glacial climate interactions in Alaska and Antarctica, geohazards and tectonic processes in Alaska, Sumatra, and Japan, and the geologic processes and environmental effects of the Cretaceous-Paleogene Chicxulub meteor impact. Gulick served as co-chief on IODP Expeditions 341 (Southeast Alaska tectonics and climate) and 364 (Drilling the K-Pg impact crater). He is current Science Evaluation Panel Co-chair for IODP.

The Cretaceous-Paleogene (K-Pg) boundary layer, which records the global processes caused by the Chicxulub impact 66 Ma, is often condensed or incomplete. Impact cratering creates instantaneous accommodation locally and thus drill cores into the peak ring of the 66 Myr old Chicxulub impact structure provide an incomparably high-resolution record. IODP Expedition 364 acquired ~130 m suevite and melt rock spanning roughly the first day to months of the Cenozoic. Within seconds sedimentary and crystalline target rocks were vaporized or ejected from the crater. Samples from the suevite show <1% anhydrite or gypsum despite the sedimentary target being ~50% evaporites due to a shocked particle size effect, and possibly preferentially vaporization implying release of significant sulfate aerosols. Within minutes, melt rock and target clasts were emplaced in a ground-hugging flow as centrally uplifted basement collapsed outwards to form a peak ring. Within tens of minutes the ocean waters resurge into the crater from the North-Northeast. Within hours, an array of processes are recorded within the fining upwards suevite deposited into a now flooded crater including seiches, gravity flows, and airfall. Within a day, Gulf of Mexico crossing tsunami rebounded to arrive back in the crater recorded as signatures of a polycyclic aromatic hydrocarbon (PAH) perylene and unidirectional cross-bedded, sand-sized layers. PAHs together with abundant charcoal fragments just above the tsunami layer unit provide direct evidence for ejecta-induced wildfires. A 74 cm-thick transitional unit includes grain size fluctuations caused by waning energies within the crater over the weeks to months that followed.

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Sedimentological and palynological investigations from Mesozoic strata of the Bight and Mentelle Basins, Australia: Preliminary results from IODP Expedition 369

Wainman C[1], Holford S[1], McCabe P[1], Huber B[2], Hobbs R[3], Bogus K[4], Expedition 369 Scientists E[5]
[1]Australian School of Petroleum, University Of Adelaide, [2]National Museum of Natural History, Smithsonian Institution, [3]Department of Earth Sciences, Durham University, [4]International Ocean Discovery Program, Texas A&M University, [5]Expedition 369 Scientists

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Carmine C. Wainman is a Postdoctoral Fellow at the University of Adelaide in Australia. He completed his PhD in 2018 at the same University and received his M.Sc. (integrated) degree in geology from the University of Southampton, United Kingdom in 2012. Before commencing his PhD, he worked for the RSK Group and Woodside Energy. His research focuses on Middle to Upper Jurassic coal-bearing strata in eastern Australia and the evolution of Upper Cretaceous strata in the Bight Basin on Australia's southern margin.

The Bight and Mentelle Basins are underexplored offshore regions of Australia. Interpretation of their depositional history is strongly dependent on seismic data with only limited well penetration. International Ocean Discovery Program Expedition 369 drilled in these basins in late 2017 to investigate 1) palaeoceanographic conditions during the Cretaceous hothouse, and 2) plate tectonics during the separation of Australia from India and Antarctica.

Recovered at Site U1512 in the Bight Basin was a 700m continuous succession of Turonian–Santonian silty claystone with a few beds of glauconitic and sideritic sandstone <32 cm thick. The succession, representing ~10 million years of deposition, is relatively uniform in composition and is mostly bioturbated. Palynological assemblages suggest water depths > 200 m. Sedimentation rates (up to 260 m/Myr) and silt content (2-25%) suggest the strata were deposited by hyperpycnal flows rather than by pelagic sedimentation. Palynofacies analysis indicate a prevailing dysoxic marine environment. The low abundance of dinocysts (16% of total palynomorphs on average) and high abundance of phytoclasts (40-90% of total kerogens) suggests there was water column stratification with a low salinity cap. This was probably the result of elevated freshwater runoff into the restricted basin.

At Site U1515 in the Mentelle Basin, pre-breakup sediments interpreted from seismic profiles were intersected. Sediments from the recovered 150 m-thick succession comprised organic-rich claystones and coal that are indicative of a fluviolacustrine environment. Spore-pollen assemblages support a latest Bathonian–early Tithonian age.

These new datasets require a substantial re-evaluation of the palaeogeography of these basins.

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Multi-method geological mapping of the Kambalda region, Eastern Goldfields, Western Australia.

Gwandu K[1]
[1]Botswana Geoscience Institute

Biography:
I joined DGS in December 2008 as an assistant economic geologist after leaving Water Surveys (Botswana) where I worked as a junior hydrogeologist for eight (8) months upon finishing my BSc. Geology at the University of Botswana in 2007. I progressed from an assistant geologist through geologist to being a senior geologist in 2016 before DGS transformed into BGI where I currently work as a senior economic geologist. During my tenure at DGS in 2013 I was given an opportunity to further my studies in Australia where I graduated with an MSc. Ore Deposit Geology the same year.

The study was carried out in the Eastern Goldfields Superterrane , which is part of the Archaean granite-greenstone belt of the Yilgarn Craton. Multi-method geological mapping of this area was used because; combining various data sets to map geology can yield good and reliable results and is an important support for field mapping. Each data set can give a different signature which is not present in others based on its advantages and disadvantages. Here I aim to assess 'How good are remote-sensing methods at mapping geology'. This was achieved by using four data sets namely, high resolution aeromagnetic, gravity, radiometric, and ASTER satellite imagery. These data sets were integrated in ArcGIS™ environment and lithological characteristics for each data set were used to categorize lithological units. The following units were recognized; granite as both bedrock and intrusions, basalts, komatiites, igneous felsic volcanic rocks and siliciclastic sediments on top of the stratigraphy. Isoclinal folds are evidence of crustal shortening (D1), followed by another deformation (D2) causing folds with NN-W trending axes and faulting of most units (D3). The greenstone belt sequence and granites were mapped moderately well as they seem to correlate with the existing map but other lithologies. Some structures like faults can only be identified at the field by presence of mylonite and fault breccia. However mapping the structure was not good enough. Therefore good chance for Nickel (Ni) exploration as it is stratigraphically controlled but Gold (Au) exploration chances are very low as it is structurally controlled.

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The OSNACA Project: Updates to the Map of Magmato-Hydrothermal Space

Brauhart C[1], Hagemann S[2]
[1]CSA Global, [2]Centre for Exploration Targeting

TS5 - 3.1.6 New frontiers in ore system research, Hall E2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Carl Brauhart graduated from UNSW in 1991 and after three years with RGC did his PhD on the Panorama VHMS Project in the Pilbara. So began a long association with Sipa Resources that continued until 2013 when he joined CSA Global as a consultant. Carl has focussed on field mapping and geochemistry in a career that has tended towards exploration rather than mining

The OSNACA Project began in 2011 as an open source project where ore samples from around the world are analysed at BV-Ultratrace in Perth for 65 elements. Data are made available through the CET website at the University of Western Australia where corresponding hand-specimen and laboratory pulp collections are maintained.
"Magmato-Hydrothermal Space" (MH-Space) is a mathematical construct where 24 ore and pathfinder elements are used to quantify ore-element signatures and was proposed by OSNACA Project researchers in 2016. The OSNACA-transform is used to define MH-Space.
The broad-scale view of Magmato-Hydrothermal Space reveals three important trends: (1) Zn-Pb sediment-hosted mineralisation to igneous-associated Cu-Au mineralisation, (2) Cu-Au mineralisation to Au-only mineralisation, and (3) ultramafic associated magmatic Ni-Cu-PGE mineralisation through Cu-Au mineralisation to granitoid-associated Mo, W and Sn mineralisation. The view provided by Magmato-Hydrothermal Space reveals that there is a spectrum of ore element signatures that mirrors the spectrum of ore deposit classes described in the literature.
The latest data from the OSNACA database, which now contains over 1,000 analyses, are used to illustrate MH-Space. Improvements to the OSNACA-transform are also presented whereby Cr, Sc and Th are used to model lithological variations in ore and pathfinder element abundance above average crustal abundance. Previously, the OSNACA transform only excluded variations below average crustal abundance as owing to lithology.
Variations in metal signatures at the deposit scale can also be modeled using the OSNACA-transform and represent a new and important perspective for explorers and researchers alike.

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Big data paradox and modelling strategies in geological modelling based on horizontal wells data

Wensong H[1], Heping C
[1]Petrochina Research Institute Of Petroleum Exploration & Development

TS5 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
I graduated from China Petroleum University in 1991 and now work for CNPC. My main work is reservoir description and geological modeling.

Based on analysis of horizontal well data characteristics, the differences of data distribution and variogram between vertical and horizontal wells in MPE3 oil field of Orinoco heavy oil belt were compared, and modeling strategies were proposed to cope with the big data paradox when data of horizontal wells was used directly into geologic modeling. The study shows the horizontal wells in the study area contain a large quantity of information, strong directionality of well trajectories and high drilling ratio of sandstone, causing variogram analysis result unconformable to the geologic understanding, and in turn making errors in the modeling of sedimentary microfacies and reservoir physical properties and prediction of probabilistic reserves. Firstly, the distributary channel distribution variogram was analyzed with data of vertical wells, and then the lithofacies framework was established under the control of the sedimentary facies and seismic data. After that, the horizontal wells data revealing high heterogeneity accuracy of reservoir, was combined with the vertical wells data to analyze argillaceous interlayer variograms and the corresponding reservoir lithofacies models were constructed. Finally, reservoir physical property models were generated and the geological reserves were calculated by wellblocks. This reservoir modeling method does not only reflect the geologic features underground, but also improve the accuracy of inter-well sand body prediction, and enhance the reliability of reservoir geologic model ultimately.

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Sedimentology and depositional evolution of Junin 4 Block in Orinoco heavy oil belt, Venezuela

Wensong H[1]
[1]*Petrochina Research Institute Of Petroleum Exploration & Development*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
I graduated from China Petroleum University in 1991 and now work for CNPC. My main work is reservoir description and geological modeling.

This paper studied the sedimentary features and facies evolution of paleogene formation Merecure and Oficina which belong to Junin 4 block, a place in the center of Orinoco heavy oil belt. The formation is controlled by the tectonic movement of Eastern Venezuelan Basin. It forms a fluvial-delta depositional system by the increasing accommodation and rising sea level. A fluvial-delta system gradually develops into a tide-dominated lower delta plain and finally forms a subtidal zone. The neogene Merecure formation, developing in the upper delta plain, are typical shallow sandy braided river deposits closed to the sediments' supply. This formation includes braided channel fill, channel bar, and over-bank microfacies. The inferior of lower Oficina changes into a tide influenced, fluvial dominated upper delta plain which includes meandering channel, levee, crevasse splay, and over-bank microfacies. While the superior of the lower Oficina is a lower delta plain which is affected by both river and tide. Last, the delta front submerges, which evolves into a river mouth system with mouth bar deposit. With the continuously rising sea level, delta-platform appears with large scale subtidal zone and distal distributary. According to the changing of the sedimentary environment, the distribution of the sand body is controlled by the sedimentary facies. In Merecure, the thick sand bodies are superimposed and extend for a long distance. In Oficina (D~C), sand is local distribution. While in Oficina (B~A) thin sand bodies are in banded and stripped shape with poor connection.

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Gradual evolution from fluvial-dominated to tide-dominated deltas and channel type transformation—MPE3 block in Eastern Venezuela basin as the Example

Chen H[1], Huang W[1]
[1]Research Institute Of Petroleum Exploration & Development, CNPC

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Chen heping, Male, Professor of Oil & gas field development

Eastern Venezuela Basin is a world-class oil-rich basin, with the sedimentary environment controlled by the interaction between Caribbean and American plates. MPE3 block is located in eastern part of Orinoco heavy oil belt in the basin. Studying the sedimentary framework and sand-bodies distribution law is critical for high-efficiency development of it. Based on sedimentary phenomena and palynological analysis, fine seismic interpretation and well logging description are utilized to determine the sedimentary system, vertical evolution process and channel type transition of target layer. Our study suggests that the great sea level rise resulted in the sedimentary system transition from distal sandy braided river delta to tide-affected delta, which eventually evolved into tide-dominated delta. During early stage of sedimentation, branch channels of the delta were dominated by braided river channels; during late stage, tidal effect increased progressively, resulting in the transition from braided river channel to meandering river channel. As a result of the areal differential transgression, sedimentary framework and sand-bodies distribution varied across the regions in the area. Four key factors including structural and paleogeomorphological change, sea level variation, climate, and supply of sediments have influenced on sedimentary system evolution and sand-bodies distribution; in which, sea level variation is vital. Based on the study of sedimentary facies evolution and river type transformation, the favorable sand-body distribution of main oil bearing sand group was predicted by geostatistics inversion method, and theyare are mainly in middle and southern part of MPE3 block, and has guided significance for the subsequent horizontal well development.

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Litho-facies unit and sand-body quantitative characterization of braided river using horizontal well data:MPE3 block in Orinoco Heavy-oil Belt as example

Chen H[1], Huang W[1]
[1]Research Institute Of Petroleum Exploration & Development, CNPC

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Chen heping, Male, Professor of Oil & gas field development

The horizontal well data are valuable references for the lateral prediction of reservoir sand bodies, which is difficult to achieve just by the conventional vertical wells. According to the sedimentary characteristics of braided river reservoirs in the study area, coring data in vertical wells and electric well-logging data in vertical and horizontal wells are combined to do the research on litho-facies and sand-body distribution. Firstly, four types of litho-facies unit were distinguished and were applied to divide litho-facies units in vertical and horizontal wells. Then, vertical and horizontal well data were integrated to conduct quantitative study on sand-body distribution. The morphology and scale of braided channels and bars were obtained. In addition, constrained by sand-bodies penetrated by the horizontal wells, the seismic wave impedance inversion on braided river reservoirs were carried out. Finally, prediction of litho-facies unit was done based on the quantitative characterization of sand-bodies and the result of wave impedance inversion. The study results indicate that we can describe the distribution characteristics of internal reservoir litho-facies elaborately based on the horizontal-well data, which can improve the precision of quantitative study of reservoir sand-bodies and the description about the internal heterogeneity of reservoir. Thus more reliable models of reservoir litho-facies can be obtained.

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2008-2018 – "The Portable XRF Decade"

Baensch A[1,2,3]
[1]Olympus Scientific Solutions, [2]Deep Exploration Technologies CRC, [3]MinEx CRC

TS7 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Aaron is the Principal Geologist – International Mining Group for Olympus, headquartered in Boston, USA. He is also an embedded researcher & project manager at MinEX CRC & DET CRC based in Australia where he was a co-inventor of the recently commercialized Lab-At-Rig®. Professionally, Aaron is a graduate of the Western Australian School of Mines, Kalgoorlie and holds a BSc in Mineral Exploration & Mining Geology with 1st Class Honours. Prior to joining Olympus, Aaron spent time with Barrick, Outokumpu, Mincor, Straits and Breakaway Resources and is a Member of the AusIMM, AIG, SEG, AAG, GSA & WASMA.

The last decade (2008-2018) has seen an unprecedented acceleration in the innovation and adoption of Portable X-ray Fluorescence (pXRF) analysers within the mineral exploration and mining industries. A futuristic device that was once heavily criticized, has now become an industry standard tool and continues to evolve at an increasingly rapid pace, in line with the high performance and field ruggedization expectations demanded by the modern geoscientist. This talk will aim to summarize the key advancements and achievements both in pXRF technology, as well as application development.

Key highlights will include:

Technological Innovation (Hardware/Software):
- Move from active sources to tubes
- Evolution of form factor – computing power & ruggedization
- The innovation to Silicon Drift Detectors (SDD's) from Silicon Pin (Si-PIN) detectors
- New generation High Count Rate (HCR) Digital Pulse Processing (DPP) that has sped up performance
- The continual drive towards lower LOD's and expansion of the element suite (light elements & REE's)
- The uptake and innovation in field based sample preparation equipment
- Real-time QA/QC, data management, visualization and the move to cloud-based data delivery

Application Development & Highlights
- The change in culture and adoption of best practice guidelines (CSIRO/CAMIRO/CSA Global…etc.)
- Key organisations, researchers and companies that are leading the pack in best practice application of pXRF (CAMIRO, DET CRC, CSIRO, MDRU, Reflex…etc.)
- Chemo-stratigraphy
- Gold pathfinders & alteration vectoring
- REE & Battery Metals
- GeoMet applications
- Key Journal Volumes, Papers & Publications
- JORC / 43-101 considerations

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An alternative future for Applied Geoscience training? Micro-credentialing, Universities, Professionals and Industry.

Sims D[1]
[1]Dale Sims Consulting

TS7 - 5.2 Prediction, process, place: Geomorphology & 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Dale Sims is an industry geologist with over 30 years of experience in hard rock mining and exploration geology. He has been an independent consultant since 2010 although prior to that he held a number of operational and corporate roles with international mining companies working in Australia, Indonesia and around the world. He enjoys delivering professional training around data quality, 3D domain analysis and resource estimation modelling / communication.

In a keynote address at the AusIMM/AIG 10th International Mining Geologists' Conference in September 2017 Associate Professor David Cohen spoke on emerging trends in tertiary geoscience education including the concept of micro-credentialing.
Designed primarily for professionals requiring additional formal training in a wide variety of fields, micro-credentialing allows the building of credit points towards a post graduate qualification by taking a personal selection of university-endorsed short interval training courses, completing assessment to verify competency in the content and bundling the resultant credit points towards a recognised university qualification.
The design of programs that will permit completion by way of micro-credentialing may range from existing postgraduate coursework programs to highly flexible and individualised programs around key vocational skillsets.
Course delivery can be by external presenters who have been assessed by the university as experts in their field and training can be held away from campus. Recognised development opportunities can be single day courses through to multiple day, week and / or online content modules.
The university will have a financial stake in the process for which they can provide access to online resources including learning and assessment systems, administrative support and importantly assistance with educational design for optimal content delivery using 'state of the art' technology.
With the mining boom-bust cycle driving antithetic enrolment numbers coupled with an increasing awareness of industry focussed skillsets in outcomes we need a new model for tertiary Applied Geoscience training. Is micro-credentialing it? We explore the possibilities linking professionals, industry and academics in this quest.

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The Journey of Curious Minds to the Earth Science Olympiad

Almberg L[1,3], Dadd K[1,2], Neo Y[3]
[1]Australian Science Innovations, [2]Australian Mathematics Trust, [3]Monash University

TS7 - 5.2 Prediction, process, place: Geomorphology & 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Dr. Almberg brings over 20 years of field and lab-based geology experience to her impassioned teaching. Training as a volcanologist, seismic data analyst, and research assistant at the Alaska Volcano Observatory provided a wealth of first-hand experience. Her studies took her around the Ring of Fire and beyond. Dr. Almberg has worked with students and teachers extensively throughout her education and career, earning accolades and recognition from students, institutions, and government bodies for her efforts. She is also the TESEP Coordinator for Victoria, an AUGEN board member, a casual lecturer at Monash University, and a contributing author and editor.

Curious Minds is an invitational academic program for highly capable girls in years 8, 9 and 10 (especially disadvantaged, rural/remote, and/or Indigenous young women) with a keen interest in STEM subjects. The program comprises two residential camps and a six-month mentoring program. Students are recruited based on tests administered by the Australian Mathematics Trust and Australian Science Innovations. Curious Minds provides a unique opportunity for participants to meet like-minded young women, exposes them to new ideas and allows them to explore the interrelationships between subjects. The mentoring program pairs the girls with women working in a STEM profession. Students work collaboratively on a project while mentors share experiences, ideas about university options, volunteering or work experience, help mentees learn new skills and access information, and offer advice and guidance.

YiJie Neo and Jemima Jefferies set the gold standard for what's possible after participating in the first round of Curious Minds in 2015-'16. Although they had no previous interest in Earth science, their chance experience in the Earth and Environmental Science "supercharged session", a fun but intensive look at a range of EES topics, led them to sit the EES Olympiad entrance exam. Both girls went on to represent Australia at the UNESCO-sanctioned 2017 International Earth Science Olympiads in France, where they competed against some of the brightest young minds in the world. Their efforts placed them in the top 10 per cent of Earth Science students in the world, earning gold and silver medals for the Australian team!

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The role of the ocean in modulating the dynamics of the Havre 2012 silicic submarine eruption.

Carey R[1], Soule A[2], Manga M[3], Ikegami F[1], McPhie J[1], Murch A[4], Mitchell S[5], Conway C[6], Fauria K[2], Lin C[3], Jones M[2], Degruyter W[7], Hosseini B[3], Cahalan R[8], White J[4], Jutzeler M[1], Wysoczanski R[9], Houghton B[5]

[1]University Of Tasmania, [2]Woods Hole Oceanographic Institution, [3]University of California at Berkeley, [4]University of Otago, [5]University of Hawaii at Manoa, [6]Japan Museum of Natural History and Science, [7]Cardiff University, [8]Georgia Tech, [9]New Zealand Institute for Water and Atmospheric Research

TS6 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 9:30 AM - 11:00 AM

Biography:

Dr. Rebecca Carey is a Senior Lecturer and Australian Research Council DECRA fellow in the School of Natural Sciences in the College of Science and Engineering. She is a volcanologist with research themes in Earth and Marine sciences. Rebecca's research uses field studies, microanalytical and volatile analysis on the products of volcanic eruptions to understand magma's ascent to, and eruption at, the surface. Her expertise in volcanology of the modern seafloor and terrestrial settings has proven invaluable for knowledge and understanding of ancient volcano-sedimentary successions.

The 2012 submarine silicic eruption of Havre volcano in the Kermadec Arc, New Zealand is the largest and deepest recorded in modern history. In 2015 we conducted a tandem remote vehicle investigation of the volcanic edifice and eruption deposits. The observations and measurements constrain position and depth of new vents, eruption styles and intensities, which facilitate quantitative constraints on magma ascent, fragmentation and transport of products in the water column.

One vent was responsible for the ~1 km3 pumice raft seen in satellite imagery and is linked to a giant pumice clast deposit on the submarine volcanic edifice. 1D conduit models using Havre magma chemistry and melt inclusion water contents of 5.8 wt.% show that at vent depths of 900mbsl (9 MPa) explosive eruption was suppressed, and buoyant magma was extruded into the ocean where it rose, quenched and fragmented to produce the metre sized clasts. Future expansion of this conduit model at different vent depths will provide constraints on the depth limits of explosive silicic volcanism in the ocean.

The Havre eruption also produced lavas, domes and cryptodomes at 14 vents on the seafloor. The morphology of the eruption products was driven by the volcanic topography, and geometries of the linear vents. Observations and volatile analysis of a 2012 glassy lava records lava effusion contemporaneous with autobrecciation and explosive ash venting. The fluid morphologies of the ash demonstrates that at the time of fragmentation, the magma had a low enough viscosity to deform in ductile fashion.

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Assessing human health risks with reference to pesticide pollution in groundwater.

ABDELDAYEM R
[1]*Ass. prof - Mansoura University*

Biography:

- Dr. Rafaat is an associate consultant at Mansoura University, Egypt.
- phD of hydro geochemistry
- He also has a Diploma of toxicology and forensic chemistry (1996) from the Faculty of Medicine and a Diploma of applied chemistry (1993).
- Dr. Rafaat specializes in medical analysis, toxicology & forensic chemistry as well as water pollution.
- He has published papers over 10 local paper and 13 in international publications.
- He has spoken at 55 local conferences and workshops and 15 international meetings.
- He is currently a member of eight international scientific societies.

Objectives: Water is one of the major pathways for the diseases to acquire human body. Fresh water is one of our most vital resources, and when our water is polluted, it is not only devastating to the environment, but to human health. This study aimed at the possible effects of some trace elements in drinking water on the health of the inhabitants. Study design: A prospective study. Methods: The size of samples was forty drinking water samples and forty urine samples taken. Trace elements analysis was done to analyze some heavy metals using atomic absorption spectrophotometer (AAS). Results: The present study on abundance and distribution pattern of toxic trace elements indicates the quantitative aspect of pollution in the study area. The data shows the positive correlation between some elements. Conclusions; Using safe drinking water can greatly reduce the risks of ingesting heavy metals through drinking water.
Keywords: water; patients; urine; trace elements; AAS.

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The Chicxulub Impact: The End of an Era

Morgan J[1]
[1]*Imperial College London*

TS1 - 2.3 Mass Extinctions, Room R1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
I have a PhD in Marine Geophysics from the University of Cambridge, UK. I have been at Imperial for around 20 years, and have been a Professor of Geophysics since 2011. I first started working on Chicxulub over 20 years ago, and have been involved in acquiring seismic data across the crater and using it to determine crater size and structure, onshore and offshore drilling of the crater, and modelling of ejecta from the impact site.

In 1980, in two separate papers, Alvarez et al. and Smit and Hertogen proposed that a large body hit the Earth and caused the most recent (K-Pg) mass extinction. The Impact Hypothesis was initially widely dismissed, on the basis that the evidence for impact was weak, and that the extinctions were gradual and started before the impact occurred. The K-Pg boundary clay has now been studied at many sites around the world and is clearly formed from impact ejecta: material from the asteroid and target rocks that has been ejected from the impact site (Chicxulub), and travelled around the globe to its final destination. Studies of small fossils in marine sedimentary rocks, for which the record is more reliable due to high numbers (~100,000 fossils per gram) show that the extinctions were abrupt: life was thriving and the oceans productive immediately before the impact and then collapsed precisely at the K-Pg boundary. The impact is now widely thought to be the principal driver of the mass extinction, although eruptions from the Deccan and elsewhere may have contributed. The cause of the extinctions is still not agreed, but it is fairly certain that the impact triggered a nuclear winter, an extended period (3-14 years) when the entire Earth was cold and dark, which is likely to have been catastrophic for photosynthetic life.

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The efficacy of virtual education in undergraduate geoscience units

Roach M[1]

[1]*University Of Tasmania*

TS8 - 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Michael Roach is a Senior lecturer at the University of Tasmania who teaches both undergraduate and postgraduate geophysics and geology units. Michael has a special interest in the applications of virtual content for Earth science education

The AusGeol virtual library of Australia's geology (www.ausgeol.org) is a major digital resource for undergraduate geological education which provides free access to virtual content for over 3,500 sites around the continent. Visualisations include geometrically-correct photo-realistic 3D models, full spherical panoramas and "virtual tours". AusGeol also provides free software (GeoVis3D) for interactive geometric analysis and interpretation of 3D content.

At the University of Tasmania we utilise the AusGeol resources and GeoVis3D software for undergraduate education at first, second and third year levels. This presentation will showcase the use of virtual content in a range of undergraduate units and provide an assessment of the efficacy of the virtual approach. We cannot provide quantitative measures for improved educational outcomes using virtual resources but student and staff responses to the introduction of virtual material have been overwhelmingly positive and suggest that these tools clearly have a role in modern undergraduate geological education.

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Biogeochemical mapping in mineral exploration

Cohen D[1]
[1]*University of New South Wales*

TS7 - 3.1.1 Effective exploration and discovery under cover, Room R2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
David Cohen has over 30 years experience in geochemical exploration, including regional mapping methods. He is a former head of the UNSW School of Biological, Earth and Environmental Sciences, a Past-President and Fellow of the Association of Applied Geochemists, and a Fellow of the Royal Soc NSW and of the AIG. He is President-elect of the Australian Geoscience Council.

The selection of sampling media in regional geochemical exploration programs involves balancing various factors that include the availability of the media, the strength and consistency of geochemical patterns that can be spatially related to the effects of mineralisation and the cost. The use of vegetation as a sampling media in mineral exploration is rare in comparison with regolith materials such as soils and stream sediments. This partly stems from a lack of systematic biogeochemical orientation studies, but also the perception that complexity in the controls on plant chemistry renders interpretation of biogeochemical less reliable than other conventional media.

At the regional scales variations in parent lithology, regolith-landform settings and effects of mineralisation are reflected in plant chemistry, as demonstrated in Cyprus (brutia pine) and the NE region of NSW (mixed genera). At the mineral deposit scale, biogeochemistry has demonstrated a capacity to effectively map geochemical dispersion patterns, including the historical Sunny Corner Ag-Pb-Zn (radiata pine) and Woodlawn Cu-Pb-Zn mine-sites (green and black acacia), the Thackaringa Co-pyrite deposit (saltbush), the McKinnons Tank Au and other base and precious metal deposits of the Cobar Basin (cypress pine), using conventional analytical techniques such as INAA and ICPMS, and more recently by field portable XRF. The capacity of fpXRF to provide real-time biogeochemical data that is fit-for-purpose in mineral exploration and/or assists in the selection of samples for subsequent laboratory analysis is evaluated.

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Understanding the causes of low frequency shadow below gas hydrates

Qadrouh A[1]
[1]*Kacst*

Biography:
Ayman N. Qadrouh is employed as a geophysicist in National Center for Oil & Gas Technology at King Abdulaziz City for Science and Technology (KACST), Saudi Arabia, since 2004 until present. In 2004, he achieved his Bachelor degree in Geology - Geophysics from the King Abdulaziz University in Jeddah, Saudi Arabia. In 2008, he got his MSc degree in Petroleum Geosciences at the University of Adelaide, Australia (2008). In 2017, he completed his PhD from Universiti Teknologi PETRONAS (UTP), Malaysia. His research interest is seismic exploration with emphasis on seismic inversion, velocity model building and rock physics.

Gas hydrates consider as one of the prospective natural resource that can supply energy. The seismic method has successfully been applied to locate gas hydrates. Their presence is revealed by bottom simulating reflectors (BSR) which represent the seismic signature of the base of gas-hydrate saturated sediments, with a layer partially saturated with free gas below the BSR. It is observed that the seismic response of the BSR is characterized by low frequency, which it is called the low frequency shadow (LFS). The possible causes of LFS are the presence of free gas or normal moveout (NMO) stretching. In order to have a deep understanding of the low frequency shadow causes, 1D and 2D synthetic seismograms and spectrograms are computed. The 1D and 2D simulations of seismic signal are based on rock physics and numerical modeling, considered the effect of the seismic attenuation and NMO stretch. The results of numerical seismograms and spectrograms show that attenuation affects the lower interface with minimum amplitudes for lower values. The quantification of the maximum frequency is obtained as the shift of the centroid spectrum. Moreover, the non-stretch NMO corrections improve the resolution to detect the BSR layer, and a stacked trace can be achieved without loss of frequencies. As a result, using an appropriate rock physics method is required to obtain valuable knowledge about the effect of the different parameters on the wave properties.

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The use of heat as a groundwater tracer

Irvine D[1]
[1]Flinders University/NCGRT

TS6 - 3.3.2 New groundwater technologies and approaches, Room R5, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Dr Dylan Irvine is a lecturer in hydrogeology at Flinders University. He has an interest in the use of heat as a groundwater tracer, and in the production of computer software to automate data analyses.

Heat transport theory has played an important role in hydrogeology. For example, it is widely known that the Theis (1935) solution to determine transient drawdown in a confined aquifer was produced using a heat transport analogue. Similarly, the book “Conduction of Heat in Solids” by Carslaw and Jaeger (1959) has been used to produce several hydrogeological approaches. After a flurry of publications (and associated methods) in the 1960s, the use of heat as a groundwater tracer has largely taken a back seat to the use of isotopic tracers and hydraulic methods. Since the mid-2000s, the interest in the use of heat as a groundwater tracer has increased. This is off the back of several key reviews, improvements in temperature sensors/loggers that are cheap, highly accurate and self-contained, and improved methods for quantifying fluid flow from temperature data.

In this presentation, I will discuss various uses for temperature data in hydrogeology. Contexts which will be covered will include the quantification of; surface-water groundwater interactions, vertical flow in aquifers and vertical groundwater flow on the sea-floor. In each case, a discussion on typical equipment required, and computer software tools which can be used to automate the data analysis process will be provided. The use of heat as a tracer is not new, but it is underutilised in hydrogeology. The aim of this presentation is to show that this need not be the case.

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Collision of the Caribbean Plateau with the Americas: earliest evidence from the forearc geology of Costa Rica

Andjic G[1], Baumgartner P[2], Baumgartner-Mora C[2]
[1]*The University of Queensland - School of Earth and Environmental Sciences,* [2]*University of Lausanne - Institute of Earth Sciences*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
My research interests currently focus on the response of forearc areas to the collision of bathymetric features. Mode and timing of collision are investigated by using a multidiscplinary approach which combines fieldwork, provenance studies, biostratigraphy, and sedimentary and igneous petrology. A coherent picture of the collision events is obtained by integrating data from other disciplines of earth sciences.

The ages and the origin of the oceanic assemblages exposed along the Central American land bridge represent a key to the understanding of the tectonic evolution of the western Caribbean Plate margin. The basement underlying Costa Rica and Panama consists of Upper Cretaceous mafic igneous rocks of the Caribbean Large Igneous Province (CLIP). In contrast, northernmost Costa Rica and Nicaragua are underlain by the Mesquito Composite Oceanic Terrane (MCOT). The MCOT corresponds to an Upper Jurassic–Lower Cretaceous serpentinite-matrix mélange containing Upper Triassic–Jurassic high pressure metamorphic blocks, including metacherts, arc-derived metamafics, and quartzose metasediments. The boundary between these vast oceanic assemblages is exposed in the Nicoya Peninsula (NW Costa Rica) and consists of an ancient left-lateral strike-slip zone where two, much smaller, Mesozoic terranes are exposed: the Aptian–Turonian Manzanillo Terrane and the Bajocian–early Campanian Nicoya Complex s. str. These terranes originated from Farallon Plate oceanic crust of Jurassic age that was overthickened by Lower and Upper Cretaceous hotspots. Prior to their accretion, these terranes were part of the northwestern edge of the CLIP. Their accretion histories testify of the early tectonic interaction between the CLIP and the MCOT, the latter representing North America at that time. Here we present stratigraphic, biochronologic and geochemical evidence which allow us to constrain the accretion timing of the Manzanillo Terrane and the Nicoya Complex s. str.

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Discovering geological stories in every postcode through online self-guided fieldtrips: an example of small geotourism.

Swann L[1]

[1]*Kirkland Lake Gold*

TS5 - 5.1 Geology in Society: geotourism and geoheritage & 5.6 Diversity in the Geosciences, Room R8, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Lauren completed her Bachelor of Science (Honours) in geology at Monash University in mid-2016. She has since been exploring and mining gold as a geologist at Fosterville Gold Mine in Victoria. In her free-time she develops self-guided geological field trips at a range of sites in Victoria and Tasmania. She first developed an interest in geotourism at university, on field trips and volunteering at the Melbourne Museum on fossil digs as well as a gallery explainer. A passion which she has continued, becoming involved in projects such as the tourist gold mine Central Deborah in Bendigo.

Hikers and bushwalkers often pass through geologically significant sites and whilst they may wonder at their meaning or significance, they are not armed with the interpretive information to comprehend them. These sites have usually been extensively mapped and studied by government survey organisations, universities and museums. However, this content has not been been readily accessible to the public.

For many geologically interesting sites, pamphlets may have been created by special interest groups such as The Field Naturalists Club of Victoria and distributed to the local information centres. Some sites may even have an interactive map and panels to geosite features, however they are not immediately obvious from main roads or advertised through any other media. These are not alone sufficient in this age of new technologies, including: apps, QR Codes, online interactive maps and web pages, to promote geological sites as a form of education and tourism.

The purpose of the 'Weekend Geology' website is to remove these technological barriers to tourists and locals, often visiting these sites on weekends, to allow them to increase their understanding and appreciation of geology in the field – the natural laboratory of geoscience.

To best achieve this outcome, self-guided field trips have been created for several sites using a combination of available geological maps, overlays/place markers for Google Earth/Maps, and geological illustrations/annotated photos accompanied by text. This enables 'potential geotourists' to comprehend the geosites within the context of the formed landscape, and in the process enhance their interpretative experience.

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Neoproterozoic stratigraphic revisions to key drillholes in the Amadeus Basin, NT; implications for basin paleogeography, and petroleum and mineral potential

Normington V[1], Edgoose C[1], Weisheit A[1], Donnellan N[1]
[1]*Northern Territory Geological Survey*

TS7 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Dr Verity Normington recently completed her PhD at the University of Adelaide which explored how sedimentology, geochronology, lithogeochemistry contrinuted to the depositional mechanisms of the late Palaeozoic glacigene rocks of South Australia and their minex implications. Verity has been with the NTGS for 5 years working as a project geologist in the Basin Geoscience team studying the sedimentary rocks of the Amadeus Basin and is based in Alice Springs. Prior to working with NTGS she worked in uranium exploration and for the Geological Survey of South Australia.

The Neoproterozoic-Devonian Amadeus Basin extends across much of southern Northern Territory (NT) and partially into Western Australia. It has proven petroleum resources but poorly defined mineral potential. Northern Territory Geological Survey work in the basin is aimed at developing a better understanding of the palaeogeography, basin architecture, and petroleum and mineral potential of the Neoproterozoic stratigraphy of the Amadeus Basin. A field-based stratigraphic characterisation study along the structurally controlled northeast margin of the basin has enabled significant improvements in the understanding of the basin's Neoproterozoic succession, and resulted in an updated and revised stratigraphic nomenclature. These stratigraphic findings have been successfully applied to a part of the central basin during recent field-mapping, where detailed structural interpretations have also resulted in a revised structural model for the NT portion. Herein we apply these revisions and updated nomenclature to some key diamond-drillholes geographically spread across the NT. Revised logs resulted from integration of relogging, correlating hyperspectral data sets, reviewing published logs, and incorporating biostratigraphic studies.

A major outcome is the recognition of the nearly basin-wide distribution of the Johnnys Creek, Wallara (which include globally important biostratigraphic markers) and Aralka formations, previously thought to be largely restricted to the northeast and central northern parts of the basin. Substantial lateral variation in thickness of these units is also recorded. Syn-sedimentary fold-and-thrust belt tectonics, as well as post-sedimentary faulting has likely contributed to these variations in thickness.

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Zircon provenance of Late Palaeozoic glacigene sedimentary rocks in the Troubridge and Arckaringa basins, South Australia.

Normington V[1,2], Hill S[3], Tiddy C[1,4], Giles D[1,4]

[1]Deep Exploration Technologies Cooperative Research Centre (DET CRC), [2]Department of Earth Sciences, University of Adelaide, [3]Geological Survey of South Australia, [4]Future Industries Institute, University of South Australia

TS8 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Dr Verity Normington recently completed her PhD at the University of Adelaide which explored how sedimentology, geochronology, lithogeochemistry contrinuted to the depositional mechanisms of the late Palaeozoic glacigene rocks of South Australia and their minex implications. Verity has been with the NTGS for 5 years working as a project geologist in the Basin Geoscience team studying the sedimentary rocks of the Amadeus Basin and is based in Alice Springs. Prior to working with NTGS she worked in uranium exploration and for the Geological Survey of South Australia.

U-Pb zircon geochronological data was collected from eight samples taken from late Palaeozoic glacigene sedimentary rocks in the Troubridge and Arckaringa basins in South Australia. The zircon age distributions provide an opportunity to constrain and compare provenance of the glacigene sedimentary rocks at different geographic locations and stratigraphic levels as an aide to interpreting palaeogeography and evolution of the Palaeozoic Gondwanan icesheet. The zircon grains have heterogeneous morphology, including numerous fragmented grains, and varying patterns of internal zoning consistent with diverse source rocks. The zircon populations significantly predate the ca 285-300 Ma depositional age for the Troubridge and Arckaringa basins sedimentary rocks determined independently from palynology. Zircon populations from the Troubridge Basin are dominated by a significant mode at ca 550 to 650 Ma. Older zircons are more abundant in the glaciomarine sedimentary rocks in the upper part of the sequence. The Arckaringa Basin samples are characterised as having a large component of ca 900 to 1200 Ma and ca 1700 to 1900 Ma zircon age populations and containing a significant late Proterozoic to early Palaeozoic population. The resulting provenance assessment suggests that the sedimentary rocks from the Troubridge Basin were sourced almost exclusively from the Kanmantoo Group and the Transantarctic Mountains of Antarctica. Conversely, the Arckaringa Basin sedimentary rocks were primarily sourced from the Gawler Craton and Adelaide Rift Complex.

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A new pathway for chemical fractionation resulting from SO2 - basaltic glass reactions

Palm A[1], King P[1], Renggli C[1], Mernagh T[1]
[1]*Australian National University*

TS8 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Andrew Palm is a student at the Australian National University, under the supervision of Dr. Penny King. His major research focus is studying rock alteration resulting from high temperature gas-solid reactions in nature and in experiments.

SO_2 is a highly reactive gas species which is abundant in magmatic systems on Earth and other planetary bodies. Sulfate and oxide minerals form during surface-mediated, high temperature reactions between SO_2 and silicate glasses over time scales of minutes, causing some major and trace elements to be rapidly mobilised and fractionated.

Chemical depth profiling (LA-ICPMS and SIMS) in addition to isotopic mapping (nanoSIMS) identified that coatings, formed during reactions between silicates and SO_2, are host to a wide range of major and trace metals which are mobilised from basaltic glass substrates. Calcium, Na and Mg are the key major elements in sulfate phases (e.g., $CaSO_4$, Na_2SO_4, $Na_2Ca(SO_4)_2$, $MgSO_4$), which coat the surfaces of the reacted basaltic glass. We show that Fe and Ti form oxide minerals in the coating. Within the modified basaltic glass, micro-crystalline phases (pyroxene and quartz) form due to destabilisation of the glass structure during reaction with SO_2, which fractionate major and trace elements within the modified glass substrate.

In terms of trace elements, we observe that Sr, Ba, Eu and Pb are incorporated into sulfate coatings, K and Rb form an enrichment at the 'interface' between the coating and the modified glass, and other REEs, Th and U remain in the modified glass.

Our results demonstrate that surface-mediated gas-solid reactions provide a previously unrecognised pathway for the formation of sulfate and oxide minerals, and the fractionation major and trace elements. This work adds to our understanding of volcanic systems, where persistent, high-temperature, SO_2-rich degassing occurs.

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Ghosts of the Mediterranean Sea

Penny T[1]
[1]*Australian National University*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
PhD Student at the Australian National University

Natural variability in sea-level needs to be better understood to give more reliable glacio-isostatic adjustment (GIA) markers for future sea-level models and to understand the pre-anthropogenic effects of sea-level in respect to glacial-interglacial cycles. The Mediterranean Sea has been used extensively for palaeoclimate and palaeoceanography studies. There are organic-rich sedimentary deposits in the Mediterranean Sea termed “sapropels” which are characterised by a light stable isotope signature that is not related to changes in ice-volume. As they do not reflect changes in ice-volume, sapropel intervals must be removed from the record to create a reliable relative sea level (RSL) record. However, these intervals are sometimes completely oxidised upon re-oxygenation of the bottom water (termed “ghost” sapropels) and no longer visually identifiable. Down-core stable isotope analysis, environmental magnetism and chemical tracers can be used to identify ghost sapropels. The chronology of the Mediterranean Sea RSL record (Rohling et al., 2014) is based on tuning the midpoint of sapropels (organic-rich sedimentary deposits linked to African Monsoon dynamics) to the precession cycle, a method independent of ice-volume assumptions. This study looks at the light isotopic anomalies that have not been defined as sapropels within the Mediterranean Sea stable isotope record, to assess whether they are sapropel(-like) events and represent a monsoon influence on deposition, or if it is appropriate to keep them within the Mediterranean RSL record.
References:
Rohling, E.J. et al., 2014. Sea-level and deep-sea-temperature variability over the past 5.3 million years. Nature 508(1): 477 - 482.

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Revitalising Botswana's Mineral Exploration Potential

Ngwisanyi T[1]
[1]Botswana Geoscience Institute

TS5 - 3.4 Resources sustainability – responsible investment and management & 3.5 Technology integration, Room R2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Mr. Tiyapo Hudson Ngwisanyi has BSc in Geophysics obtained from Memorial University of Newfoundland, Canada, and MSc. in Exploration Geophysics obtained from ITC, Delft, Netherlands. He is responsible for providing overall leadership and implementation of Botswana Geoscience Institute strategy and delivery of geoscience products and services and advises Botswana Government local, regional and global changes in natural resources such as strategic minerals, water, and natural energy sources as well as environmental and geohazards. He has experience in geophysical surveys related to the search for minerals and groundwater. He previously worked at Department of Geological Survey as the Director

Revitalising Botswana's Mineral Exploration Potential

Abstract
Botswana's mineral led economy has of recent been threatened by challenges and uncertainties in the mineral sector. Though Botswana is endowed with various types of mineral resources, diamond extraction has been pivotal to the country's economic growth. Efforts to diversify away from the dependence on one commodity, diamonds, have largely not been successful as there has not been any major mineral discoveries in the recent past. The Government of Botswana is actively seeking new opportunities for diversification and growth of the mineral sector.
This presentation discusses the role mining has played in the development of the economy of Botswana and how the country can continue to derive optimal benefits from mining. The presentation will also look at how Botswana can stay competitive in light of the fierce competition for foreign direct investment in the mining sector. Botswana still has potential to continue mineral investment due to her favourable geologic environment, low tax rates, investor friendly legislation and political stability.
With the current global demand for minerals, Botswana is in a good position to supply a portion of the world demand. Here we seek to present competitive advantages and to highlight strategies and recommendations of encouraging expansion of private sector investment in the mineral sector as well as promote the search for minerals in the country. Institutions such as Botswana Geoscience Institute are meant to ensure that there is grassroots exploration in the long run to maximize the potential for discovering new mineral deposits.

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Combined usage of GNSS and InSAR to implement and maintain a dynamic Australian datum

Fuhrmann T[1], Lawrie S[1], Garthwaite M[1], Brown N[1]
[1]*Geoscience Australia*

TS1 - 4.4.1 The Geoscience of Where, Room R7, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Thomas Fuhrmann received his PhD entitled "Surface Displacements from Fusion of Geodetic Measurement Techniques Applied to the Upper Rhine Graben Area" from Karlsruhe Institute of Technology, Germany, in April 2016. Since July 2016 he is working as a GNSS & InSAR Scientist in the Geodesy Section of Geoscience Australia. His work focusses on measurement, validation and modelling of ground movements related to resource extraction in the Sydney Basin. Furthermore, he investigates on a combined usage of geodetic data sets observed at GNSS (Global Navigation Satellite System) sites and by radar satellites (InSAR technique) for nationwide products such as Geodetic Datums.

The Geodetic Datum of Australia is defined by a network of permanently operating Global Navigation Satellite System (GNSS) sites that observe the movement of the Australian tectonic plate. GNSS provides geodetic observations with a high temporal sampling but at a relatively small number of positions that are sparsely distributed throughout Australia. Interferometric Synthetic Aperture Radar (InSAR) is a satellite remote sensing technique which can map millimetre to centimetre scale surface movements over large areas with a high imaging resolution. However the temporal sampling of InSAR is limited to the orbit revisit time of the satellite.

Geoscience Australia is currently investigating the combined usage of GNSS and InSAR for monitoring the Earth's surface movements exploiting the complementary properties of both techniques. While we obtain high accuracy from GNSS for the horizontal components of displacement, InSAR is more sensitive in detecting vertical surface displacements.

In this contribution we will present a joint analysis of GNSS and InSAR data at 21 geodetic monitoring sites in the Sydney Basin consisting of co-located GNSS antenna and InSAR corner reflectors. Our analysis includes a novel data fusion technique and robust validation of both datasets at our monitoring sites.

The advent of the European Sentinel-1 satellite mission in 2014 provides Australia with an excellent opportunity to use InSAR on a national scale and to integrate InSAR-derived deformation map products into the national geodetic reference frame. We will discuss how this big radar dataset can be used in the future to monitor deformation and improve positioning in Australia.

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New results from the southern Thomson Orogen: implications for geodynamics and mineral systems in NSW

Folkes C[1], Gilmore P[1], Hegarty R[1]
[1]Geological Survey Of New South Wales

TS8 - 3.1.7 Studies on the Thomson Orogen, Room R2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Chris Folkes is a senior geologist at the Geological Survey of NSW. He has PhD in physical volcanology and igneous geochemistry and geochronology from Monash University, Melbourne. His current work includes being a Project Leader for the NSW Seamless Geology Project - a statewide compilation of best available mapping data in an internally consistent format. he is also Project Leader for the Southern Thomson Orogen Project - investigating basement rocks of an undercover region in remote north-western NSW involving geophysics and stratigraphic drilling. Previous employment includes being a regional geologist at Geoscience Australia and lecturer at Monash University.

The southern Thomson Orogen (STO) in north-western NSW is a frontier region where poorly understood basement rocks and structures under sedimentary cover have potential to host mineralisation. The Geological Survey of NSW is working with other government agencies and universities to advance understanding of the structural framework, geological history and mineral potential of the region.

Stratigraphic drilling in 2017 (in collaboration with Geoscience Australia and the Geological Survey of Queensland) involved seven holes in NSW successfully sampling basement lithologies under Eromanga Basin cover. Another five holes were completed in Queensland as part of this collaboration.

New data from the drilling program (including lithology, petrography, geochemistry, U–Pb geochronology and geophysics) have implications for geodynamic history and mineral systems. Older intrusions (~430–425 Ma) along the southern margin of the Thomson Orogen have I-type affinities, whilst younger intrusions (~425–420 Ma) to the north have S-type affinities. Both volcanic and plutonic rocks with ages of ~400 Ma are also now recognised – coincident with volcanism in the Paka Tank Trough. These results confirm Tabberabberan-aged extension in this region. New geochemical analyses of igneous units in the NSW part of the STO confirm that they have potential for Silurian intrusion-related Sn–W and Cu–Mo mineral systems. These results have improved our understanding of the tectonic and magmatic history of the region, as well as provided fundamental information for future mineral exploration activities and land-use planning in the STO.

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2 ½ D Solid Geology- A cost- effective precursor/ alternative to 3D

Isles D[1]

[1]*Tgt Consulting*

Biography:

Dave has worked in the hard-rock exploration arena since the late 1970s and has specialised in the effective use of aeromagnetics. He has conducted R&D and training programs in this field and co-authored a book on geological interpretation of aeromagnetic data.

Past affiliations have included BHP Minerals, World Geoscience Corporation, NewHampton Goldfields, Gravity Capital and Mineral Deposits Limited. He is currently an independent consultant and associated with Southern Geoscience. He is a graduate of Melbourne (BSc hons Geophysics,1975) and Adelaide (PhD Economic Geology, 1983) universities and is a member of AIG and ASEG.

The momentum toward 3D geological interpretation and visualisation is established and warranted, particularly in 'data-rich' environments. There is often, however, insufficient data to facilitate robust 3D interpretation. In many mapping situations at a range of scales, good quality aeromagnetic data can provide a wealth of 'solid geology' when integrated with available surface mapping and drill hole information. The conventional '2D' aeromagnetic interpretation can and should be extended to an integrated solid geology including conventional cross sections, but this is rarely done. The essentially qualitative integration of geology and aeromagnetics need not be supplemented by time-consuming and often costly forward modelling or 3D inversion in order to produce a coherent '2½D' interpretation.

Two examples are presented showing how conventional, qualitative solid geology interpretations and cross sections can be compiled with the aid of aeromagnetics and visualised in 3D. The example from the Western Australian Archaean illustrates the 'dominant cover' situation where the aeromagnetic data provides most of the bedrock information. At the coarse compilation scale (1:50,000) the cross-sections are largely diagrammatic but they do add valuable insight to the interpretation. The second example, from the Pine Creek Orogen in the Northern Territory, is one where outcrop is extensive and the mapping is very good. The modest amount of aeromagnetic data adds remarkable detail to the geological picture at 1:25,000 scale and with cross-sections viewable in 3D, the process of interpretation and exploration targeting is greatly enhanced.

This process represents a viable alternative to 'full' 3D geological modelling in 'data-poor' environments.

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Demonstrating long-term safety of nuclear waste disposal: Geosciences leads the way

Mallants D[1], Suckow A[1]
[1]*CSIRO*

TS2 - 3.2.3 Petroleum and its co-products & 3.2.5 Geoscience aspects of the storage of energy related waste, Room R2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr. Dirk Mallants is Team leader of the Environmental Tracers and Applications Team at the CSIRO (Commonwealth Scientific and Industrial Research Organisation) in Australia. He holds a PhD in vadose zone hydrology from the University of Leuven, Belgium. At CSIRO, he leads the R&D that supports the Federal Government in developing disposal facilities for Low-level (LLW) and Intermediate-Level radioactive waste (ILW). Prior to joining CSIRO in 2011, he worked for 15 years at the Belgian Nuclear Research Centre in Mol leading a team of scientists and engineers undertaking safety assessments for repositories of LLW, ILW and High-level Waste.

The long-term safety of geological disposal of nuclear waste is based on two key principles: (i) containment of the waste until the radioactivity has decayed to negligible levels, and (ii) the isolation of the waste packages in stable conditions that are conducive to maintaining containment integrity for as long as required. We review how suitable disposal site characteristics look like and show how geoscientific investigations play a pivotal role in demonstrating long-term safety of nuclear waste disposal. Using examples from around the globe, we discuss the various types of geoscience information that are typically collected throughout the decade-long waste disposal programme. Broadly, geoscientific information is required to satisfy four criteria: (i) demonstrate safe containment and isolation of the waste, (ii) demonstrate long-term site stability, (iii) avoid inadvertent human intrusion, and (iv) demonstrate suitable repository construction characteristics. The mineralogy of the rock together with the geochemical composition of the groundwater and rock are important in relation to containment (e.g. radionuclide retardation, canister and buffer corrosion) and isolation. Host rocks should have negligible groundwater flow, e.g. low frequency and permeability of conductive fractures. To maintain long-term stability of the site and rock properties, tectonic activity should be relatively low. Furthermore, future climate change impacts due to permafrost and sub-glacial erosion should be sufficiently understood. Sites should minimize the likelihood for repository disruption by exploration and exploitation of mineable resources. Finally, in-situ stresses should not affect constructability or the degree to which the rock conditions facilitate adaptations to the design

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The legacy for engineering geology from the Snowy Mountains Hydro-electric Scheme, New South Wales

Goldsmith R[1]
[1]*SMEC*

TS6 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Robert Goldsmith is a practicing engineering geologist with extensive experience dams, hydropower schemes, tunnels and other underground openings, power stations, bridges, highways, large excavations, plus water and material resources. In addition to wide experience in Australia has worked on many international projects including in Africa, the Himalayas, South east Asia and Papua New Guinea and is currently involved with the Snowy 2.0 scheme.

The development of the Snowy Mountains Hydro-electric Scheme in New South Wales, from 1949 to 1976 required extensive geological studies. Broadly, the Scheme was devised to transfer waters from the Snowy River for irrigation purposes inland with the combined benefit of generating hydro-electricity. The Scheme comprises two sections: the northern, Snowy-Tumut development; and the southern, Snowy-Murray development. Both developments are connected by tunnels to a main regulating storage on the Eucumbene River. The completed Scheme includes 16 large dams, over 145 km of tunnels and 7 power stations with an installed generating capacity of 3740 MW. The challenges of gathering detailed survey, hydrological and geological information were enormous in the remote rugged mountains that were often snow covered in winter. The systematic approach to investigating and consistent recording of the geological data was formative in setting standards and procedures for engineering geology still in practice worldwide. Significant contributions to engineering geology were the methods of classification of weathering and strength of rock masses, drilling and in situ testing methods, tunnel logging practices, assessment of in situ stresses, and applications of rock mechanics to hard rock tunnelling and excavation of large underground power stations. Relevant examples are the Eucumbene-Tumut Tunnel, the Tumut 1 Power Station and Talbingo Dam.
The legacy from this project is again being applied to the new Snowy 2.0 project that involves a pumped storage system with 27 km of tunnels and a deep underground power station with 2000 MW of power generating capacity.

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National Guidelines for Tsunami Hazard Modelling: A collaboration between scientists and end-users

Davies G[1], **Sexton J**[1]
[1]Geoscience Australia

TS4 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Gareth Davies works in the Community Safety and Earth Monitoring division of Geoscience Australia on a range of projects related to coastal hazards. Recently he has been leading the update of the Australian Probabilistic Tsunami Hazard Assessment

Tsunamis are relatively rare in Australia and emergency managers rely on information sharing at national forums to assist them in managing the tsunami risk. Emergency managers across Australia recently identified the need for consistency in tsunami hazard information to enable the hazard to be compared and contrasted nationally. The need for consistent advice on how to procure this complex information was also identified, and as a result, a project was initiated to develop national guidelines for tsunami hazard modelling.
This presentation will outline the approach adopted to develop these guidelines, focusing on the collaboration of end-users and tsunami modelling practitioners. The guidelines were explicitly designed to facilitate appropriate standards of rigour and improved national consistency in tsunami hazard modelling, without dictating software choices or otherwise suppressing innovative practices (which will evolve over time in concert with improvements in tsunami science). The focus was on providing guidance in designing a study suitable for the use-case being considered. Core issues included the treatment of uncertainties in tsunami generation, propagation and inundation modelling, and scenario return periods.
Whilst emergency managers proposed the development of these guidelines, the target audience includes any agency that would potentially commission tsunami hazard studies for a particular purpose (e.g. coastal infrastructure owners, insurance), as well as the modellers conducting such studies. In many situations, tsunami modelling is conducted by coastal hazard modellers who may not have current understanding of Australia’s tsunami hazard. The guidelines will also become a valuable resource for the tsunami modelling community.

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Geophysics in Australia Enters a Decade of Transformation

Reading A[1]
[1]*University Of Tasmania*

TS1 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Anya Reading leads the 'Compute Earth' research group in the
School of Natural Sciences, University of Tasmania as a Professor of Geophysics. Her innovative approaches to data science build on a foundation of experimental field seismology in challenging regions such as Antarctica and outback Australia. Special interest areas include interdisciplinary research and public engagement with science and mathematics.

Geophysics encompasses the extensive group of subdisciplines that aim to reveal the hidden reaches of the Earth, and understand it's processes, using physical measurements, mathematical methods and computing. It complements geological and geochemical approaches which rely on direct access to the rocks, or other Earth materials. Australia has long been an international leader with regard to deployments of portable instruments, temporary instrumentation that has allowed reasonable coverage of Australia's considerable land area. Australian geophysics has also contributed significantly in the realm of mathematical approaches to making inferences from data in the Earth Sciences, and has also made notable contributions to fundamental, global Earth Sciences through the development of computational environments for plate tectonic and geodynamic modelling. In industry-relevant activity, successes in minerals discovery have been made through Australian geophysics, particularly in reconnaissance techniques for exploration under an electrically conductive cover. The countries of southeast Asia lie on the active tectonic margins or adjacent plates and hence Australia plays a role in understanding the inherent natural hazards of its region.

This presentation describes the likely future transformation as the separate areas of Australian geophysics expertise become more integrated in the forthcoming decade. Coordinated national computing resources will become the norm as we see a possible departure from project-led data collection to national initiatives that combine integrated data collection and archives with high-performance computing. Further, the needs of industry-relevant and fundamental geophysics will converge as we perform higher resolution studies over a greater area of the Australian continent and surrounding regions.

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Erosional Response to Monsoon Intensity Change and Rock Uplift in the Western Himalaya since the Late Miocene

Clift P[1], Zhou P[1], Stockli D[2], Blusztajn J[3]

[1]Department of Geology and Geophysics, Louisiana State University, [2]Department of Geological Sciences, Jackson School of Geosciences, University of Texas, [3]Department of Geology and Geophysics, Woods Hole Oceanographic Institution

TS7 - 1.3 Marine Geoscience - The evolving oceans/IODP, Room R1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Clift has 28 years of experience in marine geology and sedimentary geology, largely with scientific ocean drilling. He is an expert on the Asian marginal seas and constraining the evolution in the erosional with reference to monsoon intensity and mountain uplift. He applies single grain provenance methods in order to reconstruct the development of major river systems. He has interests in basin tectonics and links to surface processes. Clift is a GSA Fellow and holds visiting positions at Yunnan University (China), Woods Hole Oceanographic Institution and MIT (USA).

The Indus Fan is the main depocentre for sediment eroded from the western Himalaya, Karakoram and neighbouring ranges. Drilling by International Ocean Discovery Program (IODP) in the Laxmi Basin of the eastern Arabian Sea has provided a relatively continuous record of the erosion back to 10.8 Ma. Spectral reflectance data implies increasing hematite/goethite values and thus increasing aridity over the 9–5 Ma period. At the same time Nd and Sr isotopes show increased erosion from Himalayan rather than Karakoram sources. Combined with detrital zircon U-Pb ages we identify two sharp increases in erosion from the Lesser Himalaya, especially the Crystalline Lesser Himalaya, at 8.3 Ma and after 3 Ma. The isotopic shift is not driven by intensified erosion of Nanga Parbat since the Pliocene. This shift follows a period from 17 to 9.5 Ma when erosion was increasing from the Karakoram, probably linked to activity and uplift along the Karakoram Fault. The focusing of erosion in the Lesser Himalaya at a time of climatic drying and generally lower erosion is hard to relate to monsoon development and may reflect orographic precipitation linked to rock uplift of these sequences driven by tectonic forces such as duplexing over a ramp in the main basal Himalayan Thrust. Continued flux from the Greater and Tethyan Himalaya since 10.8 Ma precludes large scale drainage capture of the Indus tributaries.

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The application of mineral potential mapping to the southern New England Orogen of NSW

Blevin P[1], Downes P[1], Peters K[2], Partington G[2]
[1]Geological Survey of New South Wales, [2]Kenex Pty Ltd

TS7 - 3.1.2 Making better exploration decisions through an integrated geoscience approach & 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Phillip Blevin is a graduate, postgraduate and postdoctoral research fellow of UNE, JCU and ANU with thirty years experience in industry sponsored academic research, private consulting and government geology. He specialises in the metallogenic fertility of igneous rocks, and the deposit- to regional-scale geology of related mineral systems including Sn, W, Mo, Cu, Au and related rare metals. He has published in the international literature. Phil joined the GSNSW in 2006 initially in strategic assessments, then as a research scientist and is now currently manager of the minerals team at the survey.

The Geological Survey of NSW (GSNSW) has embarked on a statewide mineral potential mapping project designed to inform land-use planning, aid mineral exploration and focus future geoscientific data acquisition. Kenex Pty Ltd has been engaged as a partner in the process. In the southern New England Orogen, region-specific mineral system models for orogenic Au–Sb and intrusion-related Sn–W and Au were used to determine the key predictive geological, geochemical and geophysical variables that represent the critical source, transport, trap and depositional components of each mineral system.

Between 71 and 101 predictive maps describing these components were created for each mineral system using a wide range of spatial datasets. Of these, 18 predictive maps were selected and combined to create mineral potential maps for each system using a weights-of-evidence approach. Final results were highly encouraging, with the odds of finding the 13 to 28 training point sites selected for each model increasing from 0.01–0.2% (prior probability) to 74–93%, with efficiencies in how the training sites were classified within each model being 98% or better. The high quality of GSNSW's datasets, underpinned by the Seamless Geology of NSW, was key in assuring the success of this study. Predictive maps generated during the study are significant outputs in their own right as they comprise distillations of large datasets that are adaptable to other mineral system models. The methodology and workflows established will form the basis for ongoing mineral potential mapping across NSW, with work currently underway in the state's west.

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Towards an isotopic atlas of northern Australia

Fraser G[1], Jones S[1], Anderson J[1], Champion D[1], Waltenberg K[1], Huston D[1], McLennan S[1], Lewis C[1]
[1]*Geoscience Australia*

TS1 - 3.1.1 Effective exploration and discovery under cover, Hall E2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Chris Lewis completed his undergraduate degree (B.Sc. Hons) at the University of Adelaide in 2009. He joined Geoscience Australia in 2010 and has worked in both the Energy Systems Branch and Mineral Systems Branch with a focus on applying geochronology and isotope geochemistry to both large- and small-scale projects.

Radiogenic isotope geochronology and complementary isotopic studies have been conducted in Australia for several decades, incrementally improving the geographic coverage of key datasets. Most of these results are published in disparate reports or journal articles with a focus on local geological history or a particular geological problem. The collective scientific value of these studies, most of which have been publicly funded via government or academic programs, can be enhanced via systematic collation of data at continental-scale to: (i) visualise large-scale trends and (ii) facilitate integration with other continental-scale geoscience datasets.
In addition to an ongoing program of data acquisition to address key data gaps, recent effort at Geoscience Australia has focussed on compiling new and legacy geochronology and isotopic data from northern Australia for visualisation in map form. Data layers in various stages of development include; Sm-Nd, Lu-Hf, U-Pb, Ar-Ar and Pb-Pb, and together comprise an isotopic atlas of northern Australia.
Here we provide a progress report on this work, illustrating the power of the collective data sets, and the challenges in collating and visualising data with diverse provenance in geologically meaningful ways.
Delivery of these isotopic data at the semi-continental scale complements other geological and geophysical datasets available at similar-scale.

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Mapping in a Connected World

Beltran J[1]
[1]SRK Consulting

TS1 - 4.4.1 The Geoscience of Where, Room R7, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Jason has over 17 years' experience in the GIS industry. His expertise in GIS project management includes implementing procedures for digital map creation and best practices in GPS field mapping. Since joining SRK, Jason has worked on projects that require map production for publicly released reports, and provided technical GIS support and database administration for junior miners. Jason has experience in the production of geological maps, and has worked on various projects that require the use of analytical GIS, such as viewshed analysis and floodplain mapping. He also specialises in closure cost estimation using the Standardized Reclamation Cost Estimator model.

Traditional paper maps are static and limited to the size of the paper on which they are printed. Another drawback is the difficulty in viewing the detail when maps portray a lot of information. The solution is either to split the map into different map sheets, or to remove some of the features shown, which lessens the value or usefulness of the end result.
But in a digitally connected world, we can make use of smart devices – mobile phones and tablets – as tools for collecting and sharing mapping data. Doing so enables accurate digital maps to be produced collaboratively in a shorter timeframe, and without limitations in terms of size and scale.
By leveraging a customised in-house mapping portal using ArcGIS technology initially developed by ESRI, digital field data collection is integrated with a centralised database, making it possible for maps and other geographical information to be accessed in real time, and shared by a variety of users simultaneously, enabling a single point of truth for authoritative data.
Data is accessed via a dedicated GIS portal using a browser or a customised WebApp URL. This enables anyone within the organisation to create their own maps via the web to aid in their decision making, rather than wait for the GIS team to construct the map. It's also possible for maps to be produced by multiple parties working in collaboration for quicker decision making.

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Seamless Geology of NSW: a new paradigm for geological mapping

Greenfield J[1], Colquhoun G[1], Ballard J[1], Deyssing L[1], Hughes K[1], Phillips G[3], Fitzherbert J[1], Gilmore P[1], Folkes C[1], Vega-Faundez M[1], Troedson A[2]

[1]Geological Survey Of NSW, [2]Troedson Geoscience Consulting, [3]Private consultant

TS2 - 4.4.3 Geoscience data delivery & 4.4.2 Understanding the Surface, Room R7, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

John Greenfield is the Director of Geoscience Acquisition & Synthesis the Geological Survey of NSW. He has a 1st Class Honours degree in geology from the University of Wollongong and a PhD from the University of Sydney in 1998, mapping in east Antarctica and central Australia. After four years mapping in the Yilgarn for the Geological Survey of WA, he joined CSIRO Exploration & Mining working on base-metal mineral systems, and as a consultant with Gold Fields Ltd, he worked in Venezuela on orogenic gold targets. He has been with the Geological Survey of NSW for the last fourteen years.

The Seamless Geology of NSW is a statewide GIS geodatabase developed by the Geological Survey of NSW (GSNSW) containing best-available regional geological mapping of the state. The difference to other jurisdiction-wide geology map datasets are two-fold: it seamlessly combines 464 of the best-available maps irrespective of original map scale, and is divided into seamless tectono-stratigraphic layers representing the major basement, basin and cover sequences of NSW. This has allowed unprecedented public access to detailed mapping data that contain consistent map attribution, allowing continuous spatial analysis within each layer. With over 60 million polygonal and line vertices and 85 attribution fields available, it is one of the most complex geological mapping databases ever released.

Use of the Seamless Geology by GSNSW as the single source for all geological mapping data has simplified data delivery and management (e.g. updating of datum projections), and has given the GSNSW confidence to value-add with derivative datasets, for example:

- fault attribution data including interpreted fault geometry, order and character, as well as interpreted kinematics for all major geodynamic cycles
- peak metamorphism maps for relevant geodynamic cycles
- reactive rock and igneous fertility attribution layers
- comprehensive unit description information that will replace maps' explanatory notes
- integration with the NSW 3D geological model.

Seamless Geology will change the way GSNSW conducts field mapping. Future programs will be more agile and focused on problem-solving in particular basins or provinces. New mapping will be stitched directly into the master geodatabase, allowing fast access to mapping results.

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Evaluation of cover sequence geochemical exploration sample media through assessment of element migration processes: The Prominent Hill IOCG deposit, Australia

Baudet E[1], Tiddy C[1], Giles D[1], Hill S[2]
[1]FII/UniSA, [2]Geological Survey of South Australia

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I graduated from a Masters degree in Geology in France in 2015. I first came to Adelaide for my Masters Thesis with the Geological Survey of South Australia. I got offered to continue my research as a PhD so I enrolled with the University of Adelaide in 2015. I transferred to UniSA in 2017 and I am now in my last year of PhD. I am looking at sediments from the Eromanga Basin to understand the processes responsible for variable geochemical and mineralogical signatures within these sediments and how they could relate to buried mineralisation.

Exploration has now moved into buried terranes as surficial mineral deposits have mostly been discovered. Using the cover sequence as sample media toward mineralisation could make exploration more efficient in such terranes however our understanding of the processes responsible for variable geochemical and mineralogical signatures within cover sequences and their relationship to any underlying mineralisation is limited.

The aim of this project is to further understand these processes through regional investigation of the Eromanga Basin (Australia) to define geochemical background and compare it with the geochemical signature of this basin above a known deposit. The Bulldog Shale and the immediately underlying Cadna-owie Formation have contrasting mineralogy and chemistry and form a ~100 m thick package above the Prominent Hill iron oxide-copper-gold (IOCG) deposit.

These formations preserve elevated concentrations of identified IOCG pathfinder elements (e.g. Cu, Zn, REE, Mo) but intense surface weathering of the Bulldog Shale impacts significantly the mineralogy and induces the redistribution of trace elements in two very distinct zones within the formation. However, CIW calculations in the Bulldog Shale suggests that other processes are at play and the spatial distribution of elevated trace element concentrations in both the Bulldog Shale and Cadna-owie Formation highlighting known zones of mineralisation is baking up such hypothesis. We will show that the interplay of weathering versus element migration processes involved in the development of elevated geochemical signatures within the sedimentary cover impacts on the viability of using cover sequence materials as sample media in mineral exploration.

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Signal or noise? Isolating grain size effects on Nd isotope variability in Indus delta sediment provenance

Jonell T[1,2], Li Y[3], Blusztajn J[4], Giosan L[4], Clift P[3]
[1]School of Earth and Environmental Sciences, The University of Queensland, [2]School of Geosciences, University of Louisiana at Lafayette, [3]Department of Geology and Geophysics, Louisiana State University, [4]Department of Geology and Geophysics, Woods Hole Oceanographic Institution

TS7 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Tara Jonell is a postdoctoral research fellow within the School of Earth and Environmental Sciences at The University of Queensland. She completed her B.Sc. Geology with Distinction in Geology at Kent State University in Ohio, her M.Sc. Geology at New Mexico State University in igneous petrology and volcanology, and her Ph.D. Geology at Louisiana State University in sedimentology and geomorphology. Prior to her current position, she was an instructor for the Louisiana State University Senior Geology Field Camp and a Visiting Assistant Professor at University of Louisiana at Lafayette.

Rare earth element radioisotope systems, such as neodymium (Nd), have been traditionally used as powerful tracers of provenance, chemical weathering intensity, and sedimentary processes over geologic timescales. Recent evidence suggests fractionation (hydraulic sorting) of sediments during transport introduces considerable bias, such that no meaningful interpretation of provenance or weathering can be unraveled. Using grain size analysis, trace element geochemistry, and Nd isotope geochemistry of bulk and grain-size fractions (<63 µm, 63-125 µm, 125-250 µm) from the Holocene Indus delta of Pakistan, this study evaluates if and how grain size affects Nd isotope variability and further resolves the total uncertainties associated with bulk sediment Nd isotope compositions. Fine-grained bulk sediment Nd isotope compositions are controlled by the finest (<125 µm) sediments enriched in Nd-bearing monazite and allanite, with coarser bulk sediments influenced by mica. Within the isotopically diverse Indus drainage system (εNd = -26 to +8), bulk isotopic compositions are estimated to deviate on average no than ±1.04 εNd units for any sediment as a result of mineralogy, grain size distribution, and analytical error. Isotopic excursions >1.04 εNd units can be unambiguously assigned to a change in upstream provenance. Over the Holocene, resolvable provenance-driven trends are confidently identified in Nd isotope compositions from the Indus delta, although the total isotopic shift is less than previously estimated (0.69–1.91 vs. ~4 εNd units).

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Optimal multi-objective pumping/injection strategy to mitigate seawater intrusion

Yang Y[1,2], Ataie-Ashtiani B[2], Wang J[1]
[1]Hohai University, [2]Flinders University

TS8 - 3.3.5 Groundwater science for policy development and decision making, Room R5, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
I am an associate professor in Hohai University, China. I have been working on regional groundwater numerical modeling; contaminant transport; groundwater environmental impact assessment; groundwater remediation; simulation-optimization model; Pareto-optimal design; multi-objective evolutionary algorithm; seawater intrusion; multi-objective optimization; water resources management; artificial recharge. And now I am a visit scholar in Flinders University (1/1/2018~31/12/2018).

Coastal aquifer management with an intractable design of the layout of artificial injection system poses significant decision analytical challenges. The problem is imbued with deep complexity because decision makers do not know the most effective injection positions and need to pose multiple objectives to explore tradeoff strategies between conflicting resources, economic and environmental requirements. Here, we develop an evolutionary multi-objective decision-making framework involving three components: (1) identify the candidate sites for artificial injection based on hydrogeological knowledge and numerical modeling; (2) develop a simulation-optimization methodology for optimal pumping/injection (P/I) strategies (including P/I rates and injection well locations) between three conflicting management objectives under complicated seawater intrusion (SI) constraints; and (3) seek the specific strategies that balance multiple preferences of diverse decision makers with available realistic conditions through cost-benefit analyses. We demonstrate the proposed methodological framework on a large-scale coastal aquifer management problem in Baldwin County, Alabama. A well-calibrated simulation model is employed to predict the extent of SI and identify the SI encroachment area, where potential injection wells intend to be located to push back the saline front. The niched Pareto tabu search combined with a genetic algorithm (NPTSGA) with moving-well option is combined with a physical SI model to discover optimal pumping policy and injection design. Alternatively, the implementation of optimal P/I strategies and cost-benefit analysis enable the discovery of tradeoffs between each pair of management objectives and allows the decision makers to select more sustainable strategies to capture the different realistic preferences.

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Virtual Reality makes Outback and Armchair Geotourism Real in SA

James P[1], Kor M[1]
[1]*University of South Australia*

TS5 - 5.1 Geology in Society: geotourism and geoheritage & 5.6 Diversity in the Geosciences, Room R8, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Pat James retired in 2015 after 30 years at Adelaide University as a field and structural geologist and 10 years at UniSA, where he was Head of the School of Natural and Built Environments. Retirement has allowed a return to field geology through the development of innovative geotourism products in conjunction with Nature Foundation SA for their sensational Witchelina and Hiltaba Nature Reserves in Outback SA.

Wild and wonderful Witchelina Nature Reserve in outback South Australia is attracting visitors with interpretation tools developed by Nature Foundation South Australia (NFSA) and the University of South Australia. These include comprehensive track notes, detailed signage and maps for 4WD geotours, guides for walking trails; illustrated brochures, Google Earth "fly-through" tours and satellite images, together with substantial on-the-ground infrastructure. Wayfinding and visitor safety are also essential for this isolated, remote and harsh desert outback landscape.

Interpretive collateral material was initially paper-based then digital media acquisition and processing was developed for the NFSA website, and for internet and mobile access. The aim was also to integrate these digital technologies into Virtual Reality (VR) Geotours for each track and trail.

Witchelina is an inverted sedimentary basin in an ancient mountain belt, which has been and deformed by complex folds and thrusts. It has been exposed by erosion and is clearly visible on satellite images (Google Earth), airphotos and drone footage over the whole 440 Km2 area of the Reserve. These images have been supplemented with mobile GoPro videos, 360 degree panoramas (panatours) and narrated video commentary for individual geosites. The aim is to maximize understanding and enjoyment of the visitor experience on-site and to enable "remote" access for those considering or unable to visit.

This interpretation will add significant value to the geotourism experience for on-site visitors with its spectacular landscapes and geology, but lack of experienced tour guides. Marketing will also benefit from the "armchair" experience added by the digital materials.

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Revised geology of the Central Lachlan Orogen: new insights from the East Riverina Mapping Project

Gilmore P[1], Bodorkos S[2], Bull K[1], Campbell L[1], Eastlake M[1], Trigg S[1]
[1]Geological Survey Of NSW, [2]Geoscience Australia

TS8 - 1.6 Advances in structural, igneous metamorphic and sedimentary geology, Room R1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Phil Gilmore is Manager, Regional Mapping at the Geological Survey of NSW. In this role, Phil leads and has been mapping across different parts of NSW. His early career was in mineral and energy resources. He completed a BSc (Hons) at the University of Newcastle and is a Master of Economic Geology from the University of Tasmania, and has worked in industry and government for more than 20 years.

The Central Lachlan Orogen (CLO) is a key piece in the tectonic puzzle of the Tasmanides. The Geological Survey of NSW's East Riverina Mapping Project has integrated field mapping with specialist studies to revise and update the geological history of the southern CLO. The project area includes parts of the Gilmore Fault Zone (GFZ), Wagga–Omeo metamorphic belt, Tumut Trough, and the Junee–Narromine belt of the Macquarie Igneous Province.

Key findings include: (a) establishment of a revised stratigraphic framework for the Ordovician sedimentary rocks, based on conodonts, graptolites and detrital zircon analysis, with correlation to the Abercrombie Formation and Pinnak Sandstone, (b) new U–Pb zircon geochronology on Cambrian to middle Silurian mafic to intermediate rocks along the GFZ implies multiple cycles of tectonism and (potentially) mineralisation, (c) the recognition of a complex history of felsic magmatism in the Siluro-Devonian, with previously recognised ~430 Ma S-type granite batholiths now complemented by ~423–412 Ma granites and widespread ~418–415 Ma volcanic rocks. The Jindera nested pluton has been dated at ~405 Ma – comparable to plutonism in central Victoria, (d) the extensional history includes Early Silurian basins that predate ~430 Ma felsic magmatism, Siluro-Devonian basins containing ~430 Ma detrital zircons, but predating ~418 Ma volcanism, and Late Devonian basins that postdate all significant magmatism, (e) multiple deformation events have been constrained to the Silurian and Devonian, with implications for timing of gold mineralisation along the GFZ.

These results have important implications for the geodynamic history of the Tasmanides, mineral potential and land use.

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Seamless Geology of NSW: on smart phones and tablets

Ballard J[1], Collins D[2]
[1]Geological Survey of NSW, [2]Trilobite Solutions

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
James Ballard was born in Griffith NSW in 1991. He received the B.S and B.S (Hons) degrees from University of Newcastle, in 2013 and 2014, respectively. He received the University Medal in Earth Sciences and the Faculty Medal from the Faculty of Science and Information Technology at the University of Newcastle for his First Class Honours studies. Since 2014, he has been working as a GIS Geoscientist with the Geological Survey of NSW.

The Geological Survey of NSW (GSNSW) uses new software and advances in mobile device technology to create geology maps that can be viewed on Apple and Android devices, completely independent of the internet and mobile phone reception.

Using TileMill, a program created by ©Mapbox, any geodatabase can be converted into an MBTiles map format that can then be viewed and interrogated in mobile applications. GSNSW is currently implementing this ‘mobile maps’ technology to deliver the Seamless Geology of NSW through its geology phone map applications.

The MBTiles map is a tiled raster dataset which contains a ‘UTF grid’ to link the pixels of the seamless geology map to the underlying dataset, so that the app user can display information about the seamless geology. Important attribute data such as unit name, geological description, age and geological province can be viewed on the user’s smart phone or tablet. The stratigraphic boundaries and units in the mobile maps version are identical to the full desktop GIS version of the geodatabase. The symbology used for the full desktop GIS version is closely matched in the MBTiles file for mobile maps styled using CartoCSS.

This new level of accessibility provides a simpler and more mobile alternative to viewing and interrogating NSW geology in full-featured desktop GIS software such as ArcGIS (ESRI™), MapInfo® (Pitney Bowes) or QGIS® (Open Source).

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Origin of arc magmatic signature: A temperature-dependent process for trace elements (re)-mobilization in subduction zone

Gamal El Dien H[1], Li Z[1], Kil Y[2], Abu-Alam T[3]

[1]Earth Dynamic Research Group, The Institute for Geoscience Research (TIGeR) and ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS), School of Earth and Planetary Sciences, Curtin University, [2]Department of Energy and Resources Engineering, College of Engineering, Chonnam National University, [3]Norwegian Polar Institute

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

My name is Hamed Gamal EL Dien. I am a PhD student at Curtin University (student ID 19100928). My supervisor is Prof. Zheng-Xiang Li, the head of IGCP 648. My study focuses on Neoproterozoic oceanic Large Igneous Provinces (O-LIP) record with especially concern to the Arabian-Nubian Shield and helps infill the pre-170 Ma O-LIP record.

Accurately defining and understanding arc magmatic signatures are crucial for tracing paleo-subduction zones in deep time. Serpentinites are a major carrier of fluid-mobile elements in subduction zones and can be stable over large temperature and pressure ranges. Here we report the role of antigorite, an important mineral phase of serpentine, from Neoproterozoic Arabian-Nubian Shield in the transportation of fluid-mobile elements (FME) and rare earth elements (REE) to arc magmatic rocks during subduction. The studied serpentinites have two generations of antigorites. The elder and coarse-grain antigorite was formed at a temperature of 150–250 oC (20–30 km depth) in subduction zone and is enriched in Li, Rb, Ba and Cs, while the relatively younger and finer-grain antigorite were formed at a higher temperature condition of 400–475 oC (50–60 km) and has high concentrations of B, As, Sb, Mo, Pb, Sr and LREE. In addition, geochemistry of magnesite argues its stability beyond antigorites in sub-arc depths, and magnesite therefore represents a potential reservoir of FME and LREE. The FME similarities between the studied serpentinites and arc basalts suggest a significant role for serpentinites dehydration in the generation of arc-related magmatism. We identified temperature being the main factor that affect (1) the releasing and distribution of these elements from subducted slabs into the antigorites and (2) the cross-arcs geochemical variation trend that can help to determine the subduction polarity of ancient arcs.

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The Fundamental New Science We Need to Support Future Discovery Success

Hronsky J[1,3], Begg G[2,4]
[1]Western Mining Services, [2]Minerals Targeting International, [3]Centre for Exploration Targeting, UWA, [4]GEMOC, Macquarie University

TS1 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Jon Hronsky has more than 30 years experience in the mining and exploration industry. He is currently a Principal of Western Mining Services (WMS), a consultancy group that provides strategic-level services to a wide range of groups (from juniors to majors) across the global mineral exploration industry. Jon is Chair of the board for the Centre for Exploration Targeting, an Adjunct Professor at the University of WA, and current Chair of the Australian Geoscience Council. Jon is also a Director of ASX mining companies, Encounter Resources and Cassini Resources, and a partner in PE fund Ibaera Capital.

In recent years, much good work by the Australian geoscience community, under the umbrella of the UNCOVER national initiative, has led to a roadmap for the data collection, technology and scientific development required to support future exploration success. This roadmap naturally has a relatively applied focus and did not consider fundamental research that might be required over the longer term to support exploration discovery. However, this is part of the Decadal Plan for Geoscience in Australia.
It is proposed that this research can be grouped into five main programs:

1) Developing better technology for imaging the deep Earth- a key enabler for achieving the next two goals.
2) Understanding the mass-fluxes of relevant elements between various earth reservoirs (from the core to the hydrosphere) over geological time, with the ultimate goal of better understanding metallogenic fertility. This work should seek to explain observations such as the Os content of Au in deposits systematically decreasing over time.
3) Developing integrated, global-scale models for geodynamic evolution over Earth history, founded in a robust understanding of the Hadean/Early Archean starting conditions.
4) More robust, higher resolution methods for dating all components of mineral systems, and building from this, better models for the dynamic evolution of ore formation that are integrated across multiple time scales, from the almost instantaneous to millions of years.
5) Better models for the physics of fluid flux within the lithosphere, with focus on the sub-set of conditions that produce highly organised, as opposed to background, fluid flux.

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Land Cover Mapping using Digital Earth Australia.

Kooymans C[1], Siggins A[2], Lucas R[2], Mueller N[1], Bunting P[2], Lewis B[1], Lymburner L[1]
[1]Geoscience Australia, [2]Department of Geography and Earth Sciences, Aberystwyth University

TS2 - 4.4.3 Geoscience data delivery & 4.4.2 Understanding the Surface, Room R7, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Cate graduated with first class honours in Earth and Marine Sciences from the Australian National University in 2016. After spending a brief time at the Department of Environment and Energy, she joined Geoscience Australia as a graduate in 2017. Cate now works in Digital Earth Australia as an earth observation scientist working on land cover, change detection and geological applications for earth observations.

The Earth Observation Data for Eco System Monitoring (EODESM) system uses environmental data layers to map land cover and land cover changes according to the Food and Agriculture Organisation Land Cover Classification System (LCCS; Di Gregorio 2005). The classification uses a decision-tree to produce increasingly detailed levels of land cover classification, dependent on the level of available data. EODESM, which was progressively developed through a series of Welsh (Lucas et al., 2007, 2011) and European projects, namely the FP7 Biodiversity Multi-Source Monitoring System (BIOSOS) project (Lucas et al., 2014) and the EU Horizon 2020 Project, ECOPOTENTIAL (Lucas et al., 2017), is now the pillar of a new project called Living Wales. An objective of Living Wales project is to openly support the translation of the EODESM system to other countries and regions, so that it can be used to advance better and more sustainable utilisation of natural resources (including carbon and biodiversity), facilitate ecosystem restoration and support their economy, society, welfare and education.

This presentation will report on a test implementation of EODESM system for Australia making use of the Digital Earth Australia (DEA) platform. DEA provides corrected, orthorectified datasets that can be easily interrogated both spatially and temporally. DEA provides the opportunity to test the application of the EODESM system at a continental scale with the availability of nationally continuous remotely sensed environmental datasets. This project aims to produce a prototype land cover classification for Australia that can map Australian land cover and provide evidence-based change assessments.

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PETROLOGY AND GEOCHEMISTRY OF FERROSYENITE FROM UPPALAPADU ALKALINE COMPLEX, CUDDAPAH INTRUSIVE PROVINCE, SOUTHERN INDIA

Saikrishna K[1], Mallikarjuna Reddy R[2]

[1]Department of Geology, Kakatiya University, [2]Department of Geology, Kakatiya University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

I Mr.K.Saikrishna is pursuing PhD program under the supervision of Dr.R.Mallikarjuna Reddy, Assistant professor of Geology, Kakatiya University, Warangal, Telangana state, India. I am working in the area of Igneous petrology and Geochemistry and awarded the INSPIRE fellowship by the Department of Science and Technology, Government of India. Till date I had published 7 research papers in reputed journals and presented my research work in several national and international conferences. In the year 2017, I attended and presented my research paper in EGU-2017, held in Vienna, Austria.

The ferrosyenite hosted by Uppalapadu alkaline complex is located on the eastern side of the Cuddapah basin, which is spread in an area of 30 km2. The pluton mainly comprises of nepheline syenite, hornblende syenite, ferrosyenite, metapelite, anorthosite, olivine clinopyroxenite and olivine gabbronorite. The ferrosyenite has sharp contact with olivine gabbronorite on the eastern side and hornblende syenite on the western side. The Uppalapadu pluton is conspicuously confined to the junction zone between two contrasting major rock formations and between two fold belts i.e. the Dharwar (granite-greenstone) belt towards the west and the Eastern Ghat (gneiss-granulite) mobile belt towards the east (Leelanandam, 1989).

Microscopically, the ferrosyenite is medium to coarse grained rock which shows hypidiomorphic texture, leucocratic in nature and is chiefly composed of perthitic K-feldspar, plagioclase, fayalite, ferrohedenbergite, ferroaugite, ferrosilitic orthopyroxene, interstitial quartz as essential minerals and inverted pigeonite, almandine rich garnet, apatite, calcite and opaques as accessory minerals.

The syenite is high in FeO and low in MgO content, enriched in LREE and depleted in HREE concentration, with Eu positive anomaly. The conspicuous presence of Fe-rich pyroxene and the lack of hydrous mafic minerals, reveal that the ferrosyenite is the product of fractional crystallization of a gabbroic/tholeiitic basaltic magma, which must have crystallised under reducing low fO_2 conditions.

Reference: Leelanandam, C., 1989. The Prakasam Alkaline Province in Andbra Pradesh, India. Geological Society of India, 34(1), pp.25-45.

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Unravelling the structural and metamorphic evolution from MT–MP to LP–HT: a journey through the crust in the Georgetown Inlier (NE Australia)

Volante S[1], Collins W[1], Nordsvan A[1], Blereau E[2], Pourteau A[1], Li Z[1], Li J[1]
[1]Earth-Dynamics Research Group, ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS) and The Institute for Geoscience Research (TIGeR), School of Earth and Planetary Sciences, Curtin University, [2]ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS) and The Institute for Geoscience Research (TIGeR), John de Laeter centre for Isotope Reasearch, School of Earth and Planetary Sciences, Curtin University

TS7 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
I am currently a Ph.D. student of the Earth-Dynamics Research Group at Curtin University. My research project is to investigate the tectono-metamorphic evolution of the Georgetown Inlier (NE Queensland) during Mesoproterozoic and unravel which role this Inlier played during Nuna assembly. As structural and metamorphic geologist my interest lies in reconstructing the deformational and thermal history of tectono-metamorphic units by applying a multi-scale analytical approach based on petro-structural mapping, microstructural analysis, mineral chemistry and reconstruction of P–T conditions. My Master thesis at the University of Milano (Italy), was on the Argentera–Mercantour Massif, which encompasses relicts of a Variscan suture zone.

Recent tectonic model suggests that the Mesoproterozoic Georgetown Inlier (NE Queensland) records the continental collision between Laurentia and the North Australian Craton at 1600 Ma (Nordsvan et al., 2018). We test this record by combining analysis of fabrics and their defining paragenesis, with mineral chemistry, thermodynamic modeling, and geochronology.

The dominant fabric at the regional scale (S2) is a pervasive cleavage marked by low-grade Ms-Qz-Chl* assemblage in the west. In the Robertson River area, S2 is defined by St-Grt-Bt-Ilm-Qz, where GrtI (Ca-rich/Mn-poor) preserves an earlier fabric (S1), while St and GrtII (Ca-poor/Mn-rich) are early-S2 (Bell & Rubenach, 1983). North of the staurolite-domain, S2 and S3 are defined by And-Bt-Qz-Ms with andalusite replacing staurolite, while closer to the granites sillimanite replaces andalusite. The sillimanite assemblage (Sil-Bt-Grt-Pl-Kfs-Qz) is associated with partial melting of metasediment, which is related to the emplacement of granites at 1560-1540 Ma. Therefore, the granites are syn- to late-S2. On the S3 plane, an andalusite/sillimanite lineation (L3) developed, plunging ESE, consistently with the AX3/L3 recorded in the eastern migmatitic complex. During D4, E-W trending macro-to micro-scale folds are locally associated with growth of a retrograde mineral assemblage.

The MP–MT staurolite-garnet paragenesis suggests a moderate crustal thickening associated with the continental collision between Laurentia and Australia; whilst the LP–HT sillimanite-bearing paragenesis, associated with granite emplacement and dated at 1560-1540 Ma (U-Pb in monazite), is interpreted as an extensional post-collisional thermal record.

Reference

Nordsvan et al., 2018 https://doi.org/10.1130/G39980.1
Bell & Rubenach, 1983 https://doi.org/10.1016/0040-1951(83)90089-6

*Mineral Abbreviations Whitney & Evans, 2010 https://doi.org/10.2138/am.2010.3371

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Quantitative and qualitative management of groundwater basin in Japan

Fujisaki K[1]
[1]*Independent Groundwater Consultant*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr. Fujisaki is a groundwater consultant experting on a modeling and basin management. He studied geology at the Nagoya University and obtained PhD in hydrogeology at the Ibaraki University. He has worked as consultant for over 40 years in Japan and three other contries. He is editor and author of several groundwater text books including "Environmental Management of Groundwater Basins", Tokai University Press.

In Japan, excess withdrawn had caused land subsidence from the 1960s to the 1980s. To prevent land subsidence, groundwater modeling has been developed as a tool of groundwater basin management. A permissible yield which stops land subsidence was proposed to use modeling results. Regulation of extraction by laws and ordinances had progressed and surface water supply had improved. Then land subsidence had almost ceased in the 1990s. Meanwhile groundwater contamination has increased in the 1990s. A quantitative and qualitative management of groundwater basin is necessary to achieve effective use of groundwater resources which threatened by groundwater contamination. At present basin management system is not worked well as a total system. The background of this phenomenon is a construction of wide area surface water supply system abandoning groundwater resources for the reason of land subsidence protection. Recently desertion of groundwater is also urged for the reason of health protection from groundwater contamination. In Japan there is no comprehensive groundwater law. Recently the Basic Act on water cycle was legislated. The purpose of the act is to achieve sustainable water cycle in basins. A basin management committee which would be composed of governments and groundwater users should plan sustainable groundwater management in a basin. The quantitative and qualitative management of groundwater basin will assist management planning and increase of groundwater utilization against the trend of abandoning groundwater resources.
Key words: Groundwater basin management, Modeling

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Devonian twins? The age, stratigraphy and provenance of the Cocoparra and Mulga Downs groups, NSW

Trigg S[1]

[1]*Geological Survey Of New South Wales*

TS8 - 1.6 Advances in structural, igneous metamorphic and sedimentary geology, Room R1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Steven Trigg has been involved in regional mapping for the Geological Survey of New South Wales for nearly twenty years. During this time, he has mapped extensively through the Cobar-Bourke area of central NSW and also in the southern Sydney Basin. Most recently he has been working in the Ardlethan -Narrandera area as a part of the Survey's East Riverina Mapping Project

The Cocoparra and Mulga Downs groups are widespread Devonian non-marine sequences up to 4 km thick that crop out in central NSW. They are intermittently exposed over 400 km, north to south, and extend westward undercover. They overlie the latest Silurian to Early Devonian Cobar Supergroup and older basement rocks. Although a general correlation between these two units has long been suggested, recent mapping in the Narrandera area indicates that it may be possible to correlate down to the formation scale. The exact age of the two units within the Devonian period is uncertain. Historically, the Mulga Downs Group (and by extension the Cocoparra Group) has been considered Late Devonian, mainly based on correlation with the 'Lambie facies' of eastern NSW. However, the scarce fossil evidence available – mainly freshwater fish fossils from low in the Mulga Downs Group – indicates a probable Early to Middle Devonian age. Recent detrital-zircon U–Pb geochronology, on the other hand, is suggestive of a Late Devonian age. A fundamental question is when the units were deposited relative to the Middle Devonian Tabberabberan Orogeny. If the units were deposited post-orogeny, highlands to the south resulting from this orogeny are a probable source of the abundant sediment that formed the groups. However, if the units are pre-Tabberabberan Orogeny, a feasible sediment source needs to be determined. Considering the potential sediment sources, detrital zircon ages, depositional environment and field relationships highlighted in recent fieldwork, a post-Tabberabberan Orogeny age is suggested for the Cocoparra and Mulga Downs groups.

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Breathing New Life Into Old Collections – Revitalising Geoscience Australia's Microscope Slide Based Collections

Blewett R[1], Pring J[1], Poignand B[1], Raymond O[1], Champion D[1], Bastrakova I[1], Evans N[1], Butler P[1], Stewart A[1]
[1]*Geoscience Australia*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Richard Blewett (General Manager - Minerals Systems Branch), Geoscience Australia, with carriage of the minerals component of the new Exploring for the Future programme. He has responsibility for leading GA's minerals science programme and the promotion of Australia as an attractive investment destination for minerals exploration. Richard graduated 1st class Hons in Geology from Swansea University (Wales) in 1985 and a PhD in structural geology from Leicester University (UK) in 1989. Richard joined GA in 1990 as a research scientist and has worked in a number of minerals-related mapping projects across many of Australia's mineral provinces.

Since soon after the federation of Australia in 1901 Geoscience Australia, and its predecessors organisations, have gathered a significant collection of microscope slide based items (including: thin sections of rock, micro and nano fossils) from across Australia, Antarctica, Papua New Guinea and beyond. The samples from which the microscope slides were produced have been gathered via extensive geological mapping programs, work conducted for major Commonwealth building initiatives such as the Snowy Mountain Scheme and science expeditions. The cost of recreating this collection, if at all possible, would be measured in the $100Ms (AUS) even assuming that it was still possible to source the relevant samples. Access to these slides is open to all but it has not been easy to locate specific slides due to the largely ledger and card catalogue management system. The fragmented nature of the management system with the increasing potential for the deterioration of physical media and the loss of access to even some of the original contributors meant that rescue work was (and still is) needed urgently.
Through the use of citizen science the project has seen the transcription of some 35,000 sample metadata and data records from a variety of hardcopy sources by a diverse group of volunteers. The availability of these data has allowed for the electronic discovery of both the microscope slides and their parent samples, and will hopefully lead to a greater utilisation of this valuable resource and enable new geoscientific insights from old resources.

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Targeted Inversions of Airborne Electromagnetic Data for Mineral Exploration

Hauser J[1], Gunning J[2], Annetts D[1]
[1]CSIRO, [2]CSIRO

TS8 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Juerg Hauser has extensive experience in the development and application of Bayesian techniques for a wide variety of geophysical inverse problems, among them developing a probabilistic seismic model for the European Arctic and employing model based inversions to determine the probability of detection for geosequestered CO2. At the moment, his research is centred around applying Bayesian concepts to exploration under cover and how an understanding of associated uncertainties may allow optimising mineral exploration strategies.

Mapping interfaces, for example the boundaries of a palaeochannel, and the detection of economic basement conductors, such as a subvertical massive sulphide body, are among the key reasons for the acquisition of airborne electromagnetic data in greenfield exploration. A model for the distribution of electrical resistivity is then inferred from the data, and geological features are the result of subsequent qualitative interpretation. For uncertainty quantification, we introduce a Bayesian approach for the inference of a thin-plate layered-earth hybrid model, which enables direct inversion for geologically meaningful parameters and uncertainties, for example the boundary of a palaeochannel, or the dimensions and orientation of basement conductors. We use the Bayesian parametric bootstrap to generate model realisations, which provides a sufficient exploration of model space at a significantly lower computational cost than Markov Chain Monte Carlo approaches. It also allows us to quantify support in the data for discrete basement targets, and thus to objectively rank anomalies in the data according to their likelihood of being caused by a basement conductor. Using the Walford Creek prospect in northwest Queensland as a basement conductor delineation example, we demonstrate how our approach can recover a plate-like target from multiple GEOTEM survey lines in the vicinity of a fault associated with a conductivity contrast. The recovered uncertainties reveal both the expected trade-off between model parameters, such as plate size and plate conductance, and provide compelling evidence of sufficient exploration of model space, and thereby increased confidence in the uncertainty estimation.

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Petrology, geochemistry and mapping of Paleoproterozoic mafic-ultramafic series and granulitic charnockites from Abeleyel Basin, Tekhamalt, In Ouzzal terrane, Hoggar, Algeria.

Djemai S[1], Guellai D[1], Ouzegane K[1], Bendaoud A[1]
[1]USTHB University

Biography:
Prof. Safouane Djemai is a geologist specialized in structural geology, metamorphic petrology and geochemistry of Precambrian rocks in the Touareg Shield in Algeria. He obtained his PhD in 2008 on remote sensing for geological mapping and is a lecturer and research scientist at the Department of Geology and the Laboratory of geodynamics, geotechnics and planetology at the Houari Boumediene University in Algiers, Algeria. He supervises MSc and PhD students with field trips. His current research focus is on geological mapping of the Touareg Shield terranes using remote-sensing and airborne geophysical data.

The In Ouzzal terrane (Hoggar, southern Algeria) is an Archean crustal segment (3.3–2.5 Ga) that was remobilized by a regional-scale tectono-metamorphic event during the Paleoproterozoic at c. 2 Ga (Ouzegane et al., 2003). The different image processing (Landsat 7 ETM) remarkably individualize domes of TTG and basins of supracrustal granulites in the Abeleyel area (In Ouzzal, NW Hoggar) Such patterns occur on a regional scale. Color composition 731, for example, highlights the Abeleyel supracrustal basin in a dark greenish-blue and the TTG in the clearer colors. The sigmoidal basin shows a variation in the direction of foliation (from NE-SW to E-W) clearly visible on principal component 1, PC1.
Within the basins there are layers of a variety of rock in particular aluminous metashale, and pods and lenses of norites, anorhosites and spinel pyroxenite. Geochemistry shows that the metanorites have an affinity with the archean komatiite and high magnesian tholeiite series. The associated anorthosites and pyroxenites correspond to cumulates. The enderbites in the domes have K2O / Na2O (La / Yb) N compositions comparable to those of the Archean TTG series.
UHT metamorphism in the In Abeleyel area is well defined from metashale that exhibit spinel quartz assemblages and ternary feldspar. They indicate a clockwise P–T path characterized by near-isobaric heating to peak conditions (800–1000°C at 10–11 kbar), followed by significant decompression to 5 kbar. This study based on remote sensing and petrology confirms the structure of domes and basins resulting from the Archean tectonics of these greenstone belts series.

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Tectonic evolution of the Neoproterozoic Bemarivo Belt in northern Madagascar: from Rodinia to Gondwana

Armistead S[1], Collins A[1], Payne J[2], Foden J[1], De Waele B[3,4]
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TS6 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Sheree Armistead is a PhD candidate at the University of Adelaide. She received her BSc. Hons from Monash University in 2013 looking at structural controls of IOCG deposits in the Curnamona Province of Australia. She subsequently worked as a geochronologist and mineral systems geologist at Geoscience Australia in Canberra working on the Tasmanides of eastern Australia. Her PhD research is on the Neoproterozoic amalgamation of central Gondwana with a focus on Madagascar and India. She is particularly interested in structural geology and isotope geochemistry, as well as using a range of techniques to analyse large datasets both temporally and spatially.

The Neoproterozoic Bemarivo Belt of northern Madagascar and its relationship to the rest of Madagascar, as well as its position in the Rodinia supercontinent is poorly understood. Reconciling the tectonic evolution of the Bemarivo Belt will help constrain paleogeographic reconstructions of both the Rodinian and Gondwanan supercontinents.

The Bemarivo Belt can be broadly considered as two parts; the northern Bemarivo Belt and the southern Bemarivo Belt. To the south of this area is the Anaboriana Belt – a metasedimentary sequence that structurally overlies the Archean craton of central Madagascar.

We have analysed 10 samples from this region for Hf and O isotopes. Samples from the northern Bemarivo Belt have U-Pb ages of c. 750–700 Ma. These samples have positive εHf values, and mantle-like δ18O values, suggesting a relatively juvenile, mantle-like source. Samples from the southern Bemarivo Belt are slightly older at c. 770–720 Ma, and have negative εHf values and δ18O values ranging from mantle-like to hydrothermally altered. This suggests significant reworking of older crust in this region. Samples from the Anaboriana Belt overlap with the range of εHf and δ18O values from the southern Bemarivo Belt, suggesting that detrital zircons from the Anaboriana Belt may have been sourced from the southern Bemarivo Belt.

By integrating these new Hf and O data with other published isotope datasets from the region, we present a model for the tectonic evolution of northern Madagascar. We compare this region to other age-equivalent terranes to better understand tectonic links during the Rodinia and Gondwana supercontinents.

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Detrital record of Kaladgi-Badami basin: Constraints and implications for the formation of intracratonic basins in Indian Peninsular shield during Paleoproterozoic

Katuru V[1], Collins A[1]
[1]*The University Of Adelaide*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
The author is currently a PhD candidate at the Department of Earth Sciences at the University of Adelaide working on the project studying the crustal evolution of Dharwar Craton in south India. The project involves U-Pb dating of the archaean granitoids along with Hf-isotope analysis, whole rock geochemistry with Nd isotope analysis, the detrital record of sedimentary sequences associated with the craton.

Has completed Master of Science in Earth and Environmental Sciences at The Indian Institute of Science, Bangalore, India.

The Kaladgi-Badami basin belongs to the group of 'Purana basins' which formed as a result of widespread Proterozoic sedimentation in independent basins on Indian Peninsular Shield. The Kaladgi supergroup is an irregularly east-west trending basin consisting of the lower deformed Bagalkot group unconformably overlain by the undeformed Badami group. The basin is surrounded by the Dharwar craton on the south and is partially covered by the Deccan traps on the north.
Zircons from arenites and sandstones belonging to various stratigraphic layers of the basin have been analysed by LA-ICPMS for U-Pb ages and rare earth element (REE) compositions.
The detrital record of the Bagalkot group shows that the maximum depositional age was during the Neoarchaean with detrital ages ranging from 2.5-3.0 Ga and the REE patterns show that the sources could include nearby granitoid and syenite bodies along with the adjacent Hungund Schist belt from older concordant analyses.
The detrital record of the Badami group shows that the maximum depositional age was during the Paleoproterozoic with detrital ages ranging from 1.8 Ga to 3.5 Ga suggesting depleted Paleoproterozoic sources along with adjacent granitoids and greenschist belt sources.
As the Badami subgroup is unconformably overlying the lower Bagalkot group, we infer that the lower constraint for deformation age of the Bagalkot group is 1.8 Ga. We conclude that the crustal region was under stress in the North-South direction during the Paleoproterozoic which ceased around 1.8 Ga.

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Decoding the Cobar orebodies of central NSW: paragenesis, geochronology and isotopic characteristics

Fitzherbert J[1], Blevin P[1], Downes P[1]
[1]Geological Survey Of New South Wales

TS4 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Joel completed undergraduate studies in Victoria followed by post graduate studies at The University of Sydney, with a focus on field mapping and thermodynamic studies in high-pressure and high-temperature terranes. Joel has been working for the Geological Survey of New South Wales for the past 11 years and, has in recent years focussed on mineral systems analyses of the Curnamona (Broken Hill) and the Central Lachlan Orogen (Cobar Basin).

Orebodies in the Cobar region are hosted within anchizone (200-250°C) turbidites of the Siluro-Devonian Cobar Basin, with orebody distribution controlled by long-lived faults. The deformed nature of mineralisation and lack of precision dating has given favor to an inversion-related, orogenic deposit model. Recent studies in the southern Cobar Basin have shed new light on the southern orebodies, which preserve pre-deformation, ≥ 400°C distal skarn assemblages. Dating of hydrothermal minerals gives unprecedented timing constraints for mineralisation and deformation. For Hera the paragenesis involves:

- Zn-rich skarn assemblage at ≥405 Ma
- overprinting Au-rich mineralisation (405±5 Ma; titanite)
- foliation formation (390±0.2 Ma; biotite)
- reverse faulting and orebody dismemberment (383.9±2.2 Ma; titanite).

Stable isotope data (O-H-S) for skarn hydrosilicates and sulfides are consistent with mixed magmatic/formational fluid and sulfur sources. Conversely, Sr-Nd isotopic characteristics of garnet and scheelite fingerprint a non-magmatic, basin sedimentary source for Mn and W in skarn mineralisation. Mineralisation is envisaged to be associated with fault-channelised, hot magmatic fluid in the visceral plumbing network to a broader magmatically driven, intrabasinal hydrothermal system at ≥ 405 Ma. Metals are likely to have an intrabasinal (Pb-Zn-Ag-W), direct magmatic (Cu-Au), or compositionally amenable (Cu-Au) basement source. Extreme thermal contrast (≥ 200°C) and reactive stratigraphy influenced sites of metal deposition. Basin inversion resulted in remobilisation and dismemberment of the orebody ca. 390-380 Ma. The success of these geochronological and isotopic studies has led to a reassessment of the northern Cobar Basin orebodies where abundant hydrothermal titanite and biotite are observed.

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Permian pumice to Miocene magmas: a new geological map of Warrumbungle National Park

Bull K[1], Troedson A[2]
[1]Geological Survey NSW, [2]Troedson Geosciences Consulting

TS6 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Kate received an MSc in ore deposit geology from the University of Alaska Fairbanks in 1988, and a PhD in volcanology from CODES, University of Tasmania, in 2006. Her doctorate described facies architecture of an Early Devonian submarine volcanic succession in central NSW, supported in part by the GSNSW. In 2005–12 Kate worked at the Alaska Volcano Observatory for Alaska's state geological survey. In 2014, Kate took a position with GSNSW as Senior Geologist-Petrographer, also contributing to the Regional Mapping team.

Warrumbungle National Park (WNP) encompasses the central parts of a hot-spot generated Miocene volcano that erupted through much older (late Paleozoic to Mesozoic) sedimentary sequences of the Surat Basin and underlying Gunnedah Basin. Previous geological work has primarily focused on the igneous petrology of the volcano, and has mostly been limited to areas outside WNP. The new map of WNP is the fruition of four weeks of field mapping and detailed petrography, and utilised data from previous geological studies, a concurrently acquired airborne geophysical survey, and newly obtained LiDAR elevation data.

New mapping shows Warrumbungle Volcano to be a complex shield volcano built from a series of mafic to felsic alkaline lavas, intrusions and volcaniclastic deposits, whose emplacement and magnetic anomalies coincide with regional-scale basement lineaments. The magmas were derived from a single differentiation trend that yielded highly fractionated and evolved felsic differentiates. Volcaniclastic facies include mafic spatter-rich deposits, felsic block-and-ash flow deposits, lahar deposits and polymictic vent-proximal volcaniclastic breccias. A series of radial felsic dykes and elevated basement sandstones around the central vent indicate inflation and dyke emplacement late in the history of the volcano. Centrally located valley-fill volcanic deposits suggest catastrophic crater-rim collapse events, possibly in the late Neogene. The new mapping also reveals new boundaries to, and outcrops of, Surat and Gunnedah basin deposits.

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New technologies and supporting policies to counteract urban development impacts on groundwater recharge, stormwater discharge and evapotranspiration

Dillon P[1,2,6], Lawry D[5], Myers B[3], Sapdhare H[3], Johnson T[3,4], Barry K[1], Shahzad H[3]
[1]CSIRO Land and Water, [2]NCGRT, Flinders University, [3]University of SA, [4]City of Mitcham, [5]SPACE Down Under, [6]University of Adelaide

TS8 - 3.3.5 Groundwater science for policy development and decision making, Room R5, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Peter was a research scientist at CSIRO Land and Water 1985-2014 and led the team that undertook supporting research to facilitate uptake of managed aquifer recharge of stormwater and recycled water. He is now assisting Water Sensitive SA in encouraging research on stormwater infiltration systems that so far have lacked data to quantitatively evaluate their performance and impacts.

Urban development affects the urban hydrologic cycle in ways that current planning policies and practices fail to recognise in some Australian jurisdictions. Urbanisation has previously been associated with increased groundwater recharge from irrigation of urban parks and gardens and leaky water mains and sewers. However, in mature cities, subdivision reduces irrigated areas increases stormwater discharge, and improved pipe technologies and leak detection have also reduced groundwater recharge. Trees planted alongside roads are intended to compensate for loss of trees on private land and mitigate the urban 'heat island'. These trees need water and it is postulated that water sensitive urban design (WSUD) measures such as kerb-side infiltration pits, permeable pavements, biofilters and raingardens may be used to offset the hydrologic effects of urban development and sustain street trees. Data on the hydrologic performance of infiltration measures are limited, particularly in clay soils. Recent preliminary monitoring of infiltration pits in Adelaide revealed infiltration rates up to three orders of magnitude higher than predicted due to preferential flow paths via 'urban karst' (sand backfill along buried urban infrastructure) and biopores. Preliminary data are informing a new research program to partition stormwater infiltrate into winter and summer evapotranspiration and groundwater recharge at many sites, and inform infiltration strategies above shallow and deep and fresh and brackish groundwater tables for various soil types and tree types. These are needed to evolve simple evidence based policies that unite green space, stormwater management and water harvesting objectives for different soil, tree, groundwater and climatic conditions.

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Identifying the tectono-metamorphic overprints of a Gondwana forming collision: a thermobarometric transect of the Southern Irumide and Zambezi belts, Zambia

Alessio B[1], Collins A[1], Glorie S[1], Clark C[2], Kelsey D[1], Zack T[3]
[1]The University Of Adelaide, [2]Department of Applied Geology, Curtin University, [3]Department of Earth Sciences, University of Gothenburg

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Brandon Alessio is a PhD candidate at the University of Adelaide. His research seeks to better constrain the evolution of central Africa throughout the Neoproterozoic Era with the aim of refining current plate tectonic models. To do this, he investigates the Southern Irumide Belt, located in Zambia, Malawi, Mozambique and Tanzania, using thermobarometric modelling, structural geology, geochronology, and thermochonology to understand the belt's evolution in a plate tectonic context.

The Southern Irumide Belt (SIB) of southern Zambia is an orogenic belt consisting of structurally stacked, predominantly Mesoproterozoic terranes. Located on the southern margin of the Congo Craton, it bears a Neoproterozoic overprint relating to collision between the Congo and Kalahari cratons during Gondwana amalgamation. Similar overprints are also recorded in the adjacent Kafue region that comprises part of the Zambezi Belt, which together with the Lufilian Arc and Damara Belt marks the suture zone between the Congo and Kalahari cratons. A common feature to both the Southern Irumide and Zambezi belts are largely variable metamorphic overprints, ranging from high-pressure ‘whiteschist’ mineral assemblages to lower grade, amphibolite facies assemblages. These contrasting tectono-metamorphic overprints along the southern Congo margin provide a unique opportunity to better constrain and understand the evolution of central Gondwana.
This study provides pressure–temperature constraints for a whiteschist from the SIB and metapelite from the Zambezi Belt that are obtained via phase equilibria modelling. These data are used to understand and compare the metamorphic overprints recorded in southern Zambia. The thermal history of these rocks are constrained via U–Pb apatite, as well as Rb–Sr and Ar–Ar muscovite thermochronology. The different overprints recorded in southern Zambia are interpreted to relate to different aspects of Congo–Kalahari collision, where the amphibolite facies rocks formed in a compressional setting proximal to the southern Congo margin. The whiteschists instead formed directly at the site of continental collision, marking the suture zone between the Congo and Kalahari cratons.

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Geochronology and geochemistry of the Early Devonian Gumbardo Formation: Evidence for Silurian basement rocks beneath the Adavale Basin

Asmussen P[1], Bryan S[1], Allen C[1,2], Purdy D[3]
[1]Queensland University Of Technology, [2]Central Analytical Research Facility, [3]Geological Survey of Queensland, Department of Natural Resources and Mines

TS8 - 3.1.7 Studies on the Thomson Orogen, Room R2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Pascal acquired a Bachelor of Science (Geography) on spatial modelling of rock mechanics; followed by a Master of Science (Geology) which focused on the development of a semi-automatic approach in digital thin section image segmentation. Both of these degrees were completed at the Universität Hamburg, Germany. In 2016, he moved to Brisbane to commence his PhD project studying subsurface Devonian basins across Queensland, and their implications for the stabilisation of the Thomson Orogen.

The Thomson Orogen is the largest subprovince of the Tasmanides of eastern Australia by area and crustal volume. However, exposure is limited to just under 2.5% of the known areal extent, and restricted mainly to the northern margins. The Devonian subsurface Adavale Basin occupies a central position in the Thomson Orogen and potentially records the tectonic setting of the central Thomson Orogen during this time. The basin was a target for petroleum exploration during the 1960s that established a reasonable dataset of partly cored stratigraphic wells and seismic surveys. However, the tectonic setting at the time of basin initiation in the Early Devonian has remained unclear. Here we have focused on the basal volcanics of the Gumbardo Formation to clarify the tectonic setting of the basin. The approach has been to undertake stratigraphic logging, U-Pb zircon geochronology via LA-ICP-MS and whole-rock geochemical analysis. Five new U-Pb zircon ages indicate basin initiation occurred at ~398 Ma, and the initial volcanic phase of basin development was brief, potentially as little as ~1 Myr. Significant zircon inheritance records reworking of Silurian and Ordovician silicic igneous materials from the Thomson Orogen and provides insight into the upper continental crust of the Thomson Orogen. Collectively, the new data presented here suggest the Adavale Basin is a cover-type basin that developed on a stabilised Thomson Orogen after the major Bindian deformation event in the Late Silurian.

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Understanding the Continental Crust and Tectonics of the Norwegian Barents Sea through Regional Deep Seismic Profiles

Clark S[1], Lie J[2], Anderson M[2]
[1]UNSW Sydney, [2]Lundin Norway AS

TS1 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
I am a geophysicist with an interest in basin formation processes in both active and passive margins. I'm also interested in the application of machine learning to automate and optimise Earth models. I completed my PhD in geodynamics at the University of Sydney in 2007 and then worked for 10 years with oil industry clients in Norway delivering R&D products and solutions. I'm currently a Senior Lecturer at the University of NSW.

In 2016, Lundin and Seabird acquired deep-tow, long-offset seismic data. The 2D profiles cover the southwestern Barents Sea from the continental-ocean boundary in the west to the Fedynskiy High in the East and from the Norwegian shelf in the South to the Bjarmeland Platform in the North. The seismic profiles image the crust and upper mantle and we have interpreted features like terrane sutures, Moho-offsets and faults that truncate the entire crust. In the Precambrian basement, we have interpreted crustal imprints from the Caledonian thrust-tectonics. Mesozoic rifting and the early Paleogene breakup of the North Atlantic have also been interpreted in the sections. To aid the interpretation, we derived crustal composition, structure and depth information from potential field data. The regional extent of the potential field data allowed us to map continuous onshore-offshore structural trends such as the northward prolongation of Archean and Proterozoic lithology beneath the Caledonian nappe units. As a result of this interpretation work, we were able to construct a regional tectonic reconstruction of the western Barents Sea using GPlates.

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Using reworked palynomorphs as sediment provenance markers in the Surat Basin

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D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

A former high school science teacher turned budding palynologist. Jennifer is a PhD student examining the palynology of the Jurassic-Cretaceous transition in the Surat Basin under the supervision of Prof. Joan Esterle and Dr. John McKellar at the University of Queensland. As well as a keen interest in biostratigraphy and its use in correlating sedimentary sequences she's fascinated by what paleopalynology can tell us about the worlds of the distant past.

Reworked palynomorphs of Permian – earliest Triassic age have been found included in assemblages of Jurassic–Cretaceous palynomorphs from samples taken from GSQ Roma 2, a Geological Survey of Queensland stratigraphic drill hole located in the north-western region of the Surat Basin. These reworked palynomorphs can provide new insights as to the provenance of sediments inputting to the basin during deposition of the late Jurassic Westbourne Formation through to the Early Cretaceous Mooga Sandstone, a topic that has hitherto been largely unaddressed. Australian paleogeographic maps of this period (Bradshaw and Yeung, 1992) limit exposures of Permo-Triassic strata during the latest Jurassic and earliest Cretaceous to the Gunnedah and Sydney Basins to the south with the contemporaneous Bowen and Galilee Basins buried under Surat and Eromanga Basin sediments. However, isopach maps and available palaeocurrents infer a north to north-easterly drainage direction during deposition of the Westbourne Formation followed by a switch to a southerly drainage from the Gubberamunda Sandstone onwards (Green, 1997). This, combined with GSQ Roma 2's location at the far northern edge of the current Surat Basin, makes a south-eastern source seems unlikely. We propose that the sediment source was an uplifted and unpreserved region of the Bowen Basin and/or Galilee Basin to the north or north-west. This has not been recognised previously in paleogeographic reconstructions.

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Glacial palaeoenvironments of the Elatina Formation at Pichi Richi Pass, Flinders Ranges, South Australia

Virgo G[1,2], King R[3], Tyler J[4], Bunch M[2], Moffat I[5]

[1]Department of Earth Sciences, The University of Adelaide, [2]Australian School of Petroleum, The University of Adelaide, [3]Centre for Tectonics, Resources and Exploration (TRaX), Department of Earth Sceinces, The University of Adelaide, [4]Sprigg Geobiology Centre, The University of Adelaide, [5]Archaeology, College of Humanities, Arts and Social Sciences, Flinders University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

I completed my Bachelor of Science with first class honours in Geology at the University of Adelaide in 2017. My honours project focused on the sequence stratigraphy and palaeoenvironments of the Elatina Formation in the southern Flinders Ranges, South Australia. In 2018 I commenced my PhD candidature at the Australian School of Petroleum. My project is focused on the palaeoenvironments of the Tonian to Cryogenian transition in the Adelaide Rift Complex at the onset of the Sturtian Glaciation. I have an interest in sedimentary geology, in particular palaeoenvironmental reconstruction of Neoproterozoic sediments throughout South Australia.

The Elatina Formation in the Flinders Ranges, South Australia, has proven essential to the development of the Snowball Earth hypothesis because it reflects low palaeolatitude glaciation. Distinct glaciogenic deposits in the central and northern Flinders Ranges most notably represent this formation, which is part of the terminal Cryogenian Yerelina Subgroup. Substantial uncertainties exist regarding the local sequence stratigraphy and interpretation of depositional environments for the Elatina Formation. A detailed facies analysis and 3D model of this formation at Pichi Richi Pass - an area in the southern Flinders Ranges containing well exposed outcrop - was established to demonstrate the spatial and temporal variability in this part of the depositional system. The facies demonstrate a stratigraphic sequence of thick coastal, deltaic and fluvial sediments interbedded with thin glacio-fluvial units. The presence of tidal facies within the Elatina Formation at Pichi Richi Pass infer that the hydrological system was active and the stacking of marine and continental sediments indicate that sea level fluctuated during deposition at this time. The predominance of sediments deposited under moving water and the interlayering of sediments with varying degrees of glacial influence is consistent with small-scale glacial advance and retreat, or deglaciation. Therefore, it can be concluded that the Elatina Formation at Pichi Richi Pass was not deposited during frigid glacial conditions, but instead under variable glacial conditions. This substantiates that the depositional system at this time during Snowball Earth was much more complex than the solid icehouse of the original hypothesis.

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Biogeochemistry of the Nullabor Plain, developing workflows for mineral exploration

Reid N[1], Noble R[1], Cole D[3], Krapf C[2], Gonzalez-Alvarez I[1], Lau I[1], Robertson J[1], Pinchand T[1]
[1]CSIRO, [2]Geological Survey of South Australia, [3]CSIRO

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Nathan Reid completed a PhD in biogeochemistry at Adelaide University in 2008 and moved to the CSIRO where he has been involved in biogeochemical, hydrogeochemical, and regolith science projects across Australia. He has developed new technologies for geochemical exploration under cover and during drilling.

As part of the Coompana regional geochemical sampling campaign ~300 pearl blue bush (Maireana sedifolia) and bladder salt bush (Atriplex vesicaria) were sampled on a 4 km grid pattern across an area 80 km by 40 km. The aim of this project was to develop rapid sampling techniques for regional greenfields mineral exploration. Biogeochemical sampling was one component of this project. The species selected were consistent across the area and were the subject of a previous study in the region. The focus area was over a large magnetic anomaly and the substrate is the Nullarbor Plain limestones, so exploration in this region is to determine whether surface geochemical media can detect lithology or anomalism beneath the limestones.
Samples were collected using leather gloves and electric shears. The shears were pre-contaminated with the plant before taking the sample to avoid cross sample contamination. Sample details were collected using the FAIMS android application. Thirty samples were randomly chosen across the grid to test leaves and twig chemistry, and the medium with the greatest chemical ranges for elements of interest was chosen to be assayed across all samples.
This presentation will show the results of the different biogeochemical media and the full survey. The biogeochemistry will be compared to soil and limestone geochemistry and we shall present the mineral exploration implications for this methodology and region.

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Reserves Evaluation, Reporting and Sensitivity Analysis of Tight Gas Project under a Royalty & Tax System in British Columbia, Canada

Fa G[1]
[1]CNPC

Biography:
Guifang FA, is a geologist engineer, with over 8 years of experience in oil and gas resources/reserves evaluation and unconventional oil and gas research.

Canada has an abundant tight gas resource, offers tremendous potential for future reserve and production growth, which attracts major international oil companies. Royalty & tax system is the main contract mode in Canada and different provinces have different royalty tax items. Royalty rate not only depends on gas price and production, but also relies on gas component, drilling zones, spud time, well type and well depth. Canadian royalty & tax system is the most complex system all over the world, coupled with complexity characteristics of tight gas reservoir. Therefore, reserves evaluation and reporting for tight gas reservoir in Canada are a significant problem.
This paper took a tight gas project in British Columbia (Canada) as an example, combining the characteristics of the tight gas reservoirs with royalty & tax policy of this region. The research on tight gas reserves evaluation and the principles of net reserves calculation under royalty & tax contract was carried out. Four main aspects such as technique, economy, commerce and engineering, were studied to analyze the influence on net reserves from the following factors: production, declining rate, development plan, oil price, taxes, Opex and Capex, etc. Sensibility analysis was conducted by adopting the most weighted factors, such as oil prices, production, Opex and Capex. All the effort was to put forward the corresponding suggestions on optimizing development strategy, solve the current reserves evaluation problems of tight gas, and provide reference for the tight gas assets transaction, development and perfection of reserves value evaluation.

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Reconciling geochemistry and geophysics: Feasibility test of Century, a sediment-hosted Pb-Zn system at Mt Isa

Chopping R[1], Mei Y[2], **Siegel C[1]**
[1]CSIRO, [2]CSIRO

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Coralie's research interests lie in geothermal energy exploration, U- Pb geochronology of accessory minerals, igneous petrology, geochemistry, and crustal evolution. She has previously worked on several projects aiming to unravel the nature of the crustal basement beneath thick sedimentary cover. Coralie utilises multidisciplinary techniques including the merging and interrogation of existing datasets, stochastic 1D thermal modelling, field work, GIS techniques, U-Pb geochronology, Hf and O isotopes in zircons, petrography, and whole-rock chemistry. She is currently undertaking reactive transport modelling on the Century Pb-Zn deposit in Mount Isa to establish the feasibility to reconcile geochemistry and geophysics.

Quantitative approaches that have been successful in seismic imaging of petroleum resources are based on an understanding of the links between geophysical and petrophysical parameters. An improved understanding of the relationships between mineralisation, geophysical and petrophysical parameters will assist discovery of mineral resources under cover. This motivates the development of workflows to translate mineralogical and geochemical information into knowledge that will ultimately help constrain the range of plausible models resulting from geophysical inversion. A first important step is to undertake geochemical modelling to understand the geochemical processes controlling the variation in geophysical parameters. To establish the feasibility to reconcile geochemistry and geophysics, we study the Century Pb-Zn orebody in northwest Queensland. This deposit is post-Isan orogeny, has limited metamorphic overprint and is well-studied with a wealth of multidisciplinary data. Investigation of geophysical well logs reveal that unit 2 of mineralisation, a 4 to 5 m-thick shale package is characterised by a distinctive low magnetic susceptibility, coinciding with elevated Pb and Zn content. Here, we will present the development of a conceptualised geochemical model, and discuss the results from 1D reactive transport models to explain how geochemistry controls the geophysical responses of the orebody.

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Dropping the bottom LIP: Magmatic processes in an expanded Warakurna LIP

Wise T[1], Pawley M[1], Dutch R[1,2], Jagodzinski L[1], Foss C[3], Thiel S[1,2]
[1]Geological Survey of South Australia, [2]School of Physical Sciences, University of Adelaide, [3]CSIRO

TS5 - 1.1.6 Proterozoic tectonics, Hall A, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Tom Wise is a geologist working within the Geological Survey of South Australia's 4D Geodynamic and Metallogenic Evolution team. After graduating from the University of Leeds (UK), Tom has spent the last 5 years at the GSSA working on large-scale geological interpretation of geophysical data in the Gawler Craton and Coompana Province.

Geophysical data has revealed a NNW trend of circular reversely-magnetized features under the Officer and Eucla basins, which were investigated by a recent drilling program in western South Australia. The smaller reversely-magnetized bodies have higher densities, whereas larger bodies, such as the ~50 km wide Coompana Magnetic Anomaly, have markedly lower density signatures. We propose a body size-dependent model of mafic magma emplacement whereby smaller batches of magma were able to ascend into the upper crust, whereas larger batches stalled at depth allowing extreme fractionation. Anorthosite (± magnetite?) crystallization and floating, accompanied by the ultramafic cumulate sinking through negative buoyancy is a suggested model for achieving the similar magnetization and different density signatures of these rocks.
One of the intrusions intersected in recent drilling campaign has been dated at c. 1077 Ma. We correlate these 1077 Ma gabbroic rocks from western South Australia with the 1078-1070 Ma Warakurna Large Igneous Province, previously known only from central and Western Australia. Magmatic crystallization age, magnetization polarity and direction provide evidence for the Giants Head Suite (new name) being contemporaneous with the Giles Suite of the Musgrave Province, the latter of which is known to host Ni-Cu-Co mineralisation.
larity and direction provide evidence for the Giants Head Suite (new name) being contemporaneous with the Giles Suite of the Musgrave Province, known to host economic mineralisation.

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Hypothesis testing earth observation time series to detect vegetation change

Burton C[1], Roberts D[1], Yuan F[1], Mueller N[1]
[1]*Geoscience Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Chad Burton is a recent graduate at Geoscience Australia. He completed his B.Sc (honours) majoring in Geosciences at Monash University, before completing a Masters of Environmental Change and Management at Oxford University. His research interests include earth observation science, earth system sciences, and environmental geosciences.

Monitoring changes to Australia's vegetation cover is important as the land sector plays a large role in both emitting and sequestering atmospheric carbon dioxide. However, identifying regions undergoing land use change over such a large continental area (769 million hectares) is not economically feasible. Remote sensing using earth observation time series offers the benefit of assessing land use change over large regions, but it is challenging to distinguish permanent phenological change amidst the high variability of Australia's climate. We exploit Digital Earth Australia's full 32-year archive of Landsat satellite data to produce a novel change detection approach. Examining any two discrete time intervals, we combine differencing based change detection methods with hypothesis testing, allowing us to assign a probability and direction of change to each pixel over the Australian continent. Preliminary results suggest this approach can identify the regeneration of pastureland into native forests, growth of plantation forests, and clearing of existing forests.

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Geomorphic mapping of Perth submarine canyon, southwest Australia: Insights into canyon evolutionary processes

Nanson R[1], Nichol S[1], Picard K[1], Borrisova I[1], Huang Z[1], McCulloch M[2]
[1]*Geoscience Australia,* [2]*University of Western Australia*

TS6 - 1.3 Marine geoscience - The evolving oceans, Hall E1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
* Rachel first worked in environmental management for state and federal government agencies, and private industry.
* After being awarded her PhD in fluvial geomorphology in 2006, she has since worked in postdoctoral and lecturing roles as a geomorphologist at the Australian National University and Adelaide University.
* In 2017 Rachel was appointed to the role of Marine Geomorphologist at Geoscience Australia, within the Marine Observations Branch.
** Her current research interests include fluvial, coastal and marine geomorphology.*

Submarine canyons are a pervasive feature on the Australian continental margin, with more than 700 canyons mapped along the western, southern and eastern margins. Perth Canyon is among the largest, covering ~1500 km2 and extending from the shelf break (~170 m depth) to the foot of the continental slope (~4700 m) along a path that appears structurally controlled. Here we present a new geomorphic map of Perth Canyon as the basis for interpreting canyon formative processes. We use 20 metre resolution bathymetry data acquired in 2015 by the Schmidt Ocean Institute, and sub-bottom data and sediment samples collected by Geoscience Australia in 2005. Mapping results show that 45% of the canyon area is characterised by escarpments (gradient >10 degrees), 37% by slope (2-10 degrees) and 18% by low gradient plane (<2 degrees). Geomorphic features that make up escarpments include ridges, gullies and blocks that collectively define mass movement features that extend the length of the canyon and locally span water depths of over 2000 m. Lower gradient slope surfaces also display geomorphic evidence for mass wasting. Sub-bottom data across a canyon feeder channel show a 1.5 km wide slump block as further evidence for instability. Along the lower reaches of the canyon floor, bedforms up to 5 m high are evidence for bedload transport. Overall, the distribution of mass movement features and bedforms is a key factor influencing the long-term stability of the seabed and potential diversity of benthic habitats within the canyon.

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The Critical Role of Geoscience in delivering the Future Energy Mix

O'Brien J[1]
[1]*Deloitte*

TS4 - 3.2.1 Future energy mix & 3.2.6 Using geoscience to address social licence concerns for energy projects, Room R5, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
John has over 20 years' experience in the Australian energy sector. This work has included industry development plans for governments and strategic advice on energy transition for industry.
Before joining Deloitte, John ran Australian CleanTech, a corporate advisory firm focussed on energy and environmental projects. Previously he worked in corporate development at Origin Energy and engineering and oil & gas roles in UK and Syria.
John has engineering and business degrees from Oxford, Dublin and Adelaide. He has published two books on the opportunities that come with the transition to a low carbon economy.

The Future of Energy will be determined by many things, not least of which will be the transition to a lower carbon economy. Paris Commitments on greenhouse emissions indicate that the world will transition to near net-zero carbon by 2050. This will necessarily impact every aspect of our lives and every industry.
Transitioning industry transitions is never easy and few large companies survive major industry transitions. Only those that are most innovative, flexible and willing to truly explore options can do this. Embracing innovation and exploring market options provides invaluable insurance for every market participant.
However, the energy transition is inevitable for another reason. The amazing fall in cost of renewables and the forecasts for electric vehicles and batteries will mean that this is fast becoming the greenfield solution of choice for the financially astute.
Energy transport networks of all types are becoming smart, flexible and interactive and this is creating massive opportunities and risks for both new entrants and those already heavily invested in the sector. However, the balance sheets and industry knowledge of incumbents presents them with opportunities that are for there for the taking.
Geoscientists and their transferable skills will play a very significant part in this transition. The minerals of the future might be different from those we've used to date but the skill of finding and exploiting them are not. The talk will explore how the future energy mix will determine the future role for geoscience.

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Electrical Conductivity Structure Derived from Magnetotelluric Data in the Mt Isa Region

Jiang W[1], Duan J[1], Wang L[1]
[1]*Geoscience Australia*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Wenping Jiang joined Geoscience Australia in 2012 after completing a PhD from the University of Sydney. She also holds a Bachelor's degree in Computer Science and a Master's degree in Software Engineering. Currently she is working on Magnetotelluric (MT) data processing, analysis and modelling. She has been involved in a number of projects since she joined the Mineral Systems Branch. She also provides support to survey planning for EFTF and regional surveys, e.g., AusLAMP and Olympic Domain MT survey.

The Mount Isa inlier in northern Australia is one of the world's most prospective regions for base metals and gold. Geoscience Australia and the Geological Survey of Queensland have collaboratively acquired magnetotelluric data to investigate electrical conductivity structure of the subsurface in the region. Two and three-dimensional data modelling\inversion were undertaken using sophisticated algorithms. The MT models reveal a pronounced crustal-scale conductor interpreted to be part of the Carpentaria Conductivity Anomaly, which is a major deep electrical conductivity structure of the Australian continent. It also shows that the conductive zone aligns with a major crustal boundary, i.e. Gidyea Suture Zone. This supports the hypothesis that major conductivity anomalies may define the location of fundamental tectonic boundaries. A number of discrete conductors are detected in the crust by the MT models. Some of these conductors correspond to known major faults identified by seismic and geological data. Those faults linking into the middle and lower crust are considered the primary factors in the partitioning of mineralisation in the region. In addition, two prominent conductors embedded in the resistive Mount Isa Block in the upper crust coincide with known mineral deposits in the Ernest Henry and Mount Margaret mining sites, which provides supporting evidence that the enhanced conductivity is attributed to deformation or mineralisation associated with faulting.
Results from the magnetotelluric data provide new insights in understanding of the complex crustal structure and mineralisation in regions where little geological knowledge is known.

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Separating neighbouring geological units within iron ore deposits using measure while drilling data

Silversides K[1], Melkumyan A[1]
[1]The University of Sydney, Australian Centre for Field Robotics

TS3 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Katherine Silversides is a research fellow at the Rio Tinto Centre for Mine Automation (RTCMA), Australian Centre for Field Robotics, The University of Sydney. Her research aims to provide quick, automated or semi-automated processing of the relevant geological data to allow objective, fast processing of new data and faster ore boundary identification and model updates. Her current work focuses on the banded iron formation-hosted iron ore deposits of the Hamersley Ranges in Western Australia.

The quality of geological models is highly dependent on accurate spatial definition of the geological units. Geological units are often defined using exploration holes that are typically sparse, causing uncertainty for the spatial definition between holes. Data from blast drilling can be used to fill the gaps and improve the model. Measure while drilling (MWD) data provides information about the relative hardness of rocks using the force inputs and response of the blast drills. However, penetration rate (PR) alone cannot be used, as the same PR may indicate a soft rock with low drilling force or a harder rock with more force. Several measures combine MWD parameters, including adjusted penetration rate (APR). However generic measures may not be the best way to represent the differences between two specific rock types and identify the contacts between them.

In this banded iron formation-hosted iron ore mine, three MWD parameters are available, PR, pulldown pressure and torque. The proposed approach is based on defining a function of these parameters that can be optimised for the transition between any two specified rock units. PR, which is regularly used by geologists and drill operators, is a special case in this optimisation space. If it provides the best separation then it will be chosen by the optimiser. Similarly, APR may be selected by the optimiser as the best indicator. This technique allows for a more flexible approach that allows it to be adjusted to better match the geology, improving the separation and classification of the units.

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Multiple environmental tracers elucidate anthropogenic and climate change effects since the last glaciation on groundwater in the Peel Area, WA

Gerber C[1], Suckow A[1], Deslandes A[1]
[1]*CSIRO Land & Water*

TS2 - 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Christoph recently finished his PhD at the University of Bern, Switzerland, where he used radioactive noble gas isotopes (37Ar, 39Ar, 85Kr, 81Kr) and other tracers for groundwater dating on a wide range of residence times. After his PhD, he moved to CSIRO Land & Water in Adelaide to help expand the capabilities of the noble gas laboratory with some of the techniques he used in his PhD.

Agricultural and urban development projects planned for the Peel area south of Perth have resulted in increased interest in characterizing the regional aquifer system. The main aquifers are the Yarragadee, Cattamarra, and Leederville formations, which underlie the unconfined Superficial aquifer. Recharge rates to the partially confined aquifers as well as connectivity between them and across faults is poorly known. To address this issue, a multi tracer study was undertaken (δ^2H, ^3H, $\delta^{18}O$, $\delta^{13}C$, ^{14}C, $^{36}Cl/Cl$, stable noble gases [He, Ne, Ar, Kr, Xe], $^{87}Sr/^{86}Sr$). This is one of the first studies within Australia to use the full suite of noble gases, allowing to estimate noble gas-based groundwater recharge temperatures (NGT) and excess air (EA). In addition to constraining recharge rates and connectivity, our results also provide insight into effects of climate change since the last glaciation on groundwater in the Peel area. Tracer results indicate the system consists of an eastern part with younger water and significant vertical groundwater flow across all formations and a western part where groundwater flow is more horizontally. Stable isotopes, NGT, and EA all show changes as a function of residence times inferred from radiocarbon and He. However, they do not coincide temporally, implying that several processes are responsible for the observed patterns (temperature change, changes in the atmospheric water cycle, or in infiltration processes). Additionally, we found excess N_2 down to depths of 300m in parts of the system, which may either be related to anthropogenic sources and fast groundwater pathways or natural sources.

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Spectral logging in skarn systems – making a difficult task easy

Fabris A[1], Gordon G[1]
[1]Geological Survey of South Australia

TS1 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Since joining the Geological Survey of South Australia in 2000, Adrian Fabris has worked on projects related to regolith geoscience, exploration geochemistry and alteration mapping throughout South Australia and on commodities such as heavy mineral sands, uranium, base metals and iron-oxide-copper-gold deposits. From 2012, he has focused on recognizing distal footprints of IOCG deposits in the Olympic Cu-Au Province of South Australia.

Skarn is a descriptive word that refers to alteration that results in a dominance of calc-silicate minerals (Meinert et al. 2005). Although there are several mechanisms for forming skarn, skarn deposits are commonly associated with hydrothermal fluids derived from an igneous intrusion into a carbonate-rich host rock. Skarn mineralogy can be complex and difficult to identify visually, yet is critical to defining the style of the skarn system, unraveling the composition of the host rock, and environment of formation (Meinert 1992). In mineralised skarn systems, predictable zonation patterns can be mapped using mineralogy, and provide a means of vectoring towards magmatic-hydrothermal fluid sources and in identifying regions that are most compatible with forming economic mineralisation. This presentation describes the use of spectral mineralogy derived from Hylogger-3TM, to rapidly and consistently map extensive garnet-pyroxene skarn systems developed within the Olympic Cu-Au Province in South Australia's eastern Gawler Craton. These skarns host significant Cu, Au, Ag, Pb and Zn, and were formed during the same hydrothermal event that developed breccia-hosted IOCG deposits in the district (Reid et al. 2011). Complex mineralogy on drill core from oxidized Cu skarn prospects within the Punt Hill region will be used to demonstrate the usefulness of Hylogger-3TM data as an aid to exploration of skarn systems.

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Towards improved stratigraphy of Proterozoic Basins: Telling the time from a single glauconite grain based on in-situ Rb/Sr dating

Farkas J[1], Collins A[1], Al Sarakhi H[1], Chakrabarti R[2], Reeda A[1], Loehr S[3], Blades M[1], Cox G[1], Gilbert S[1], Zack T[4]
[1]University Of Adelaide, [2]Indian Institute of Science , [3]Macquarie University , [4]University of Gothenburg

TS8 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
My reserch focuses on the application of new isotope techniques and numerical modelling approaches to better understand the Earth's system evolution based on the analysis of sedimentary archives from Proterozoic and Paleozoic Basins.
I acquired my PhD in 2007 at University of Ottawa, Canada, followed by postdoctoral training at Harvard University (2007-2010), and a research position at Czech Geological Survey, Prague (2010-2014). Since 2015, I have been working as Lecturer and researcher at University of Adelaide, Department of Earth Sciences, focusing on development and applications of new analytical and dating techniques relevant to basin exploration and Earth system evolution studies.

Reliable dating of sedimentary rocks is essential for the calibration of geological time scale and for absolute age determination of major tectonic and depositional events throughout the Earth's history. Such geochronological constraints are particularly important for studies and exploration of Precambrian basins, which cannot rely on biostratigraphy due to a lack of reliable macrofossil record. The intra-basin correlation and burial histories in Proterozoic basins, can be constrained via dating of selected authigenic minerals, which readily form either during the sediment depositions (glauconite), and/or later stages of sediment diagenesis (illite).
Here we present the first successful in-situ (laser ablation based) Rb/Sr dating of glauconite grains collected from Proterozoic basins in India, and discuss how these single-grain age constraints could be used for better understanding of the basin stratigraphy, intra-basin correlation, as well as burial histories and later thermal events that could potentialy reset the Rb/Sr system. Data are complemented by detail micro-scale mineral maps (nanomin technology) of analysed glauconite grains and sample matrix to evaluate the preservantion and possibe diagenetic histories of studied samples.
Our new in-situ Rb/Sr approach combined with detail mineral maps thus provides a new way to acquire absolute ages of sedimentary sequences, which in turn are important for realistic calibration of numerical models simulating sedimentary processes and tectonic/thermal events shaping the formation Proterozoic basins. Finally, intra-basin correlations and provenance studies based on in-situ RbSr dating of authigenic and detrital minerals in sediments, can also aid to improved understanding of an internal basin architecture and local source-to-sink relationships.

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Germany's geological subsurface can contribute to the energy transition with significant storage potential

Chabab E[1], Kempka T[1,2], Kühn M[1,2], Martens S[1], Nakaten N[1]
[1]*GFZ German Research Centre For Geosciences,* [2]*University of Potsdam*

TS4 - 3.2.1 Future energy mix & 3.2.6 Using geoscience to address social licence concerns for energy projects, Room R5, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Michael Kühn studied Chemistry and received his PhD in Hydrogeochemistry from the University of Bremen (Germany) and a higher EngD from the Technical University of Hamburg-Harburg (Germany). Currently he is Director of the Department Geochemistry and Head of the Section Fluid Systems Modelling at the GFZ German Research Centre for Geosciences. At the same time Michael Kühn is Professor for Hydrogeology at the University of Potsdam. His key competencies are simulation of coupled processes in the subsurface and quantitative description of the dynamics of geogenic fluid systems and the use of geo-resources.

Ambitious climate and energy targets have been set by the German government. In the course of the energy transition foreseen, renewable energy resources will become the central pillar of future energy supply. Here, utilization of the geological subsurface obtains new relevance. It will contribute significantly to the implementation of the energy policy as both potential energy source and storage site for matter and energy. Different studies show that a greenhouse gas-neutral Germany is technically possible and economically feasible by 2050. One piece of the puzzle is to store excess energy produced from renewables via the power-to-gas-to-power technology (PGP).
We present an extension of this technology via integrated underground storage of CH4 and CO2 to close the entire carbon cycle. Our assessment for the two German cities of Potsdam and Brandenburg/Havel shows that about 30% of the electricity demand can be provided as base load by renewable electricity. Taking into account the entire process chain, we have quantified a total process efficiency of 26%, exhibiting costs of about 20 Eurocent/kWh. Although the level of efficiency is lower than that of pump and compressed air storage technologies, resulting costs are on the same order of magnitude. Hence, PGP is economically feasible compared to other state-of-the-art excess energy storage technologies. Selected gas storage sites show that they already have the potential to take up 20-60% of the 90-270 TWh excess energy estimated for Germany in 2050.

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Managing Australia's groundwater-mediated cumulative impacts: Improved knowledge base and management tools

Mallants D[1], Adams M[1], Apte S[1], Barron O[1], Binet M[1], Bridgart R[1], Castilla-Rho J[1], Charles S[1], Chiew F[1], Crosbie R[1], Cui T[1], Dawes W[1], Deslandes A[1], Doan H[1], Du J[1], Fu G[1], Golding L[1], Gao L[1], Gonzago D[1], Gregg A[1]
[1]*Csiro*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr. Dirk Mallants is Team leader of the Environmental Tracers and Applications Team at the CSIRO (Commonwealth Scientific and Industrial Research Organisation) in Australia. He holds a PhD in vadose zone hydrology from the University of Leuven, Belgium. At CSIRO, he leads the R&D into risks associated with unconventional gas extraction, with a focus on chemical impacts from hydraulic fracturing.

Australia's water resources and terrestrial, coastal, and marine ecosystems are under unprecedented pressures due to intensification of land, water, and coastal resource utilisation. A major challenge for sustainable management is identifying the cumulative impacts of numerous stressors, such as industrial development, including those associated with hydrocarbon and mineral resource extraction, and environmental shifts driven by climate change. A focused cross-disciplinary research effort at CSIRO has delivered significant improvements to our knowledge base about groundwater responses to various stressors, the fate of hydraulic fracturing chemicals in soil and groundwater. Progress will be reported across the following research themes:
• Fate of hydraulic fracturing chemicals and their ecotoxicity:
o reactive transport modelling demonstrated significant attenuation of organic compounds in the vadose zone following surface spills provides
o new ecotoxicological procedures for testing the endocrine disrupting potential of geogenic and hydraulic fracturing chemicals
• Adaptive and inclusive design of groundwater management:
o we demonstrate agent-based groundwater tools that couple social dynamics and groundwater systems to assess aquifer resilience under different management interventions
o water quality impacts at connected landscapes-seascapes are evaluated based on surrogate models using genetic programming as emulators of coupled coastal aquifer pumping and submarine discharge processes
• Improved understanding of the relative impact of climate variability and change:
o trend analysis reveals climate variability can be quickly reflected in the shallow aquifers of the Clarence-Moreton Basin
o declining trends in groundwater recharge over the past 40 years in SE-South Australia has been attributed to reductions in winter rainfall

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Local Earthquake Tomography as a Complementary Geophysical Exploration Tool: Spence Northern Chile Mine

Comte D[1], Rimmelin R[2], Schijns H[2]
[1]AMTC-FCFM Universidad De Chile, [2]BHP

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Diana Comte is a full professor at the Advanced Mining Technology Center of the Physical and Mathematical Sciences Faculty of the University of Chile. She has devoted the last decades on seismic tomography at Orogen scale to understand the subduction process that is going on along Chile and she found correlations between low Vp/Vs and the presence of large Chilean ore deposits. During the last years she has been able to reduce the scale of the seismic tomography at district and mine scale, making the seismic tomography useful as a complementary tool for exploration of intrusive ore related.

The high seismic activity in the Chilean crust and upper mantle provides an outstanding environment test geophysical tools such as local earthquake tomography. In general, this type of imaging technique based on the joint determination of hypocenters and P- and S-wave speed variations from the arrival times of primary phases, have focused on seismotectonics associated with subduction along the Andean margin. Recent images that we have obtained using these type of observations, using local networks in Chile, shows that this technique can be effectively applied to refine the definition of geological structures (faults) within the upper 20-30 km, becoming a useful geophysical tool for regional characterization of mineral deposits. Specifically, we were able to get a more accurate spatial distribution and depth of the Vp/Vs ratio, to address geological anomalies associated with intrusive bodies and seismically active fault systems. We find that at the regional scale all of the largest Cu-porphyry deposits in Northern and Central Chile are associated with a Vp/Vs ratio out of the local normal range. We observed three scale topographies at mine scale (Spence deposit located in northern Chile), district scale and regional scale. At mine scale it was possible to identify geology of the Spence mine, with a resolution of tens of meters in depth. These patterns show that passive source tomography can illuminate deep (i.e., mid-crustal) structures related to the genesis of mineral deposits and providing a useful tool for mining exploration in extensive areas covered by post-mineral deposits.

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The misplaced Mesozoic history of eastern Australia is found in Papua New Guinea

Holm R[1,2], Saroa D[3], Heilbronn K[2], Geological Survey Division[3]
[1]Frogtech Geoscience, [2]James Cook University, [3]Mineral Resources Authority

TS8 - 1.6 Advances in structural, igneous metamorphic and sedimentary geology, Room R1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Rob Holm is a Senior Geoscientist with Frogtech Geoscience and an Adjunct Lecturer at James Cook University. He has worked extensively on the tectonics of the southwest Pacific with a focus on the development of Papua New Guinea. Rob's recent work together with the Mineral Resources Authority of Papua New Guinea is yielding very exciting results with significant implications for the regional tectonic evolution.

The tectonic framework for the Tasman Orogenic Zone of eastern Australia is well established as an overall convergent plate margin regime from the Cambrian to the Middle Triassic. From the Middle Cretaceous to the present, an extensional tectonic regime developed, leading to breakup of the eastern continental margin. However, the intervening Late Triassic to Cretaceous period is largely missing from the geological record. Recent investigations of Late Miocene – Pliocene volcanism in Papua New Guinea revealed extensive zircon inheritance within the volcanic rocks. Provenance of the zircons, which are recycled from the volcaniclastic basement of the Papuan Peninsula, together with a reassessment of published zircon records, indicate that the allochthonous terranes that form much of the Papua New Guinea mainland were derived from eastern Australia, and that much of the Papua New Guinea landmass first developed as part of the eastern margin of the New England Orogen, not to the north of Australia as previously inferred. Furthermore, this interpretation implies that basement inliers within the allochthonous terranes comprise a record of New England Orogen development. Significantly, these basement inliers preserve a semi-continuous record of magmatism from the Late Triassic to Cretaceous period, which provides the first evidence for a long-lived convergent margin to the east of Australia during this time. These results provide a solution to the missing Mesozoic record of eastern Australia and mark a significant advance in our understanding of the Tasman Orogenic Zone and southwest Pacific plate tectonics.

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Approach to detrital zircons geochemistry to unravel episodes of crustal growth; A study from the Capricorn Orogen, Western Australia.

Armandola S[1], Barham M[1], Reddy S[1], Clark C[1], Kirkland C[1], Spinks S[2]
[1]Curtin University, [2]CSIRO

TS1 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Sonia Armandola graduated with a bachelor degree in Natural Science and a Master Degree in Applied Geology, in Italy. Following her interest for geochemistry and geochronology she spent six months in Germany studying deep Earth mantle rocks and eventually moved to Western Australia to start a PhD joining the Uncover- Capricorn Distal Footprints project. She is interested in characterizing the sedimentary covers and in finding source to sink links, by studying trace elements coupled with age data measured from accessory minerals, that are used to reconstruct the tectonic evolution of basins and related orogens, from the sediment perspective.

Laser Ablation Split Streaming represents an important advancement in linking geochronology to geochemistry, where U-Pb age and trace element compositions of zircon grains can be measured rapidly, allowing the production of large datasets. Coupled with this analytical advancement, detrital zircon as a sampling medium has the advantage of recording source and composition through space and time, and thus, potentially holds a detailed record of crustal evolution. In this work trace element and Rare Earth Elements (REE) from 1800 concordant detrital zircon grains aged between 3.5 and 1.1 Ga, from the Palaeo- to Mesoproterozoic Yerrida, Edmund and Collier basins are evaluated through statistical model locally weighted scatter-plot smoother (LOESS), to obtain insight into the complex tectonic history of the Capricorn Orogen. LOESS curves systematically highlights variations in trace elements abundances (Y, Th/U, Gd/Yb, HREE/LREE and Eu/Eu*), corresponding to crust differentiation episodes, for example (I) enrichment of Y in detrital zircons after the c. 2.5 Ga Kenorland supercontinent breakup and the initiation of a subduction regime that increasingly fractionated incompatible elements; (II) A shift from a continental arc setting to an intracratonic setting after c. 1.95 Ga, marked by Y and HREE/LREE enrichment, due to mixing and partial melting of older continental crust; (III) Poorly constrained tectonic reactivations occurred at c. 1.72 and c. 1.88 Ga, marked by consistent peaks of the LOESS curves for Y, HREE/LREE , Th/U, Gd/Yb and Eu/Eu*. Trace elements in zircon evaluated through time are a powerful tool in reconstructing the geodynamic history of long lived orogens.

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Real time decision making in exploration - the technologies that enable it and its application to date

Carey M[1]
[1]Imdex Limited

TS6 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Michelle has over 20 years industry experience in an array of geochemical specialist and senior management roles. Michelle has worked for companies including WMC Resources and BHP Billiton. In her time with ioGlobal and now with Imdex Michelle has been involved in delivering innovative new technology into the exploration and mining sector. Michelle is currently Global Manager – Integrated solutions. In this role she leads the architecture and promotion of our "end to end solutions".

The business of minerals exploration clearly needs change, our probability of success in Greenfields environments is less than 1%, and with companies increasingly having to move under cover that will only get worse. Of course there are many factors impacting that but one of them is that at the moment geologists, whether in the office or standing at the rig are forced to make critical decisions without much of the data they need. If at the rig, they can see and touch the rocks but they often don't have any access to robust quantitative information on the properties of the rock or indeed the direction the drill hole has gone. Furthering this challenge, increasingly the geologist at the rig might not be the final decision maker, that person may be hundreds of kilometeres away. As a result decisions to stop a hole or change the next hole get made poorly or don't get made at all – geologists just revert to plan. What do geologists need to change this? Reliable data made available to them wherever they are, whenever they need it.

What does real time data look like? An array of sensors on the rig and at the drill site collecting objective, accurately located, data on chemistry, mineralogy, chemical properties and structural orientations all being delivered to the places geologists need it to be.

What does adoption look like? There are challenges but stories from early adopters in the industry show us the way forward.

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D1- and D3-related gold mineralisation in the Agnew district, Eastern Goldfields, Western Australia

Jones S[1]

[1]*Gold Fields Ltd*

TS4 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:

Sarah Jones has specialised as a structural geologist for a number of companies over the last 12 years and currently works for Gold Fields Ltd. She did a PhD at CODES in the late 90s on a VMS deposit in Canada and has worked extensively in the Eastern Goldfields as an exploration geologist in the mid-90s and for 5 years as a regional mapper for the WA Geological Survey.

Gold deposits in the Agnew region display markedly different structural styles. The Waroonga and Songvang deposits are hosted in layer-parallel extensional shears formed under highly ductile conditions. In contrast, the New Holland-Genesis deposits are shallow-dipping quartz-filled brittle fractures and breccia zones that cut across tightly folded bedding. It is difficult to attribute their formation to a single compressive event. The Waroonga and Songvang deposits formed during D1 extension, uplift and exhumation of the Agnew granitic complex and formation of the Scotty Creek basin at c. 2670–2660 Ma. The New Holland-Genesis deposits formed during east-west D3 compression at about ~2650–2630 Ma.

An S1 foliation wraps around the Agnew granitic complex and L1 stretching lineations form a radial pattern around the granite, consistent with formation during D1 uplift of the granite body. Uplift and erosion of granite bodies in the surrounding area provide a source for the granite clasts in the upper parts of the Scotty Creek basin. As clasts in the basin are undeformed, no significant deformation occurred prior to the uplift and erosion of the source granites. Syn-tectonic emplacement of the Lawlers tonalite at c. 2665 Ma may have provided a heat/fluid source for the mineralising systems during the first gold event. The distribution of the large deposits along the western edge of the Agnew granitic complex indicates that the extensional shear along the granite contact is a first order control on gold deposition by providing a conduit for rising hydrothermal fluids.

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Devonian crustal stretching in the northern Tasmanides (Australia): implications for the origin of the orogenic curvature in the Delamerian-Thomson belt

Abdullah R[1], Rosenbaum G[1]

[1]School Of Earth And Environmental Sciences, The University of Queensland

TS4 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:

I am doing Ph.D. research at the University of Queensland, under the supervision of Gideon Rosenbaum. Title of my Ph.D. Thesis is "Geodynamic evolution of the Thomson Orogen and implications on Paleozoic plate tectonic reconstructions of eastern Gondwana". My doctoral research involves structural interpretation of geophysical data to unravel the 3D geometry and kinematics of the crustal-scale structures within the Thomson Orogen and to understand subduction-related geodynamic processes along the east Australian margin. Previously, I have completed MSc degree in "Structural Geology with Geophysics" from the University of Leeds, UK.

The Tasmanides in eastern Australia exhibit a number of orogenic curvatures that include a major E-W-trending continental-scale bend marked by the possible continuation of the Delamerian Orogen (southern Tasmanides) in to the Thomson Orogen (northern Tasmanides). However, the geodynamic processes associated with the origin of this orogenic curvature at the southern boundary of the Thomson Orogen are largely unknown.

Here, we use geophysical data to investigate geometry and kinematic relationships between major fault systems, timing of fault reactivation and crustal architecture of the Thomson Orogen. Results show that the central Thomson Orogen is underlain by thinned crust, bounded in the north and south by ~E-W-trending geophysical features with apparent sinistral and dextral sense of kinematics, respectively. Within the highly extended crust of the Thomson Orogen, there is evidence for widespread Devonian basins bounded by normal faults. In stark contrast to the southern Tasmanides, where rocks show evidence for an earlier (Silurian) episode of extension and Devonian contractional deformation, no evidence for Silurian syn-rift sedimentation is observed in the Thomson Orogen.

The E-W-trending sinistral and dextral crustal-scale shear zones in the northern and southern boundaries of the Thomson Orogen, respectively, may represent tear faults, which were active during the Devonian and were likely accompanied by tear-related magmatism. We suggest that crustal stretching in the northern Tasmanides was associated with Devonian back-arc extension in response to trench retreat, bounded in both south and north by zones of slab tearing and crustal segmentation that ultimately led to the curvature in the Delamerian-Thomson belt.

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Evidence for deformation in the Cambrian-Ordovician Warburton Basin and implications for the Paleozoic tectonic evolution of the Tasmanides (eastern Australia)

Abdullah R[1], Nugroho R[1], Rosenbaum G[1], Doublier M[2], Shaanan U[1,3], Zwingmann H[4]
[1]School Of Earth And Environmental Sciences, The University of Queensland, [2]Geoscience Australia, [3]Institute of Earth Sciences, Hebrew University of Jerusalem, [4]Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto University,

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I am doing Ph.D. research at the University of Queensland, under the supervision of Gideon Rosenbaum. Title of my Ph.D. Thesis is "Geodynamic evolution of the Thomson Orogen and implications on Paleozoic plate tectonic reconstructions of eastern Gondwana". My doctoral research involves structural interpretation of geophysical data to unravel the 3D geometry and kinematics of the crustal-scale structures within the Thomson Orogen and to understand subduction-related geodynamic processes along the east Australian margin. Previously, I have completed MSc degree in "Structural Geology with Geophysics" from the University of Leeds, UK.

The tectonic evolution of the Tasmanides was predominantly controlled by Paleozoic and Mesozoic subduction-related processes along the margin of eastern Gondwana. The earliest deformation event within the Tasmanides, the Delamerian Orogeny, took place in the Cambrian and is recorded in rocks within the Delamerian and Thomson orogens. The Cambrian-Ordovician succession of the Warburton Basin covers the boundary between the Thomson and Delamerian orogens. However, very little is known about the origin and deformation history of this basin and its genetic relationship with the Tasmanides.

Interpretation of seismic reflection transects, Bouguer gravity, and aeromagnetic data provides new insights into the deformation and kinematics of major faults in the eastern Warburton Basin. Our results show that curvilinear ~NE-trending faults in the eastern Warburton Basin represent basement reverse faults that experienced multiple phases of contractional deformation. Evidence for a syn-kinematic Cambrian package (Kalladeina Formation) suggests that faulting commenced in response to contraction during the Delamerian Orogeny. Evidence for a later (Early Devonian) stage of deformation in the eastern Warburton Basin is provided by K-Ar geochronology in very low-grade (sub-greenschist) metasedimentary rocks.

Our observations include the occurrence of arcuate geophysical lineaments along the so-called Delamerian-Thomson boundary beneath the eastern Warburton Basin. We therefore suggested that the ~NE-trending Cambrian fold-thrust belt within the eastern Warburton Basin marks the northward continuation of a curved Orogen. This oroclinal structure may have developed in the Early Devonian in response to dextral transpression along the boundary of the Delamerian and Thomson Orogen(s).

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Plaeoclimatic implications of the sedimentary and paleobotanic records in Lower Cretaceous Nakdong Formation, Waegwan-Eup, Korea

Paik I[1], Kim H[1], Kim K[2], Jeong E[3], Park J[1]
[1]Dept. of Earth and Environmental Sciences, Pukyong National University, [2]Department of Biological Sciences, Chonbuk National University, [3]Museum of Natural History, Sungshin University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
I am a Professor of Sedimentary Geology in the Department of Earth and Environmental Sciences at the Pukyong National University, South Korea. I served as the Vice-president of the Geological Society of Korea (2010-2011) and Regional co-ordinator of IGCP 608 (2013-2017). During a couple of decades my research has focused on the taphonomy, paleoecology, and paleoenvironments of the Cretaceous continental deposits of Korean Peninsula. My another current research interests are on the geological heritages and Geoparks in korea.

Sedimentary facies and plant fossil records in the upper part of the Nakdong Formation (late Aptian), Korea, were interpreted in the aspect of paleoenvironmental changes. The deposits consist of diverse lithofacies of channels, bars, floodplain, and ponds in a low-sinuosity river system. Coarse-grained channel deposits are common in the lower part, whereas fine-grained calcareous floodplain deposits are prevailing in the upper part. Most beds are gray, and coaly deposits occasionally occur. Calcic and vertic paleosols are intermittently present in these deposits. By contrast meadering river deposits with red beds and calcic paleosols are common in the Hasandong Formation (Albian) overlying the Nakdong Formation.

In these deposits plant fossils are common and varying in stratigraphic occurrences. In the lower part fossil woods of Xenoxylon occur. In the middle part fossil leaves of ferns and fossil tree ferns are common. In the uppermost part fossil leaves of conifers are common. By contrast plant fossils are very rare in the Hasandong Formation.

The stratigraphic variation in sedimentary and plant fossil records from the Nakdong Formation to the Hasandong Formation implies the paleoclimatic shift from cool-humid through warm- humid to warm-dry. The increase of calcareous deposits towards the upper part and the common development of red beds and calcic paleosols in the Hasandong Formation suggest the increase of aridity. The paleoclimatic change during late Aptian to Albian in Korean Peninsula might have been related to global warming in late Aptian and the increase of tectonic activity in East Asia toward the late Cretaceous.

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Geochemical evidence for a fossil mantle wedge beneath the Gakkel Ridge, Arctic Ocean

Richter M[1], Nebel O[1], Maas R[2], Nebel-Jacobsen Y[1], Dick H[3], Bach W[4]

[1]School of Earth, Atmosphere and Environment, Monash University, [2]School of Earth Sciences, University of Melbourne, [3] Department of Geology and Geophysics, Woods Hole Oceanographic Institution, [4]Department of Geosciences and MARUM Center for Marine Environmental Sciences, University of Bremen

TS2 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

Marianne Richter is a postgraduate student at the School of Earth, Atmosphere and Environment at Monash University and is working on mid-ocean spreading ridge basalts (MORBs) from ultraslow-spreading ridges with focus on the Gakkel Ridge, Arctic Ocean. In her PhD project she wants to understand how MORBs evolve by understanding the processes from the source to the crust. For this she is using radiogenic and stable isotope systematics. Before undertaking her research at Monash University, Marianne graduated in Geology at the Johannes-Gutenberg University in Mainz (Germany) in 2013, where she was working on U-Th-Pb dating of monazite.

Over billions of years, melt extraction and crustal recycling – mostly via subduction processes – created a chemically heterogeneous Earth's mantle. Modern convergent margin lavas are inferred to be derived from ultra-depleted and/or enriched (crustally-modified) mantle sources while melts from modern oceanic spreading centres show much less variety. Here we examine how mantle heterogeneities caused by subduction processes are erased and homogenised by mantle convection and partial melting processes. Ocean floor lavas from the ultraslow-spreading Gakkel Ridge in the Arctic Ocean have unusual trace element and radiogenic isotope systematics indicating that this ridge samples an upper mantle section which is anomalous compared to that underlying other ridges. Dredged seafloor lavas from the western Gakkel Ridge show evidence for an extensive fossil subduction zone underlying the spreading centre. Elemental depletion and re-enrichment patterns paired with high 87Sr/86Sr and 208Pb/204Pb are unique compared to other mid-ocean ridge basalts and show a strong resemblance to lavas erupted in oceanic arc/back-arc regions, such as those of the Western Pacific. This is supported by paleogeographic models which imply a westward-facing subduction zone in the region in the Lower Cretaceous (145-120 Ma). We suggest that the western Gakkel Ridge mantle represents a fossil East-West arc to back-arc transition implying that subduction-modified mantle can reside buoyantly in the uppermost mantle for >100 Ma before it is disintegrated and remixed into ambient upper mantle by convection and partial melting; during this period such fossil arc mantle can contribute heterogeneous melts to ocean floor lava suites at spreading centres.

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Magma degassing timescales at Soufrière Hills Volcano, Montserrat

Handley H[1], McGee L[1], Reagan M[2], Turner S[1], Berlo K[3], Turner M[1], Barclay J[4], Sparks S[5]
[1]Department of Earth and Planetary Sciences, Macquarie University, [2]Department of Earth and Environmental Sciences, The University of Iowa, [3]Department of Earth and Planetary Sciences, McGill University, [4]School of Environmental Science, University of East Anglia, [5]School of Earth Sciences, University of Bristol

Biography:
Heather Handley is an Australian Research Council Future Fellow and Associate Professor at Macquarie University in Sydney. She is Co-Founder and President of the Women in Earth and Environmental Sciences Australasia Network (WOMEESA)

Examining the role which gas plays in volcanic systems is vital for understanding the magmatic system prior to eruption. Short-lived isotopes of the uranium series decay chain are ideal for tracing degassing histories at recently active volcanoes as the isotope ^{226}Ra decays to ^{210}Pb (half-life = 22 years) via its intermediary daughter ^{222}Rn (half-life = 3.8 days), which partitions into the gas phase of magmas. Consequently, excesses of ^{210}Pb relative to ^{226}Ra can constrain the longevity and extent of gas transfer prior to an eruption, while deficits indicate persistent open system degassing of the magma. By analysing age-constrained eruptive material, timescales can be modelled for the duration of degassing or gas build-up prior to eruption.

The 1995-2010 eruption of Soufriere Hills Volcano (SHV) on the island of Montserrat is separated into five distinct phases of activity. Mafic enclaves are a notable feature within andesitic dome material and provide an excellent opportunity to investigate the deeper parts of the magmatic system feeding the eruption. The andesites are almost entirely in equilibrium or have deficits of ^{210}Pb with the deficits becoming more pronounced over time. This suggests that the andesitic reservoirs involved were subject to continuous closed- system degassing over the course of the eruption. The majority of enclaves, however, have excesses of ^{210}Pb, showing recent gas enrichment. The highest ($^{210}Pb/^{226}Ra$) ratios are from enclaves in Phase II, and we suggest that the deeper system was closed to fresh gas influx from Phase III onwards, consistent with monitoring and petrological observations.

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Fluid flow drivers for sediment-hosted Pb-Zn-Ag mineralisation at McArthur River, Northern Territory, Australia

Sheldon H[1], Schaubs P[2]
[1]CSIRO, [2]CSIRO

TS5 - 3.1.6 New frontiers in ore system research, Hall E2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Heather Sheldon is a geologist specialising in numerical modelling of geological systems, focusing on the interaction between fluid, thermal, mechanical and chemical processes. She obtained her PhD from the University of Liverpool in 2003, and since then has worked at CSIRO, using numerical models to improve our understanding of mineralisation and geothermal systems.

The McArthur River Pb-Zn-Ag deposit is a stratiform sediment-hosted deposit located in the southern McArthur Basin. The deposit formed by reduction of an oxidised basinal brine interacting with anoxic sediments at or just below the sea floor. The brine likely originated from evaporitic deposits elsewhere in the basin, which leached metals from deeply buried volcanic units before returning to the seafloor via the Emu Fault. We use numerical simulations to investigate drivers for basin-scale fluid flow in this system. Simulations were performed using the open-source finite element solver MOOSE (Multiphysics Object Oriented Simulation Environment). Previous modelling studies showed that density variations due to temperature and salinity may have resulted in convective flow through the basin, which could explain the transport of hot, metal-charged brine to the seafloor via the Emu Fault. However, these studies did not consider the effect of deformation on fluid flow, which is particularly relevant to mineralisation at McArthur River as the host sediments were deposited in a rapidly subsiding sub-basin, implying relatively high strain rates in an extensional or strike-slip tectonic setting. Extensional deformation tends to result in downward flow, making it difficult to sustain the upward flow that is required to explain transport of hot, metal-charged brine to the seafloor. Our results suggest that extensional deformation at moderate strain rates would have been sufficient to override convection. Thus, if convection played a role in this system it seems likely that it would have been during a hiatus in deformation.

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The Role of Reactions Between Gases and Solids on the Surfaces of Earth and Mars

King P[1], Renggli C[1], Palm A[1]
[1]*Australian National University*

TS8 - 1.5 The solar system and beyond, Hall C, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Dr. Penny King's research group examines surface and interior processes on planetary bodies. The group aims to understand the fundamental aspects of how materials in the solar system behave. Knowing how materials behave under different conditions allows us to predict planetary environments (in the past and future) and to make better tools to explore our solar system, the deep Earth, active processes on the Earth's surface, and the effects of climate change.

A fundamental question in Earth and planetary systems is: how are chemical elements distributed from high temperature in the planet's interior to low temperatures at the surface? Elegant geochemical cycles help us compare Earth with other planets like Mars, aiding exploration and the search for life. But most of these cycles omit reactions between gases and solids.

Hydrogen-oxygen-sulfur-(carbon)-halogen gas mixtures are especially prevalent in low pressure and high temperature planetary crusts (e.g., magmatic terranes and following meteorite impact). There is ample opportunity in these settings for gases to react with solids as they buoyantly rise. These reactions redistribute chemical elements and electrons, and create/destroy solids. However, they typically 1) "break equilibrium rules" because reactions occur over seconds, and mass, heat and momentum transfer may be significant; and 2) produce highly soluble salt products that are not readily preserved or detected. Minerals most commonly produced in gas-rock reactions are Ca-, Na-, Mg-sulfates; Na- and Ca- halides; and Fe-oxides.

On Earth, the salts are effectively removed through dissolution, eventually enriching the oceans in Na and Cl. The remaining crust is depleted in Ca, Mg, Na and Fe; producing more aluminous or potassic compositions depending on the initial crust and extent of reaction.

On Mars, salts generally remain at the surface due to a limited hydrologic cycle. Or, at low water:rock ratios and low pH, Fe is mobilised, but at moderate pH it forms Fe-O-H-(S) minerals. Gas reactions with common minerals on Mars remove Ca, Mg, Na and Fe, leaving behind alkali-rich rocks.

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On the depth of melting of enriched components in the Tasmantid mantle plume

Ruttor S[1], Nebel O[1], Nebel-Jacobsen Y[1], Smethurst A[2], Cohen B[3], Eggins S[4]
[1]School of Earth, Atmosphere and Environment, Monash University, [2]School of GeoSciences, University of Edinburgh, [3]School of Geographical and Earth Sciences, University of Glasgow, [4]Research School of Earth Sciences, Australian National University

TS3 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Saskia Ruttor has done her Masters degree at the University of Potsdam, Germany. She started her PhD Position at Monash University, Melbourne, in February 2018 and works, together with Prof. Dr. Nebel, on isotopes The goal of her PhD research is the study of stable isotopes in Ocean Island lavas (such as the Tasmantid Seamounts, Hawaii etc.). With this, she aims for an advanced understanding of:

- the chemical composition of mantle plumes,
- processes that are taking place during the rise of a mantle plume and
- the chemical structure of the deep Earth's interior by identifying mantle components.

The Tasmantid Seamounts form a chain of submarine volcanoes along the Coral and Tasman Sea east of Australia, becoming progressively older towards the north. The spectrum of geochemical whole rock data for these melts is similar to the Hawaiian whole rock trends of Mauna Loa and Mauna Kea, ranging from alkali to tholeiitic basalts, with a wide range in radiogenic isotope compositions. Based on Nb/Yb vs Ti/Yb, and concurrent with the Kea trend, Tasmantid alkaline melts form at pressures > 3 GPa, within the garnet stability field. Tholeiitic basalts are derived from a lower-pressure source (< 3 GPa) in shallower mantle regions, similar to the Loa trend. New radiogenic Sr-Nd-Hf-Pb isotope ratios of dredged Tasmantid lavas reveal that the tholeiitic basalts have a distinctive EM1-type character (143Nd/144Nd<0.5217, 87Sr/86Sr>0.7043), similar to previous observations. Alkali basalts are dominated by more primitive isotope signatures (143Nd/144Nd>0.5127, 87Sr/86Sr<0.7042), tentatively identified as a FOZO component.
The data indicates a disparity of modes of melting that is related to enriched components in the Tasmantid plume at variable mantle depth. We suggest for FOZO to be representing the plume matrix, melting at deeper mantle levels, with EM1 extracting later at shallower depth. In comparison to Hawaii with an isotope dichotomy over only 3 Ma, the Tasmantid bimodal trend can be traced > 50 Ma ago, so is likely not related to plate tectonic processes, e.g. a tilted plume. Therefore the Tasmantid plume may allow investigations of spatial variation in the thermo-chemical structure of a plume.

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Structural Control of Neogene Barisan Orogeny Evolution: Case study Tambangtinggi, Sarolangun Jambi, Indonesia

Zelandi M[1], Hastuti E[1]
[1]University of Sriwijaya

Biography:
Student from Geological engineering Study Program, Faculty of Engineering, University of Sriwijaya. Interests in Sedimentary, Petrology and Hydrogeological research.

Barisan Hills formed by tectonic activity of Indo-Australia Plate and Eurasia Plate, create Orogeny process on Western part of Sumatra, lead the exposuring of Pre-tertiary rocks at some location. Tambangtinggi area, Sarolangun Regency Jambi located on the edge of Barisan Hills with variative structural characteristic and arranged by the Pre-tertiary rocks (Peneta Formation and Mersip Member Peneta Formation). Thus, geomorphologically the area describe as Denudational Hills with moderately steep sloping on Northeast and Steeply sloping on the Southwest and Northwest of the research area. This Research aims to understanding the geological structure controls of the Barisan Hills evolution which projected by the research area's structure characteristic. Observation held in the 9 km x 9 km area using Scanline method, measuring such as Shear and Gash Fracture, Fault breccia, faults and folds data on the area. Afterwards, the data correlated with the Digital Elevation Model to observe the relatonship between the structural data and its effect on the larger scale. Sructures formed on the area are N-E trend Reverse Fault associated to brittle rock such as metasandstone, Strike-slip fault with NW-SE trending and NW-SE trending folds observed on the ductile rock. Fractures data shows the area controls by NE-SW stress direction which perpendicular to the hinge of the fold. Structural controls of the area trends to NE-SW which associated to Semangko fault, forming the fold complex which followed by fault blocks along with the Plio-Pleistocene Barisan Hills forming.

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Automated Joint Unmixing of SWIR and TIR Reflectance Spectra

Green A[1]
[1]OTBC

Biography:
Andy Green has been involved with airborne and space-borne geophysics and remote sensing for longer than he cares to remember. He started remote sensing and image processing research with CSIRO at high frequency and gradually migrated fourteen orders of magnitude down-frequency to work on airborne EM systems. Now his research has reverted almost to childhood as he is back working in the area of his PhD in infra-red spectroscopy. He says he is excited and privileged to be able to be a small part of the development of HyLogging technology.

The NVCL includes a unique, spectroscopic data set of thousands of drill cores. To process the data in a uniform manner, an automated unmixing algorithm has been developed to estimate mineral abundances from the TIR reflectance. Because linear unmixing usually gives reasonable estimates of mineral abundances, when starting with the correct mineral assemblage, the main challenge is to determine this assemblage correctly.

Because many important phyllosilicate minerals are difficult to distinguish in the TIR, information from the SWIR region is essential to correctly assign minerals to be used for unmixing TIR spectra . However, joint interpretation can't be done by simple unmixing of the full-wavelength spectrum because different physical processes operate in the two wavelength regions. For example, the SWIR reflectance will often show phyllosilicates at trace abundances where TIR does not detect them at all. To overcome this issue an unmixing algorithm has to have knowledge of the Relative Detectability of each mineral in the two wavelength regions.

The joint unmixing algorithm commences with the TSA Subset Selection algorithm which, given reference libraries, makes lists of candidate mineral assemblages that model the unknown spectra in SWIR and the TIR. The candidate lists and selected scalar results are compared to reduce the number of assemblages. The main effect of this operation is to reject TIR candidates that include phyllosilicate minerals not seen in the SWIR and to constrain carbonates among the SWIR candidates on the basis of their TIR response.

The results are available at www.CorStruth.com.au.

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The effect of managed aquifer recharge on organic chemical removal to ensure a sustainable, high quality and safe water resource

Reeve P[1], Wallis I[1], Hutson J[1], Fallowfield H[1]
[1]*Flinders University*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Peter Reeve is a PhD candidate in the Health and Environment Group at Flinders University. His broad interests lie in environmental science, where multidisciplinary approaches are applied to investigate environmental problems and phenomena. He has specific skills in the integration of water science, environmental health, geology and microbiology.

Adelaide urban and rural catchments discharge an estimated 116 GL of stormwater and wastewater annually into the coastal zone. Urbanisation means this discharge is set to increase. With water being a scarce resource in South Australia, discharging this amount of water is not sustainable. Managed aquifer recharge (MAR), where water is captured and stored in controlled aquifers underground, presents an opportunity to reuse this water.

The potential health risks that water from MAR could pose to the public, for example when used for irrigation or vehicle washing, are increasingly recognised by the SA local governments who operate these schemes. Many organic chemicals, such as pesticides, pharmaceuticals and firefighting foams are ubiquitous in the environment. There is much to be learnt about fate of organic chemicals in groundwater environments receiving potentially contaminated water via MAR.

This new study aims to improve the understanding of how organic chemicals behave in managed groundwater environments. A combination of batch and column studies were utilised to achieve this research objective, integrating physical, chemical and biological processes which have potential to influence the removal of organic chemicals in such environments. The results of this work will be used to inform current and future management strategies for the collection, treatment and reuse of stormwater and wastewater via MAR.

This presentation will outline research methods and results from studies using authentic aquifer substrates in the presence and absence of biofilm. A commentary on the importance of multidisciplinary, collaborative research to tackle environmental research questions will also be provided.

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The power of urban wetlands as educational tools for the study of earth and environmental science

Reeve P[1], Ricketts G[2], Fallowfield H[1]
[1]Flinders University, [2]City of Marion

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Peter Reeve is a PhD candidate in the Health and Environment Group at Flinders University. His broad interests lie in environmental science, where multidisciplinary approaches are applied to investigate environmental problems and phenomena. He has specific skills in the integration of water science, environmental health, geology and microbiology.

Oaklands Wetland, located to the south of Adelaide, treats stormwater from the Sturt 'River' – a concrete channel running from hills to coast. An on-site managed aquifer recharge scheme injects water into an underground confined aquifer for storage in the winter, making this resource available for irrigation of amenity spaces in the summer. Wetlands such as these provide an ideal learning environment to teach students about pollution management, water quality, water reuse, groundwater and a whole spectrum of other scientific concepts.

An ongoing collaboration between the City of Marion and the College of Science and Engineering at Flinders University has provided valuable enhancements to the first year earth and environmental science curriculum at Flinders University through field visits and the installation of continuous online water quality monitoring equipment at various points along the wetland treatment chain.

To enhance educational opportunities further, Flinders University and City of Marion have committed to the construction of an education centre at the site. It is envisaged that this centre will be utilised by primary, secondary and tertiary students, along with the broader community and researchers, as a tool to spark interest in the function of the environment, driving a greater interest in geoscience.

This poster presentation aims to outline how Flinders has integrated Oaklands Wetland into its curriculum and improved outreach to schools and the community. It is hoped that this poster will spark discussion and potential future collaboration with other interested parties around this and similar developments.

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A Gaussian process regression model for 3D geochemical interpolation supported by geophysical inversion models

Horrocks T[1], Holden E[1], Wedge D[1], Wijns C[1]
[1]*Centre for Exploration Targeting, University of Western Australia*

TS4 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Tom Horrocks is a final year PhD Candidate at the University of Western Australia (UWA), where he develops methods for integrating geological, geophysical, and geochemical data using machine learning.

3D geochemical subsurface models, as constructed by spatial interpolation of drill core assays, are valuable assets across multiple stages of the mineral industry's workflow. However, the accuracy of such models is limited by the spatial sparsity of the underlying drill core, which samples only a small fraction ($\lesssim$0.01 %) of the subsurface. This limitation can be alleviated by integrating additional collocated and correlated 3D models into the interpolation process, such as the 3D rock property models produced by modern geophysical inversion procedures. We propose a Gaussian process regression model for 3D geochemical interpolation, where custom kernels are introduced to integrate collocated 3D rock property models while addressing the trade-off between the spatial proximity of drill cores and the similarities in their collocated rock properties, as well as the relative degree to which each supporting 3D model contributes to interpolation. The proposed model was evaluated for 3D modelling of magnesium concentration in the Kevitsa Ni-Cu-PGE deposit based on drill core assays and four 3D geophysical inversion models. It was found that incorporating the inversion models improved the regression model's likelihood over spatial interpolation alone at moderate spatial scales (approx. 100 m). Implementation used the recent machine learning package GPFlow, which leverages advances in graphical processing to compute the full 3D model in minutes.

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Machine Reading of Geological Documents to Assist Mineral Explorers

Holden E[1], Wedge D[1], Horrocks T[1], Wang R[1], Liu W[1], Duuring P[2], Beardsmore T[2]
[1]The University of Western Australia, [2]Geological Survey of Western Australia

TS4 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Prof Eun-Jung Holden established and leads a multidisciplinary research group called the Geodata Algorithms Team at UWA. She gained a PhD in computer science at UWA and made a transition to geoscience in 2006. Working closely with the minerals industry, her team developed new data analytics methods and tools which are disseminated to end users through diverse pathways, which includes the commercialisation of three software products, public release of a GSWA software product and an industry driven patent application. The team won various awards including The UWA Vice Chancellor's Research Award in Impact and Innovation for 2015.

Past exploration reports are an important source of information for mineral explorers, in particular towards understanding the geological knowledge for the region being explored. Typically there are multiple or a large number of reports available with significant overlap of geological content, and extracting specific geological information of interest is a time consuming task. Further, there is extensive ambiguity in the use of geological terms by geologists and non-unique geological terms are used to express the same meaning, which makes it challenging to use a text search engine. We report on a prototype geological document analysis system (GeoDocA) that harnesses the advances in natural language processing and text mining. Methodologies are developed for machine reading of text; generating summary graphs of geological contents that are relevant to mineral explorers; and using learnt associations of geological terms as suggestions for searching reports. The GeoDocA prototype analysed 25,419 reports from the Geological Survey of Western Australia's WAMEX database. It uses the categories of geological terms that are of high importance for mineral explorers, specifically geological timescales, mineralogy, host rock types and alteration types. Geological information contained within reports are effectively summarised in a graph form, which is also used for the search of similar reports; and figures and tables contained within reports are extracted automatically in the visualisation of their geological content, providing visual summaries of the report that can be skimmed and identified rapidly and objectively.

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Exploration on the Edge

Gabbitus M[1]
[1]*MICROMINE*

TS6 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
In 2016 Mark became Product Strategy Manager for Geobank. He is integral to defining and executing the product strategy and roadmap.
As the Product Manager, he works closely with the technology, sales, operation and marketing teams to deliver the Product roadmap. Mark is the product champion and interacts with key stakeholders to gain insights, understanding pain points and ensuring features and products are customer lead. Working with the development team in an Agile framework to ensure delivery of results throughout the product life-cycle, in a highly dynamic environment.

Mineral Exploration has always existed on the edge. From the Australian outback, to the jungles of South East Asia or the frozen wastes of Siberia, the process of collecting and managing exploration data has always been a challenge.
As resource companies embark on digital transformation projects, the challenge of integrating data collected has become more acute. The explosion of new sensors and data collection devices now available, has resulted in large increases in the amount of data collected. These sensors and devices push data collected from the drillhole to the cloud or store it in proprietary data bases, which works well when you have network connectivity, but a large amount of the Geologists work occurs where networks are unavailable.
The Geologist must wrangle siloed information into a Geoscientific database, to be visualised, analysed and used to make smarter business decisions. Often, this can be a laborious task and historically done on site or at HQ, which often is too late in the game.
If digital transformation is supposed to improve productivity and reduce costs, and siloed workflows do not add value. This is where Edge computing begins. Edge computing has historically been limited to ingesting and storing data from IoT devices, typically before being sent to the cloud. Today, devices used are powerful enough to enable interpretation and analytics in real time.
Edge computing allows Geologists to have integrated platforms with data they've collected in real-time. This provides greater visibility, allowing for increased efficiencies and productivity and reduction of costs.

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Reconstructing 'Green Sahara Periods' over the Plio-Pleistocene

Grant K[1], Rohling E[1,2], Westerhold T[3], Zabel M[3], Liebrand D[3], Amies J[1]
[1]The Australian National University, [2]The University of Southampton, [3]MARUM, Bremen University

Biography:
I gained my PhD in Ocean & Earth Sciences from Southampton University (UK) in 2013, and since then have been a postdoctoral researcher at the Australian National University. I run the scanning XRF facility and use a multi-proxy approach (scanning XRF, stable isotopes, environmental magnetism) combined with statistical analyses to produce high-resolution palaeoclimate records over the Plio-Pleistocene. My research focuses on sea-level/ice-volume reconstructions, palaeo-monsoon variability, and Mediterranean palaeoceanography.

Palaeo-monsoon reconstructions are essential for understanding long-term hydroclimate variability, and for providing an environmental context to human prehistory. For example, numerous archives document an expansion of vegetation and water bodies across the now arid Sahara desert during the early Holocene. This Green Sahara Period (GSP), also known as the African Humid Period, played a major role in human migration and settlement, and was linked to an intensification and northward displacement of the African monsoon rainbelt in response to orbitally driven insolation changes. Detailed records of earlier GSPs are sparser, however, due to the fragmentary nature of continental archives and/or dating issues, and relatively few marine records of the African monsoon prior to the last glacial cycle. Given the insights GSPs provide into long-term African monsoon dynamics, and their significance for hominin evolution and development, robust evidence of the timing and nature of GSPs through the Plio-Pleistocene is much needed. We recently established a new orbitally-tuned index of North African aridity/humidity, based on bulk geochemical and environmental magnetic records from Ocean Drilling Program Site 967 (Eastern Mediterranean). Our index reveals the timing of GSPs over the last 3 million years, and we are now extending the record back to 5 My, when global temperatures and atmospheric CO_2 were comparable to present levels. This work will not only shed light on African monsoon variability under enhanced radiative forcing, but also allows us to highlight potential 'pan-African humid periods'; these may be of considerable importance for efforts to understand human evolution/migrations.

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Geoscience at the frontiers

Hough R, McWilliams M
[1]*CSIRO Mineral Resources*

TS2 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Hough is a geologist with over 25 years experience in the application of geoscience research to industry challenges. He has a strong track record in helping create research collaborations and industry connections that build large scale research initiatives for projects, talent and infrastructure development.

Australia is a world leader in geoscience research and in the provision of geological data at many scales. The intersection of different disciplines provides for a future where geoscience captures the collaborative opportunities to combine to tackle major national challenges. The geoscience of, the often described 'Cover Challenge' of Australia, will involve the community drawing from expertise in fields as diverse as hydrology, botany, gas sensing, physical chemistry combining with our traditional skills base in areas like sedimentology, stratigraphy, geophysics, geochemistry. This presents an unprecedented opportunity in sensor development, deployment, spatial (including 3D) real-time data collection, data science and prediction that can be drawn from diverse fields to support the future of geoscience as a world leading capability in Australia. The impact that can be achieved from this includes resource discovery but also new industries from the rise of strategic minerals, sustainability and whole of system understanding of the crust to inform communities and social acceptance, examples of greater intersection between Agriculture and Resources, and new market opportunities for technologies. The impact approach from geoscience business units in CSIRO and the new future science platforms will be presented in this context.

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Fully-dynamic global models to explore the processes behind continental reorganisations

Mallard C[1], Coltice N[2]
[1]The University of Sydney, [2]ENS Paris

TS3 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Claire is a postdoctoral research associate in the EarthByte Group in the University of Sydney (Australia). She completed her PhD at the University of Lyon (France) in 2017 titled" Tectonic analyse of the surface of mantle convection models".

Her research focuses on the long term relationships between deep dynamics and surface tectonics and on the interactions between mantle processes and landscape evolution

Plate tectonics theory describes first order surface motions at the surface of the Earth. Since the 1980's, significant progress has been made to reconstruct global tectonics (Lithgow-Bertelloni and Richards, 1998; Muller et al. 2017), but increasing uncertainties in the geological record back in time makes it difficult to constrain plate motions before Pangea breakup. It implies that the relationships between deep dynamics and surface tectonics are still largely unknown.
Recent fully-dynamic global models (Tackley, 2008) used pseudo-plastic rheology to generate global Earth-like structure of the mantle flow and surface tectonics without imposing any plates velocities or boundaries at the surface. These models self-consistently generate an expansion of the oceanic floor similar to that of the last 200 million years on Earth, and a continental drift similar to what can be reconstructed with palaeomagnetism. 3D models provides access to a range of time-evolving parameters that can be interrogated (temperature, velocities, viscosity) thanks to the development of new analytical tools (e.g. Crameri 2018 Mallard et al. 2017). The constant evolution of the quality of mantle convection models allow us to improve our understanding of the link between mantle dynamics and surface tectonics, but also to target necessary improvements in existing convection models and tectonic reconstructions.
To this end, we compared the surface tectonic of the results of convection computations with the Earth models of tectonic reconstructions through continental reorganisation times. Using the underlying forces within the lithosphere and mantle to further refine their implications on continental reorganisations is now possible.

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Mafic intrusive complexes in sedimentary basins: a guide for hydrocarbon explorers

Holford S[1], Schofield N[2], Mark N[2], Watson D[2], Hardman J[2], Reynolds P[1], Meeuws F[2]
[1]University of Adelaide, [2]University of Aberdeen

TS1 - 3.2.3 Petroleum and its co-products, Room R2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Simon Holford is an Associate Professor of Petroleum Geoscience at the Australian School of Petroleum. Prior to commencing an academic role at the University of Adelaide, Simon was an ARC Australian Postdoctoral Fellow. With Ros King, he jointly leads the Stress, Structure and Seismic Research Group. Simon has published over 80 papers on various aspects of sedimentary basin tectonics and petroleum geoscience. He is a past president of the SA/NT branch of the Petroleum Exploration Society of Australia.

Mafic intrusive complexes are common features of sedimentary basins across a range of tectonic environments, often comprising networks of interconnected sheet intrusions (e.g. sills, laccoliths and dykes) that have facilitated the transfer of magma over considerable lateral and vertical distances to shallow basinal depths. This presentation will highlight some recent advances in our understanding of such intrusive complexes, and the attendant ramifications for hydrocarbon exploration. Well data from the Faroe Shetland Basin indicates that the majority of intrusions in basins have thicknesses below the level of vertical seismic resolution, with important implications for drilling and basin modelling. Seismic and well data from the Bass Basin shows that even thick mafic intrusions may be difficult to detect on seismic data under certain circumstances, making their pre-drill prediction challenging. This presentation will also address the impact of intrusions on source and reservoir rock quality, with specific emphasis on the fluid flow properties on intrusions. Mafic intrusions and generally considered to be barriers to subsurface fluid flow, but there is growing evidence that intrusions can retain fracture permeability at burial depths >4 km. This represents an opportunity in terms of additional migration pathways, but also a challenge as thin intrusions, below the level of seismic detectability, can potentially represent unanticipated drilling hazards.

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Statistical re-assessment reveals new REE-compositional trends within TTG's

Ladwig A[1], Nebel O[1], McCoy-West A[1], Moyen J[2], Ivanic T[3], Millet M[4], Saji N[4], Bruand E[5], Cawood P[1], Laurent O[6]
[1]Monash University, [2]Université Jean-Monnet, [3]Geological Survey Western Australia, [4]Cardiff University, [5]Université Clermont Auvergne, [6]ETH Zürich

TS3 - 1.1.4 Crustal evolution of Archean Cratons, Hall A, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
04/16 Master of Science in Geoscience, University of Kiel (Germany)
since 02/18 PhD Student at Monash Universtity, Melbourne (Australia)

Continents impart unique bimodality to the Earth’s crust and composition, but when and how continental crust and its cratonic cores formed remains unresolved. Granitoids of the Tonalite-Trondhjemite-Granodiorite suite (TTG's) are key components of Archean crust and their genesis is important in constraining early continental evolution. Rare Earth Element (REE) patterns of TTG's may reflect their conditions of formation, source rock compositions, and probable geodynamic settings. However, variations in REE are often subtle with variations difficult to identify, especially in craton-wide datasets. In a recent study, O’Neill [1] proposed quantifiable shaping coefficients (λ_1 and λ_2) for REE patterns, which define the slope and curvature of the REE pattern. We applied this method of enhanced visualisation of REE patterns to TTG’s from the Australian Yilgarn craton (WA) and compared them to a broader dataset of global Archean and post-Archean granitoids and to classical TTG's, Sanukitoids and evolved 2-mica-granites of the Limpopo belt (South Africa) [2]. The comparison revealed that the REE patterns are distinct from these Archean rock suites, and likely reflect the presence of different source rocks including garnet-bearing amphibolite and eclogite. Our initial assessment shows the applicability of this proxy in Archean crustal research, which we aim to expand towards individual rock types and for comparisons of regional datasets with known geodynamic variations.

[1] O’Neill, JoP, (2016)
[2] Laurent et al., Lithos (2014)

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Spectral studies from the Kanmantoo Copper Mine, South Australia.

Mauger A[1], Keeling J[1], Gordon G[1], Rolley P[2], Arbon H[2]
[1]Geological Survey Of South Australia, [2]Hillgrove Resources

TS2 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Mauger graduated BSc(Hons) Geology from the University of WA. His first graduate employer introduced him to spectral processing of Landsat data. His second employer, CSIRO, exposed him to remote sensing research and while in Sydney he undertook a MAppSc in Remote Sensing at the University of NSW. This led to a position with the United Nations in Bangkok and subsequently to work at a University in China. He has worked for the South Australian Government since 1987 with a focus on remote sensing and spectral geology. He completed his PhD in Geoinformatics at the University of SA in 2000.

The Kanmantoo copper deposit is hosted within biotite, quartz, andalusite, chlorite, garnet, ± staurolite schist on the steeply-dipping western limb of the Kanmantoo Syncline, an open syncline formed during metamorphism and folding of marine turbidites of Tapanappa Formation, Cambrian Kanmantoo Group. The origin of hydrothermal chalcopyrite-pyrite-pyrrhotite-magnetite mineralisation remains controversial and is described variously as a metamorphosed exhalative syn-sedimentary deposit, a syn-metamorphic hydrothermal deposit, or an epigenetic mineral deposit associated with granite at depth, possibly intruded during the latter stages of metamorphism. The interaction of high-temperature metamorphic conditions and hydrothermal/metasomatic activity on the thick sedimentary package is reflected in the complex pattern of metamorphic and hydrothermal mineral distribution within and proximal to the deposit. Spectral analysis of drill core was used to map mineralogy and mineral associations to assist with interpretation of proximity to mineralisation in exploration drill samples.
Continuous hyperspectral scans (450-2500 nm; 6000-14500 nm) were made of ten cored drill holes representative of various grades and styles of Cu-lodes across the deposit. Spectral absorption and reflection features were used to identify mineralogy and map variation in the chemistry of selected minerals. Fe-rich chlorite and almandine garnet are most abundant in the zone of Cu mineralisation coinciding with low abundance of andalusite. Biotite is widely distributed and shows a pattern also of increased Fe substitution for Mg close to mineralisation. Kaolinite and jarosite distribution from spectral data was confirmed by electron microscopy to reflect late-stage acidic alteration associated with etched sulphide grains and partial dissolution of andalusite, biotite and quartz.

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Understanding agricultural nitrate in groundwater using stable isotopes of nitrate to constrain an ion-based mixing model

Bourke S[1,2], Iwanyshyn M[3], Kohn J[4], Hendry M[2]

[1]University Of Western Australia, [2]University of Saskatchewan, [3]Natural Resources Conservation Board, [4]Alberta Agriculture and Forestry

Biography:

Dr Sarah Bourke specialises in environmental hydrogeology and uses tracers to quantify the impacts of human activities and climate change on shallow groundwater systems. Sarah completed her PhD in Hydrogeology through Flinders University working with Rio Tinto Iron Ore on shallow groundwater resources in semi-arid systems and those altered by mining. Sarah then completed a Post-doctoral Fellowship at the University of Saskatchewan in Canada looking at impacts of mining and agriculture on groundwater in glacial sediments. Sarah is now Lecturer and Course Coordinator of the Master of Hydrogeology in the School of Earth Sciences at the University of Western Australia.

Understanding the sources and fate of nitrate (NO3-) from animal waste or fertilizers is critical for managing impacts of human food production on the environment. Elevated NO3- concentrations in groundwater can be naturally attenuated through mixing or denitrification. Here we use snapshots of the stable isotope values of NO3- to quantify denitrification in groundwater at two confined feeding operations in Alberta, Canada. Uncertainty in δ15N and δ18O values of the NO3- source and denitrification enrichment factors are accounted for using a Monte Carlo approach. When denitrification could be quantified, we reconstructed the initial NO3-N concentration and NO3-N/Cl- ratio at the point of entry to the groundwater system. The addition of NO3- to the local groundwater system from temporary manure piles and pens equalled or exceeded NO3- additions due to leaching from earthen manure storages at these sites. Nitrate attenuation at both sites is attributed to a spatially variable combination of mixing and denitrification, but is dominated by denitrification. On-site denitrification reduced agriculturally derived NO3- concentrations by at least half and, in some wells, completely. The application of isotopes of nitrate to constrain a mixing model based on concentrations of Cl- and NO3-, which can be routinely monitored in groundwater, provides a relatively simple method to assess the sources and fate of agriculturally derived NO3- in these settings.

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A Proterozoic Perspective on Global Climate Change

Halverson G[1]

[1]McGill University, [2]Curtin University

TS3 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:

Galen Halverson is the T.H. Clark Chair of Sedimentology and Petroleum Geology and a James McGill Professor at McGill University. He is a sedimentary geologist and isotope geochemist who began his research career studying the Neoproterozoic Snowball Earth and whose research focuses on the evolution of the Proterozoic Earth system. Galen conducts fieldwork in the Arctic, Australia, southern Africa, and elsewhere to better understanding the details of Proterozoic supercontinental assembly and break-up, incremental oxygenation of the Earth's atmosphere and oceans, the links between paleoenvironments and eukaryotic evolution, and the drivers and consequences of major climatic and biogeochemical perturbations.

Series of glaciations occurred at the onset of the Proterozoic Eon (early Paleoproterozoic — ca. 2.45 to 2.22 Ga) and again at the end (late Neoproterozoic — ca. 0.72 to 0.58 Ga). Both glacial epochs are closely associated with major reorganization of biogeochemical cycles, including the rise of atmospheric oxygen (the Great Oxidation Event and the Neoproterozoic Oxygenation Event, respectively) and major perturbations in the global carbon and sulfur cycles. Although a direct link between the evolving biosphere and Paleoproterozoic glaciations remains controversial, it is apparent that the Neoproterozoic glaciations were intertwined with a rise in prominence of eukaryotes, including the origin of Metazoa. New radiometric ages and other chronostratigraphic constraints unambiguously indicate that two of the three Neoproterozoic (Cryogenian) glaciations were global in extent. In contrast to the beginning and end of Proterozoic, the long middle of the Proterozoic lacks evidence for glaciation or dramatic biogeochemical fluctuations, although it did witness the origin and early diversification of eukaryotes. It is evident that the Proterozoic glaciations were one manifestation of two great upheavals in the Earth System that lead to irreversible changes in the global environment. Even if the Phanerozoic glaciations were less striking than their Proterozoic counterparts, they also corresponded with major changes to the Earth's surface environment. The questions of what drove both Proterozoic and Phanerozoic glaciations and their recoveries are rich and hotly debated topics of inquiry that help inform our understanding of present and future climate change.

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The Groundwater Grand Challenge

Simmons C[1]
[1]Flinders University / NCGRT

TS1 - 3.3.1 Groundwater challenges and opportunities & 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Craig Simmons is Director of the National Centre for Groundwater Research and Training and Matthew Flinders Distinguished Professor of Hydrogeology at Flinders University. He is a member of the IESC and U.S. National Academies of Sciences, Engineering, and Medicine Roundtable on Unconventional Hydrocarbon Development. He is a Fellow of the Australian Academy of Technology and Engineering. He received the Anton Hales Medal for outstanding research contributions to the Earth Sciences by the Australian Academy of Science, an Australian Award for University Teaching and was named 2015 South Australian Scientist of the Year and 2017 Australian Water Professional of the Year.

Groundwater supplies half of the world's drinking water and 43% of the water used for growing food. Groundwater is front and centre in critical global issues about our environment, food and water security, coal seam gas /shale gas and fracking, mining, energy and nuclear waste disposal. The water-food-energy nexus is an important and emerging international issue.
In Australia, groundwater provides more than 30% of Australia's total water consumption and generates national economic activity worth in excess of $34 billion a year across agriculture, mining and industry. In Australia, there are a myriad of current, pressing issues in which groundwater is crucial. Securing the Great Artesian Basin, the successful implementation of the Murray-Darling Basin (MDB) Plan, the impacts of unconventional gas and hydraulic fracturing on groundwater, mining and groundwater, nuclear and radioactive waste disposal, proposals for the future development of Northern Australia, the role of groundwater in urban and rural water security, cultural flows, and the impacts of climate change on groundwater are just a few of the hugely important contemporary issues that will require rigorous groundwater science, management and policy.
This plenary address describes important challenges and opportunities that relate to the groundwater profession. A myriad of policy, management, research, technical practice, education/training and overarching governance/institutional matters are described. These form the basis of important capacity building opportunities for the future. The talk demonstrates that there has never been a greater opportunity for groundwater research, education, management and policy reform to make a difference in Australia and around the world.

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The highs and lows of Archean dolerites and the controls on gold mineralisation: examples from the Eastern Goldfields, Western Australia

Campbell I[4], Cas R[2,3], Chen M[4], Doutch D[3], Hayman P[1], Squire R[2]

[1]Queensland University of Technology, [2]Monash University, [3]University of Tasmania, [4]Australian National University

TS7 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Dr Hayman's principal research focuses on physical and chemical reconstructions of volcanoes associated with ore deposits, ranging from deposit to terrane scale. Dr Hayman has particular expertise working with altered and deformed successions from the Archean and Paleoproterozoic, researching volcanogenic massive sulphide (Cu, Pb, Zn, Au), epithermal (Au, Ag), komatiite-hosted (Ni) and orogenic gold systems. Most of Dr Hayman's research is underpinned by field mapping (outcrop and drill core) and utilises a variety of lab-based techniques (especially geochemistry, geochronology and textural studies) to resolve questions about depositional environments, tectonic processes and exploration targeting.

Coarsely crystalline mafic rocks, commonly referred to as dolerite, are hosts to major orogenic gold deposits. Although the importance of structures for focusing gold-bearing fluids is well understood, the lithological and mineralogical variety of rock types associated with coarse mafic rocks, their emplacement origins and mineralization remain poorly understood. To address these points, we examined two mineralised (Golden Mile and Cave Rocks Dolerites) and three unmineralised packages from the Eastern Goldfields Superterrane (Yilgarn Craton, Western Australia) and present drill core logging, whole rock geochemistry, gold assay and magnetic susceptibility data. The coarsely crystalline mafic rocks range from 75 to 460 m thick, extend for up to tens of kilometers, are primarily hosted in thinly bedded turbidites, are concordant to stratigraphy and have sharp and finely irregular contacts. The mafic packages consist of up to eight different lithologies, which we characterize by mineralogy, texture, composition, and magnetic susceptibility. The balance of evidence supports origins as high-level intrusive sills. A negative correlation between the thickness of ultramafic (pyroxenite and peridotite) compared to quartz- and magnetite-bearing lithologies is interpreted as evidence for undulations in the sills, with the denser minerals accumulating at low points and the less dense minerals occurring at high points. Gold data positively correlates with the quartz-bearing lithologies, which are thickest in the two mineralised examples. These observations together provide strong support for a primary mineralogical control on gold precipitation and present a tantalizing target for exploration for orogenic gold deposits: locate paleo-highs in the upper surface of sills.

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Hydrogeochemistry of Australia: providing baselines for Lithology mapping, Mineral exploration, Health and Agriculture

Gray D[1]
[1]*CSIRO*

TS6 - 3.3.2 New groundwater technologies and approaches, Room R5, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
David Gray has being researching surficial and groundwater geochemistry for 35 years, including 30 years with CSIRO in Perth. He is committed to development of new tools and data for understanding mineral prospectivity in Australian terrains. Over the past decade this has dominantly involved development of regional hydrogeochemistry to support exploration.

With high signal-to-noise, groundwaters are useful media for geological sensing and mineral exploration in specific environments. Additionally, they are sensitive to faults and other geological structures. Hydrogeochemistry may also add value to mineral exploration where prospective rocks are covered within basin margins.
Uptake of this technology is being encouraged through the development of a robust and cost-effective methodologies with field guides, notebooks, and field apps. Site studies have tested hydrogeochemical responses to mineralisation, and sensitivity and normalisation of sampling methods.
CSIRO has obtained publicly available groundwater databases, and processed them using robust QA/QC measures to develop 'seamless' data across Australia. Over 200,000 samples are represented in these datasets, which include anything from single salinity measurements up to 60+ solutes per sample.
At the Terrane scale, specific indices can delineate large scale lithologies and major mineral camps, such as the Agnew and Granny Smith Gold camps in the northern Yilgarn Craton. Other large systems, such as IOCG's or Cu Porphyries may also be observable. At the Prospect scale, indicator elements (e.g., Au, Ni, Cu, Zn, W, As) are commonly valuable, with commodity indices developed for smaller targets such as Ni or VHMS. Combined with geophysics, this may assist drill targeting.
In many areas across inland Australia, groundwater is commonly used by humans and livestock for consumption. Mapping of health sensitive solutes such as nitrate can inform water usage and treatment requirements.
Thus, hydrogeochemistry can positively assist exploration at varying scales, and provide baseline chemical data for human and agricultural health.

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The Geological Relationship between Kanmantoo Cu-Au Mineralisation and Igneous Intrusives

Kimpton B[1], Lilly R[1], Rolley P[2], Kelsey D[1]
[1]*Department of Earth Sciences,* [2]*Hillgrove Resources, Kanmantoo Operation*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Ben Kimpton is currently completing his Honours in Geology at the University of Adelaide studying the origins of the Kanmantoo Cu-Au deposit in conjunction with Hillgrove Resources. He is currently a recipient of both an AusIMM EEF Premium Scholarship and Commonwealth Scholarship for South Australia. Ben has completed six months of vacation work with Core Exploration in the Northern Territory, exploring for pegmatite hosted Lithium deposits and has been involved with the Geological Society of Australia for many years. In 2019, Ben hopes to partake in an industry based graduate program, with a medium-term drive toward exploration geology.

The Kanmantoo Cu-Au deposit has been in episodic operation since 1846 yet there is little consensus on its mode of formation. Extensive debate exists within the literature regarding the precise paragenetic sequence of the deposit and the source of its economic constituents. Models for mineralisation revolve broadly around a pro-Delamerian syngenetic or syn-to-meta-Delamerian epigenetic timing for mineralisation involving either metamorphic, magmatically derived fluids or both. Through identification and analysis of various local intrusive rocks, mineralisation and alteration styles observed within the deposit, it is hoped that this study may accurately constrain both absolute and relative spatial and temporal relationships between mineralisation and local igneous intrusive rocks. This may help to clarify both how and when mineralisation occurred, and potentially broaden regional exploration prospects to include buried Delamerian effected terrains. Samples were collected from both existing diamond drill core and directly from the active mine pit to produce a representative suite of intrusive units throughout the deposit. Structural analysis and petrography have been utilised to identify cross-cutting and paragenetic relationships and the mineralogy of samples. Quanta 600 SEM microscopy has been used to identify mineral grains suitable for LA-ICMPS U-Pb dating of accessory minerals (monazite, apatite and xenotime) present in vein sets and associated with mineralisation. Combined with whole rock geochemistry these dates will provide evidence for any temporal and spatial links between igneous activity and mineralisation.

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Preliminary analysis of Ediacaran facies-assemblage relationships from the Flinders Ranges

Reid L[1], Holmes J[2], Payne J[1], Garcia-Bellido D[2], Jago J[1]
[1]University Of South Australia, [2]University of Adelaide

TS3 - 2.1 The origins and development of life & 2.2 Ediacaran and Cambrian Symposium, Room R1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Lily Reid is a PhD student at UniSA. Her research interests focus on the Ediacara biota from the Flinders Ranges, South Australia

The Ediacara biota includes a diverse group of body and trace fossils which collectively represent the earliest evidence of macroscopic life on Earth. The Ediacara Member (c.555Ma) of the Flinders Ranges, South Australia, preserves fossils of the Ediacara biota across lithofacies representative of a range of shallow-marine environments. Fossils are preserved as in-situ and transported material across all five lithofacies. For the purpose of this preliminary analysis, facies-taxa data from ten sites has been collected and analysed. We demonstrate that the distribution of taxa within lithofacies (as a proxy from palaeoenvironment) is non-random, while a seriation analysis depicts a beta-diversity-like spatial turnover of taxa along an environmental gradient. Several taxa are identified as having a cosmopolitan distribution and are recorded in four or five palaeoenvironments. However, the majority of taxa span a total range of two or three adjacent palaeoenvironments. This study supports earlier findings from the Nilpena fossil locality and indicates a level of sensitivity to environmental parameters was present in these communities.

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Thermal Evolution and Sediment Provenance of the Cooper-Eromanga Basin: Insights from Detrital Apatite

Nixon A[1], Fernie N[1], Glorie S[1], Hand M[1]
[1]*University of Adelaide*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Angus completed his undergraduate and Honours studies in geology at the University of Adelaide, and in 2018 was awarded the prestigious Tate Memorial Medal for highest overall Honours result, for work in the Cooper-Eromanga Basin. Main interests include apatite fission-track and U-Pb systems, with application to low-temperature thermal reconstructions and provenance study of sedimentary basins. Currently undertaking a PhD working to constrain the low-temperature thermal evolution of the McArthur Basin and associated basement terranes.

Despite prolific hydrocarbon and geothermal potential within the Cooper-Eromanga Basin, the provenance and thermal history of the region remains contentious. In this study, we present new apatite fission-track, U-Pb and REE data from the Cooper-Eromanga Basin to address both issues. Apatite samples from upper Eromanga Basin sediments yielded a dominant population of early Cretaceous, and minor population of late Permian – Triassic U-Pb ages, within error of corresponding fission track age populations. Observed Cretaceous U-Pb and fission-track ages show little separation from formation stratigraphic ages, suggesting little time lag between exposure in the source region and sediment deposition, and that no significant (>~100°C) reheating occurred after deposition. Apatites were likely sourced primarily from an eastern Australian volcanic arc (e.g. the Whitsunday Igneous Association), with additional input from the New England and/or Mossman Orogens. Thermal history models suggest maximum temperatures were reached at ~95-70 Ma as a result of progressive heating by sedimentary burial and/or radiogenic basement heating, where only samples from the underlying Cooper Basin preserved evidence of post-deposition heating above ~80-100°C. Rapid cooling in the late Cretaceous – Palaeogene was evident in wells from the central and western Cooper Basin, but absent in the shallower eastern margins. This cooling event remains enigmatic, but may be related with enhanced thermal conductivity as a response to aquifer flow and/or cementation. Central and western wells also recorded a Neogene reheating event, however, more data would be required to assess the significance of this more recent thermal perturbation.

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The Southern Thomson Project

Roach I[1]
[1]*Geoscience Australia*

TS8 - 3.1.7 Studies on the Thomson Orogen, Room R2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Dr Ian Roach is the Southern Thomson Project activity leader at Geoscience Australia, coordinating the collaborative project work between Geoscience Australia, the Geological Survey of New South Wales and the Geological Survey of Queensland. Ian has a background in gold mining, land and marine geophysics at the Bureau of Mineral Resources, and regolith mapping, research and lecturing at the University of Canberra and the ANU. Ian joined Geoscience Australia in 1988, was a key researcher in the Onshore Energy Security Program and is now helping to discover new minerals provinces as part of the UNCOVER Initiative.

The southern Thomson Orogen is a poorly understood crustal element of northwestern New South Wales and Queensland. Geoscience Australia, the Geological Survey of New South Wales and the Geological Survey of Queensland have been working collaboratively on the Southern Thomson Project since 2012, aimed at improving the geodynamic and mineral systems understanding of this under-explored orogen. The state geological surveys have also been collaborating in ARC Linkage projects with the Queensland University of Technology, the University of Newcastle and the University of Queensland. The Project involved acquisition of new pre-competitive geological, geophysical and geochronological data including stratigraphic drilling that enabled analysis and interpretation of cover thickness, strategic crustal elements, geodynamic evolution and mineral potential. The Project has delivered numerous publications that encourage discussion on the evolution of the Tasmanides and will inform mineral exploration investment in the region.

This presentation introduces the Southern Thomson Project and highlights cross-agency collaboration for pre-competitive data collection and interpretation to attract industry investment. Details of the project rationale, planning, risk reduction strategies and successful drilling program are presented. The presentation also highlights some of the implications of new pre-competitive data collected and key project outcomes, and introduces the collaborative research work that occurred between the participating agencies and universities.

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The aftermath of the Cyrogenian glaciations: Intense silicate weathering and large element fluxes to the oceans?

Taylor H[1], Dosseto A[1], Farkaš J[2,3], Cox G[2], Kell Duivestein I[4], Dietzel M[4], Kingston A[5], Lorrey A[6], Shen B[7]
[1]University of Wollongong, [2]University of Adelaide, [3]Czech University of Life Sciences, [4]Graz University of Technology, [5]National Institute of Water and Atmospheric Research, [6]National Institute of Water and Atmospheric Research, [7]Peking University

TS3 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
My name is Holly Taylor and I am also currently undertaking a Doctor of Philosophy (Geochemistry) at the University of Wollongong. My research focuses on the use of lithium isotopes as a proxy for silicate weathering to investigate paleo-environmental conditions during the Neoproterozoic.

The Cryogenian marked an important stage in Earth's history, with large-scale environmental change characterised by global glaciations and the emergence of metazoan organisms. The cap carbonates deposited at the end of the Marinoan and Sturtian glaciations are critical archives for understanding environmental change through the Neoproterozoic. Deglaciation of such large glacial events undoubtedly impacted the chemistry of ocean, which may have contributed to the evolution of complex life.
Lithium isotopes (δ7Li) are used as a proxy for silicate weathering as they fractionate during clay-water interaction. Here we use the δ7Li composition of cap carbonates to understand how element continental fluxes to the Neoproterozoic ocean have varied following deglaciation. Preliminary results on post-Marinoan cap carbonates suggest that a large riverine Li flux to the ocean after deglaciation was sustained throughout cap carbonate deposition (approximately 3 Ma). This flux could have produced an accumulation of nutrients in the ocean, potentially triggering the evolution of complex metazoan organisms. Biomarkers have indicated that metazoan organisms emerged between the Sturtian and Marinoan glaciations. The Li isotope composition of Post-Sturtian cap carbonates could determine whether this large Li flux to the ocean was specific to the Marinoan glaciation. Results from the Sturtian cap carbonates could therefore contribute to understanding the evolution of complex life.

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Everything happens somewhere

Barnicoat A[1]
[1]*www.ga.gov.au*

TS1 - 4.4.1 The Geoscience of Where, Room R7, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Following a career in academia in the UK, Andy joined GA as part of the Predictive Mineral Discovery CRC in 2003. He has been Chief of division for Minerals and Natural Hazards and is currently Chief of the Positioning and Community Safety Division

Keynote

Increasingly widely available and highly accurate positioning information is coming and will have a deep impact on the Geosciences. Not only does everything happen somewhere but the Earth varies with location. Geoscientists have long created maps both to record properties across and beneath the Earth's surface and to predict what is in unsampled areas. We are able to locate events remotely – think earthquakes. We can also characterise properties like the Earth's magnetic field which varies both in space and time, and these variations have been critical in many things from navigation to the understanding of plate tectonics.
Now very accurate information on location is widely available. The movement of plates has been clearly documented using positioning data and large earthquakes can usefully (very rapidly) identified from such data. In Australia, we now have (thanks to AuScope's investments) the ability to measure not just the movement of the Australian landmass but also its deformation. In addition, using radar data it is possible to characterise the deformation associated with natural phenomena like earthquakes and anthropogenic processes ranging from resource extraction to nuclear tests. Such high accuracy and freely available data open many new frontiers for the geosciences.
This presentation will highlight how applying such data to the geosciences can be used to improve our understanding of the Earth and make better decisions for the benefit of the environment, society and the economy.

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A New Geotrail to Showcase the Spectacular Coastal Geology of Port Macquarie, NSW

Boyd R[1], Offler R[1], Fleming G[2], Meakin S[2], Spry B[3]
[1]Earth Sciences, University Of Newcastle, [2]Geological Survey of NSW, Division of Resources and Geoscience, [3]Port Macquarie Hastings Council

TS4 - 5.1 Geology in Society: geotourism and geoheritage, Room R8, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Ron Boyd is a Conjoint Professor of Marine Geology at the University of Newcastle. He has interests in marine science, stratigraphy, sedimentology and community geoscience education.

The spectacular coastal geology of Port Macquarie forms the basis of a new Geotrail opened in May 2018. This Geotrail is a guided coastal path that links significant geological features, providing navigation and earth science information for educational and community benefit. Its successful opening illustrates the benefit of collaboration between the University of Newcastle, NSW State Government, Port Macquarie Hastings Council and community groups. The Geotrail stretches for 4 km along the beaches of Port Macquarie, showcasing a unique assemblage of sedimentary, igneous and metamorphic rocks accumulated in an Ordovician subduction complex. The Geotrail starts at Shelly Beach where pillow basalts underlie pelagic cherts. Further north at Nobby Beach, trench-fill turbidites are preserved on the oceanic crust. Next, at Flynns Beach are serpentinites formed by hydration of mantle peridotite and brought to higher levels by faulting. Finally at Rocky Beach are rare blueschists and eclogites resulting from deeper subduction. This lithologic progression extends over thousands of kilometres from mid ocean ridge to trench and deep subduction zone on today’s earth, but can be seen in just 4 km at Port Macquarie. The Geotrail presents complex plate tectonic themes to a wide audience using signs, a guided brochure, a free self-guided tour app available on mobile phone platforms, and a website with more detailed information. Its innovative approach brings geological information to a wider audience of scientific, educational and community groups, and acts as a model for other Geotrail sites in NSW.

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Molybdenum isotope data from the Windimurra Layered Mafic Intrusions and their implication on a newly suggested Bulk Silicate Earth value.

Nebel-Jacobsen Y[1], Wille M[2], Nebel O[1], Ivanic T[3]
[1]Monash University, [2]University of Bern, [3]Geological Survey of Western Australia

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Yona studied Geology/Paleontologie at the University of Muenster/Germany with a focus on Geochemistry. In her PhD she investigated the possible application of combined Lu-H and U-Pb analyses from detrital zircons to different geological settings. Since 2016 she oversees the Isotopia laboratory facility at Monash University, where she continued her research on early crustal evolution and Hf isotopes. Her research work in general focuses on radiogenic and stable isotopes, the Early Earth and analytical techniques.

Yona has won research grants from DFG, DAAD, Heinrich-Hertz-Foundation and a Marie Curie scholarship.

Molybdenum isotopes show resolvable variations in convergent margin igneous rocks. It is clear that subduction zone processes are responsible for the observed variation, yet the exact origin and magnitude remains elusive, as well as the impact of these processes on global ocean floor lava Mo isotope signatures. On top of the secondary mineral formation at the slab-mantle boundary, the formation of cumulates have been suggested to alter Mo isotopic composition in modern subduction zone settings. Layered mafic intrusions (LMI) are massive primitive magmatic bodies that are sourced by high degree, mantle melting, and are composed of several zones of layered magmatic cumulates. The near mono-mineralic nature of the layers can be used to study the stable Mo isotope composition of their mantle source. Here we present stable Mo isotope composition of a series of remarkably fresh whole rock drillcore samples of cumulate rocks from Upper Zone of the 2.8 Ga Windimurra Igneous Complex, Western Australia. Our data show that igneous differentiation in this anhydrous system without detectable crustal contamination has no effect on Mo isotope compositions, in line with previous observations from Icelandic lavas. Archean komatiites so far serve as the best estimate of the δ98Mo of Archean primitive mantle, but these have been affected by variable degrees of crustal contaminations. The large degree of melting of the near-primitive-mantle-like source responsible for Windimurrra magmas allows for an estimation of the Archean primitive mantle δ98Mo value, which is lower than previously estimated.

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Are Precambrian type III and IV kerogens the result of heterotrophic communities?

Shannon A[1], Cox G[1], Jarrett A[2], Blades M[1], Hall P[1], Cassidy E[1], Bishop C[1], Collins A[1]
[1]The University Of Adelaide, [2]Geoscience Australia

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I have recently completed my undergraduate degree of Bachelor of science (Mineral Geoscience) from the University of Adelaide. I am currently an honours student at the University of Adelaide where I use nitrogen and carbon isotopes along with trace element chemistry applied to Precambrian shales to constrain the redox structure of Proterozoic oceans and contribute to the understanding of the rise of atmospheric oxygen.

The Roper Group of the McArthur Basin, northern Australia, is one of the most extensive Proterozoic hydrocarbon-bearing basins preserved in the geological record. It is interpreted to have been deposited in a large redox stratified epicontinental sea known as the Roper Seaway. Inorganic geochemistry of shales from the lower Roper Group, in combination with mineralogy and previously described eukaryotic assemblages, are consistent with very shallow oxic waters overlying anoxic deep waters.
Analysis of organic matter reveals that lower Roper group source rocks have been hydrocarbon generative, furthermore, most immature shales are characterised as type III and IV kerogens. Type III kerogens are typically associated with terrestrial plant matter while type IV kerogens are thought to be the result of oxidative degradation and recycling of organic matter. As terrestrial plant matter is incompatible with our understanding of the Precambrian biosphere and a redox structure incompatible with extensive oxidative recycling of organic matter, the presence of type III and IV kerogens requires another process in which organic matter can obtain these kerogen characteristics.
While speculative, we investigate whether Precambrian type III and IV kerogens may be the result of extensive heterotrophic recycling of organic matter by bacteria, either in the water column or bottom sediments.

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CO2 storage in the Central Surat Basin: New core data and predicted CO2-water-rock reactions

Pearce J[1,2], La Croix A[1], Dawson G[2], Golding S[2], Underschultz J[1]
[1]*Energy Initiative, University Of Queensland,* [2]*School of Earth and Environmental Sciences, University of Queensland*

TS2 - 3.2.3 Petroleum and its co-products & 3.2.5 Geoscience aspects of the storage of energy related waste, Room R2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Julie Pearce is a research fellow with international experience in the UK, Japan, and Australia on interdisciplinary projects. After accepting a prestigious Fellowship with the Japan Society for the Promotion of Science, Pearce has worked with the CO2CRC and ANLEC R&D to understand the impacts of stored CO2 streams through experimental and geochemical modelling approaches supporting safe CO2 storage. She is currently working on the UQ Surat Deep Basin Aquifer Appraisal project, which seeks to understand the feasibility of large scale CO2 storage in the Surat Basin, QLD, Australia.

The Surat Basin is one of the most prospective basins in Australia for CO2 storage. The Jurassic-aged Precipice Sandstone and Evergreen Formation are currently being appraised for their feasibility as a future CO2 storage reservoir-seal pair. This framework is key for identifying sector-scale detailed model areas. Here we will only discuss the geochemical changes that occur within smaller regions located in the deep central part of the basin – the most likely target scenario for large scale storage into the Precipice Sandstone. Whereas the Northern part of the basin is relatively data rich, and our work has predicted low reactivity of the Lower Precipice Sandstone, with mineral trapping in the “upper Precipice Sandstone” (the transgressive systems tract). The central and south areas have very sparsely distributed data and relatively few drilled wells.
Our analysis focused on drill cores that were collected from the Precipice Sandstone in two relatively deep wells south and north of the Moonie fault, respectively - Moonie 38 and Southwood 1. The “lower Precipice Sandstone” (the lowstand systems tract) is generally very-coarse grained, consists predominantly of quartz, and has visible (high) porosity. The “upper Precipice” contains calcite cemented sections that occlude porosity; with clay and mica laminae. These have the potential to favourably buffer acidic CO2-bearing fluids and encourage lateral migration. The core was characterised for mineral and chemical content and combined with existing well data to build geochemical models to predict local CO2-water-rock reactions and their potential effect on porosity and mineral trapping of CO2.

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Long-lived connection between the North China and North Australia cratons (NCC-NAC) in the supercontinent Nuna: New palaeomagnetic constraints

Wang C[1,2,3], Li Z[1], Peng P[2,3], Pisarevsky S[1], Liu Y[1]
[1]Curtin University, [2]Institute of Geology and Geophysics, Chinese Academy of Sciences, [3]University of Chinese Academy of Sciences

TS2 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Chong Wang, PhD candidate; Zheng-Xiang Li, Professor at Curtin University; Peng Peng, Professor at Chinese Academy of Sciences; Sergei Pisarevsky, senior research fellow at Curtin University; Yebo Liu, PhD candidate at Curtin University

Paleomagnetic studies of mafic dykes in eastern North China Craton (NCC) yielded two new paleomagnetic poles: a 1.68 Ga paleopole at 56.2°N, 257.5°E (A95 = 20.1°) and a 1.62 Ga one at 67.2°N, 200.7°E (A95 = 8.3°). A newly defined 1.7–1.32 Ga apparent polar wander path (APWP) for the NCC is comparable to that of the North Australia Craton (NAC). There are also geological similarities between the 1.7–1.32 Ga Yanliao rift of the NCC and the McArthur basin of the NAC in (i) strata and fossils (sedimentary, unconformities and the presence of eukaryotic microfossils Valeria lophostriata), (ii) magmatism (coeval granites, dolerites, and volcanic events), (iii) styles of ore deposits (manganese and iron), and (iv) petroleum potential (hydrocarbon source rocks). Based on the comparable APWPs and geological histories, we propose a long-lived NCC and NAC connection (NCC-NAC) for the duration of the supercontinent Nuna. However, some minor relative rotation could have occurred between the two blocks due to continental rifting or impact of the Mount Isa orogeny in northern Australia.

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Assessment of interpretation and spatial uncertainty of spatial domains

McManus S[1], Horta A[2], Rahman A[3], Coombes J[4]
[1]School of Environmental Sciences, Charles Sturt University , [2]School of Environmental Sciences, Institute of Land, Water and Society, Charles Sturt University, [3]School of Computing and Mathematics, Charles Sturt University, [4]Coombes Capability

TS5 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Scott is a geoscientist interested in data, data quality and preserving data quality. He has been involved with information geoscience, quality control, resource estimation, and spatial domain interpretation for 25+ years in the mining industry. He has qualifications in Geology, Systems Analysis & Design, Archaeology and Statistics as well as being an RPGEO (Mining and Information Geoscience) and member of the AIG. Currently he is researching methods of assessing uncertainty in spatial domains with the school of environmental science at Charles Sturt University. He resides on the Mid North Coast of NSW and enjoys long walks along the beach.

In the mining industry, code compliant reporting standards for public announcements have been developed setting minimum standards for public reporting of Exploration Results and Mineral Resources. These include an assessment of the quality and confidence in the data and work carried out since public reporting aims to provide information that is Material, Transparent and Competent to investors.

There are four phases required to estimate a Mineral Resource (Preparation, Investigation, Model Creation and Validation), and estimation is highly dependent on the accuracy of the Preparation stage which is a result of the quality of the geological interpretation given for the mineralisation process and current spatial location. This interpretation seeks to spatially define geologically homogenous areas in the resource (spatial domains), corresponding to a single statistical population with a single orientation, where possible. In the estimation workflow, the creation of the spatial domain presents a challenge in terms of assessing the uncertainty in the geological interpretation often due to the manual and subjective interpretation used to guide its creation as well as in spatial domains with several mineralisation overprint events.

The proposed work investigates a hybrid Bayesian method using multivariate quantitative data combined with qualitative data to predict and assess the interpretation uncertainty in the classification of drill hole intervals to a spatial domain and present methods available in current mining software to assess the spatial uncertainty of the 3D ‘wireframe’ or ‘rock type’ model interpretation.

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Descent into the Cryogenian: Secular trends in seawater chemistry offer insights into the South Australian pre-Sturtian paleo-environment

Bishop C[1], Cox G[1], Corkeron M[2], Toerber P[1], Shannon A[1], Farkas J[1], Collins A[1], Halverson G[3], Bruce D[1], Blades M[1]

[1]University of Adelaide, [2]James Cook University , [3]McGill University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

I recently completed my undergraduate degree at the University of Adelaide with a double major in 'Geology' and 'Geophysics and Applied Geology'. I am currently undertaking an Honours year, also at the University of Adelaide, with a focus of study on secular changes in seawater chemistry and associated paleo-environment reconstructions.

The descent into the Cryogenian was a time that displayed marked changes in paleo-environments and global seawater chemistry. In the Australian context, the laterally extensive Skillogalee Formation within the Burra Group of South Australia directly underlies Bolla Bollana Formation glacial diamictite, documenting seawater chemistry in sedimentary carbonates.

This study examines geochemical trends throughout the Skillogalee Formation to further establish the pre-Sturtian paleo-environment and offer insights into early Neoproterozoic oxygenation. The Skillogalee Formation, is a sedimentary succession of magnesites and dolomites interbedded with sands and silts, and hosts both primary and conglomeritic magnesite. Pervasive mud crack structures, most notably preserved in the Gamon Ranges, are prevalent in the lower Skillogalee Formation, evincing an evaporative setting. Isotopically the Skillogalee Formation displays coherent δ13C trends, encompassing the end of the Bitter Springs anomaly. Age constraints on the Bitter Springs anomaly in north-west Canada may suggest a maximum age of ca. 811.5 ± 0.25 Ma for the Skillogalee.

Dominantly positive Ce anomalies suggest a mostly anoxic marine environment, however, negative Ce anomalies, at the very least, evinces active oxidative cycling of Ce. Rare earth elements and ytrrium (REY) curves display enrichment of the HREE's relative to the LREE's, similar to modern seawater. Unlike modern seawater, however, REY displays only minor positive Y/Ho anomalies, proposing a more marginal marine host environment. Positive Eu anomalies suggest a significant hydrothermal influence on seawater chemistry and offers insights towards the uncommonly widespread deposition of primary magnesites within an evaporative system.

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Diminishing effects of magma recharge in the last eruptive cycle (1995-2010AD) of Soufriere Hills Volcano, Montserrat: a 210Pb-226Ra study

McGee L[1], Reagan M[2], Handley H[1], Turner S[1], Berlo K[3], Turner M[1], Barclay J[4], Sparks S[5]

[1]Department of Earth and Planetary Sciences, Macquarie University, [2]Department of Earth and Environmental Sciences, University of Iowa, [3]Department of Earth and Planetary Sciences, McGill University, [4]School of Environmental Science, University of East Anglia, [5]School of Earth Sciences, University of Bristol

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Lucy McGee is a postdoctoral researcher specialising in U-series analyses, mainly in volcanological studies. She has worked in New Zealand and Southern Chile and has an interest in small eruptive centres, the beginning of magmatism and the production of small scale melts, as well as arc magmatism and volcanism. She is also the first year coordinator for the Department of Earth and Planetary Sciences at Macquarie.

Examining the role which gas plays in volcanic systems is vital for understanding the magmatic system prior to eruption. Short-lived isotopes of the uranium series decay chain are ideal for tracing degassing histories at recently active volcanoes as the isotope ^{226}Ra decays to ^{210}Pb (half-life = 22 years) via its intermediary daughter ^{222}Rn (half-life = 3.8 days), which partitions into the gas phase of magmas. Consequently, excesses of ^{210}Pb relative to ^{226}Ra can constrain the longevity and extent of gas transfer prior to an eruption, while deficits indicate persistent open system degassing of the magma. By analysing age-constrained eruptive material, timescales can be modelled for the duration of degassing or gas build-up prior to eruption.

The 1995-2010 eruption of Soufriere Hills Volcano (SHV) on the island of Montserrat is separated into five distinct phases of activity. Mafic enclaves are a notable feature within andesitic dome material and provide an excellent opportunity to investigate the deeper parts of the magmatic system feeding the eruption. The andesites are almost entirely in equilibrium or have deficits of ^{210}Pb with the deficits becoming more pronounced over time. This suggests that the andesitic reservoirs involved were subject to continuous closed- system degassing over the course of the eruption. The majority of enclaves, however, have excesses of ^{210}Pb, showing recent gas enrichment. The highest ($^{210}Pb/^{226}Ra$) ratios are from enclaves in Phase II, and we suggest that the deeper system was closed to fresh gas influx from Phase III onwards, consistent with monitoring and petrological observations.

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CSG Exploration in Queensland

Wilkinson M[1]
[1]Santos

TS6 - 3.2.2 Energy from coal, Room R2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Mel Wilkinson is an exploration geoscientist with 35 years experience in the petroleum industry. He has worked in numerous onshore Australian basins including the Bowen, Cooper, Surat, Eromanga, Otway and Gunnedah basins, as well as the Timor Sea and Hainan Island, China. He has been working in the CSG industry since 2004 and is currently working for Santos. Mel is also interested in Australian dinosaurs and megafauna.

CSG Exploration in Queensland

Towards the end of the 1990's, the number of conventional petroleum discoveries in the Bowen and Surat basins had diminished to such an extent that Queensland was struggling to maintain a vibrant petroleum sector. From the mid 1990's to early 2000's Coal Seam Gas (CSG) rapidly replaced conventional gas such that it now supplies over 95% of the gas produced in Queensland and constitutes over 99% of the state's remaining gas reserves. CSG supplies both the domestic market in eastern Australia and through the innovative conversion of CSG to LNG, Queensland now supplies gas to the world market.
This revival was enabled by the creation of a number of large multi-national consortiums providing significant investment and technical expertise, with supportive government policy and a pragmatic regulatory framework.
To date, most of the commercial CSG production is derived from two major CSG plays; the Late Permian Bandanna and Baralaba thermogenic coals of the Bowen Basin and the thinner, high permeability coals containing secondary biogenic gas in the Jurassic Walloon Coal Measures of the Surat Basin. Each of these CSG play types has its own set of characteristics which must be understood in order to enable production to occur.
Future exploration will now be driven by the need to understand and develop the more technically challenging CSG resources both within the proven and new CSG play fairways. Unlocking low permeability, deep, under saturated or high CO2 coals is the next challenge for CSG exploration in Queensland.

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Geomechanics: A new approach to targeting structurally controlled mineralisation

McLellan J[1,2]
[1]*Director and Principal, GMEX,* [2]*Adjunt Senior Research Fellow, James Cook University*

TS5 - 3.1.6 New frontiers in ore system research, Hall E2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Dr John McLellan is currently the Managing Director and Principal at GMEX. John's specialties are in structural geology and geomechanics, where he assists mining and exploration companies in target delineation. John was a Senior Research Fellow within the Economic Geology Research Unit, James Cook University for several years and and currently maintains an Adjunct position. He has vast experience in many geological environments and mineral systems and has published more than 50 peer-reviewed articles. John has been the recipient of several awards throughout his career, with the most recent achievement being the AUSIMM Regional Resources Industry Professional of the Year.

Greenfields mineral exploration is a challenging business, and in terranes that are largely covered, this adds complexity to the mineral exploration equation. Remote methods of exploration are routinely employed today in an attempt to reveal the prospectivity value of suitable ground that is undercover, such as geophysical and geochemical techniques. The main problems facing the explorer are a) cost of geophysical, geochemical or seismic surveys; b) where to drill once the geophysics/geochemistry reveals its secrets; and c) how to apply this to structurally controlled mineralisation. If we are targeting structurally controlled mineralisation then surely understanding the structural history and the differentiation of stress and strain during these events are paramount. One extremely effective way to do this is to examine the architecture using geomechanical modelling techniques. Simulation of deformation events using geomechanics during peak periods of mineralisation provides a 'system process' approach to exploration. Geomechanical system models provide an alternative and critical dataset to exploration for structurally controlled mineralisation. This approach provides explorers with another vital tool in assessing exploration ground but also in assisting with the decision-making process of targeted drilling programs. Here, examples are given in both two and three dimensions of geomechanical validation by mineral discovery and covers structurally controlled mineralisation in a variety of terranes and commodities.

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Multiple vent eruptions at monogenetic volcanoes: Waitomokia volcano, Auckland Volcanic Field, New Zealand

Handley H[1], McGee L[1], Németh K[2], Didonna R[1], Griffis R[1], Foote A[1], Turner M[1]
[1]*Department of Earth and Planetary Sciences, Macquarie University,* [2]*Volcanic Risk Solutions, Institute of Agriculture and Environment, Massey University*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Heather Handley is an Australian Research Council Future Fellow and Associate Professor at Macquarie University in Sydney.

Heather's research interests include: (i) the integration of field volcanology and volcano geochemistry, (ii) magma genesis at subduction zones (petrological, mineralogical, geochemical and isotopic perspectives) (iii) timescales of magmatic processes using U-series isotopes and elemental diffusion in volcanic minerals, (iv) behaviour of U-series isotopes during weathering and erosion and the U-series constraints on the formation age of sediments, (v) geochemical investigations into contaminated land and water.

Heather is Co-Founder and President of the Women in Earth and Environmental Sciences Australasia Network (WOMEESA)

Waitomokia volcano (also named Mt Gabriel, Gabriels Hill, and Moerangi), is a basaltic tuff ring and scoria cone complex located in the southern lowlands of the Auckland Volcanic Field (AVF). Extensive quarrying and urban developments have resulted in the near-complete removal of three intra-tuff ring scoria cones, incision of the original tuff ring rim and some degree of infilling of the original crater floor, hindering a full understanding of the formation of the volcano. In this work, historical records are combined with detailed field studies of the remaining pyroclastic deposits to reconstruct the formation and evolution of Waitomokia, with special reference to the nature of explosive magma and groundwater interactions. The proximal sequence of the tuff ring consists of a coarse massive-to-weakly bedded pyroclastic breccia and lapilli tuff that alternates with a well-bedded, cross- and/or dune-bedded tuff. The clast-supported nature of juvenile lapilli layers and the presence of scoriaceous bombs within the tuff ring deposits suggest repeated magma discharge through an open but slurry-laden vent. The irregular and flame-like boundaries of lithic clasts within magmatic bombs indicate that coarse mixing occurred between intruding magma and water-saturated sediments (e.g., peperitic domain). Juvenile scoria fall and spatter deposits within the tuff ring crater provide evidence for a more sustained magmatic phase towards the end of Waitomokia's eruption leading to a scoria cone building phase. Field observations suggest that the tuff ring was formed by volcanic activity at multiple, closely-spaced vents with some aspect of vent migration through time.

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Filling the Southern Ocean circulation gap: insights from the Kerguelen Plateau

Wright N[1,2], Scher H[3], **Seton M**[1], Huck C[4], Duggan B[3]

[1]EarthByte Group, School of Geosciences, [2]ARC Centre of Excellence of Climate Extremes and Research School of Earth Sciences, [3]Department of Earth and Ocean Sciences, University of South Carolina, [4]Department of Ocean and Earth Science, National Oceanography Centre, University of Southampton

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Maria Seton is an ARC Future Fellow in the EarthByte Group, School of Geosciences, University of Sydney. Maria was awarded her PhD from the University of Sydney in 2005, was awarded an Australian Postdoctoral Fellowship in 2009 and a Future fellowship in 2013. In 2014, Maria was awarded the Dorothy Hill Award from the Australian Academy of Sciences.

Deciphering the evolution of mass water circulation around the Eocene-Oligocene transition has important implications in understanding the timing and inception of the Antarctic Circumpolar Current and the transition to Earth's 'icehouse' climate. Previous work has largely focused on reconstructing ocean circulation patterns in the South Atlantic and around the Tasman Gateway, with little work in the Indian Ocean, creating difficulties in explaining similarities in isotope records in the Atlantic and Pacific sectors of the Southern Ocean. To better understand ocean circulation patterns in the Indian Ocean sector of the Southern Ocean, we present a new fossil fish tooth neodymium isotope record (εNd) from the upper Eocene to upper Oligocene sections (36–23 Ma) of ODP Sites 744 and 748 (Kerguelen plateau, Indian Ocean). Reconstructed εNd values from fossil fish teeth are used to trace changes in water masses across ocean basins. The records from Sites 748 and 744 reveal a gradual shift in εNd values from -6.5 to -7.5 in the late Eocene to εNd values between -7.5 and -8.3 by the late Oligocene, consistent with a Circumpolar Deep Water influence at the Kerguelen Plateau. We interpret the shift to less radiogenic values to reflect the increased export of Northern Component Water into the Southern Ocean. In addition, our records show no major change in water mass composition around the Kerguelen Plateau that would accompany an increase in Pacific throughflow related to the opening of Drake Passage, and imply that Pacific throughflow via the Drake Passage occurred by the late Eocene.

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Arumberia banksii: how well can MISS tell time?

Allen H[1], Haines P[1]
[1]*Geological Survey Of Western Australia*

TS3 - 2.1 The origins and development of life & 2.2 Ediacaran and Cambrian Symposium, Room R1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Heidi Allen is a senior geologist at the Geological Survey of Western Australia where she has been employed for the last decade. Heidi works within the Basins and Energy team where she has worked on projects that include regional mapping and targeted stratigraphic revisions. She has worked as a palaeontologist during the remapping of the West Australian portion of the Amadeus and Murraba Basins.

The enigmatic bedding plane feature Arumberia appears as commonly branching, thin filament-like depressions on the soles of flaggy sandstone and siltstone. Historically, Arumberia banksii from the Arumbera Sandstone, Amadeus Basin, was described as the body fossil of an erect cup-like organism. The biogenicity of Arumberia was later questioned after its resemblance to structures produced in flume experiments was noted. Recent literature has regarded Arumberia as a form of Microbially Induced Sedimentary Structure (MISS), albeit several authors noting its apparent time restriction.

Recent fieldwork in the Centralian Superbasin has revealed several new Arumberia localities. A number of differences are apparent when comparing the new material, previously published occurrences and experimentally produced current structures: 1. the tuning fork branching pattern characteristic of outcrop material is absent from experimental current structures, 2. bulbous ends to current-induced flutes are smooth, but similar features are typically textured in outcrop examples 3. pimple-like markings may be present in both experimental current structures and Arumberia, but have a different distribution in each.

As noted by some previous authors, we observe that Arumberia appears to be time-restricted. New occurrences are restricted to strata independently dated as latest Ediacaran–early Cambrian in age. Arumberia is absent from similar facies at lower and higher levels of the stratigraphy, which begs the question — how well can MISS tell time?

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Global sea level fluctuations and uncertainties through a Wilson cycle based on ocean basin volume reconstructions

Wright N[1,2], **Seton M**[1], Williams S[1], Whittaker J[3], Müller D[1]

[1]EarthByte Group, School of Geosciences, [2]ARC Centre of Excellence of Climate Extremes and Research School of Earth Sciences, [3]Institute for Marine and Antarctic Studies

TS5 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Maria Seton is an ARC Future Fellow in the EarthByte Group, School of Geosciences, University of Sydney. Maria was awarded her PhD from the University of Sydney in 2005, was awarded an Australian Postdoctoral Fellowship in 2009 and a Future fellowship in 2013. In 2014, Maria was awarded the Dorothy Hill Award from the Australian Academy of Sciences.

Long-term variations in eustatic sea level in an ice-free world (i.e. most of the Mesozoic and early Cenozoic) are driven by changes in the volume of ocean basins, which in turn is greatly influenced by plate tectonic reconstructions. Previous studies quantifying sea level change based on plate tectonic reconstructions do not consider a number of important elements that contribute to ocean basin volume, such as uncertainties within the plate tectonic model itself and in the reconstruction of large igneous provinces (LIPs) and sediment thickness. Uncertainties in the plate tectonic model result from loss of oceanic crust via subduction and the need for synthetically modelled ocean crust, and the incomplete representation of back-arc basins. In order to improve reconstructions of global sea level on geologic time scales and assess the uncertainty in deriving the volume of ocean basins based on a global plate kinematic model, we investigate the influence of these poorly constrained features (e.g. LIPs, back-arc basins, sediment thickness, spreading asymmetry, passive margins) on ocean basin volume and sea level since 200 Ma. We find that these elements may influence sea level reconstructions by up to ~170 m. We incorporate predictions for these components during times where reconstructed ocean basins are predominantly based on synthetic ocean floor, and find that sea level has changed by ~280 m since the Jurassic, comparable to previous estimates. Such investigations are important for exploring Earth’s evolutionary cycles, and has implications for geodynamic studies (e.g. changes in subduction flux, carbon cycle and heat flow).

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Conservation of deep crustal heat production rates

Alessio K[1], Hand M[1], Kelsey D[1], Williams M[1], Morrissey L[2], Barovich K[1]
[1]The University Of Adelaide, [2]The University of South Australia

TS4 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Kiara Alessio is a postgraduate researcher at the University of Adelaide, specialising in the redistribution of elements and processes involving partial melting of the continental crust.

Partial melting of continental crust is generally considered to produce granitic rocks that have high radiogenic heat production rates when compared to their inferred source regions and average continental crust. If this idea is correct then residual granulite facies rocks, which are the source regions for crustally-derived melt and comprise the residual material left behind after melt loss, should have depleted heat production rates with respect to crustally-derived granites. However, there are cases where residual crustal granulites retain high radiogenic heat production. These examples demonstrate that the deep/lower crust is not necessarily always depleted in radiogenic heat production during partial melt extraction.

In this study, K¬–U–Th measurements were collected from metapelitic compositions in five different metamorphic terranes: Reynolds Range and Mt Stafford in the Arunta Complex in central Australia; Broken Hill in the Curnamona Province in southern Australia; the Ivrea–Verbano Zone in northern Italy and Sierra De Quilmes in north-west Argentina. These data show that crustal heat production rates do not change significantly between subsolidus regions and their suprasolidus equivalents that have undergone extensive fluid-absent partial melting and experienced significant melt loss. The mechanisms behind this conservation of heat producing elements in the crust are further explored by Kelsey et al. and Williams et al. (both this abstract volume). Consequently, basement terranes may retain comparatively elevated concentrations of heat producing elements and therefore be more susceptible to thermo-mechanical reactivation than typically expected.

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A new Hadean-Archean global regime: proto-plates control early Earth's tectonics

Capitanio F[1], Weinberg R[1], Nebel O[1], Clos F[1], Cawood P[1]
[1]*Monash University*

TS4 - 1.1.4 Crustal evolution of Archean Cratons, Hall A, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Researcher in the field of Geodynamics and Tectonics.
His work combines high performance computation and geophysical observations to address key questions of the solid Earth's dynamics: how Plate Tectonics works, how it emerged on our planet, forming the atmosphere, the mountain highs and the ocean lows where life thrived.
His work led to original solutions to issues such as the formation of the Andean Cordillera and the Tibetan Plateau, and the India-Asia convergence.
Awarded the AGU Jason Morgan Early Career Award, in 2012
Australian Research Council Fellow since 2009, APD, DECRA, Future Fellow.
Associate Editor for JGR - Solid Earth

The geodynamic regime of the early Earth and its transition to modern plate tectonics remains poorly constrained. Stagnant lid, involving little, or only episodic, movement of the solid Earth's outer layer (lithosphere) is envisaged as the Archean global regime. This does not reconcile with the geological record of large lithosphere mobility, shortening and subduction-like environments, since the Hadean. Here, we propose a new regime for the Hadean-Archean Earth, which involved progressive dehydrating and strengthening of large portions of the lithospheric lid, growing into proto-plates. These enabled stress propagation to be focussed at their margins, which were then the locus for shortening, recycling and thickening to form adjoining proto-cratons. Development of these domains of proto-plates and cratons triggered geochemical and petrological differentiation of mantle, and heralded the formation of continental and oceanic lithospheres. We test this hypothesis embedding lithospheric dehydration stiffening during melting in thermo-mechanical models of mantle convection, under conditions that prevailed in the Archean. The models demonstrate the emergence of a migrating rigid proto-plate in which regions of focused compression overlap with remnants of the stagnant lid, thereby reproducing the widespread dichotomy documented in the Archean tectonics record. Models' crustal growth and reworking rates are remarkably similar to those inferred in the Hadean-Archean, explaining crustal formation, preservation and recycling, prior to subduction. This lid-and-plate regime likely onsets in the Hadean (> 4 Ga) lasting until 2.8 ± 0.15 Ga, thus questioning the viability of the Stagnant lid on Earth.

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Gender equity network at Geoscience Australia

Poudjom Djomani Y[1]
[1]*Geoscience Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Yvette Poudjom Djomani is a geophysicist with over 25 years of experience. She is passionate about STEM, gender equity and diversity. Yvette is the chair of the Gender Equity Network at Geoscience Australia (GENGA), a network which aims to influence cultural and organizational change towards the pursuit of gender equity and equality.
Yvette holds a number of qualifications including a Doctor of Philosophy in geophysics from the University of Paris XI and a MBA from the Australian Institute of Business (Adelaide).
In her limited spare time, Yvette keeps busy raising three beautiful children.

The Gender Equity Network at Geoscience Australia (GENGA) is a grass-roots initiative aiming to influence cultural and organisational change towards the pursuit of gender equality and equity. The network was originally formed in 2014 as a women's support group, but evolved into GENGA in 2016 to better reflect and support GA's Inclusive Culture vision to 'create an inclusive workplace that ensures everyone has equal opportunity to contribute, participate and progress'.
Workforce data clearly demonstrates a gender imbalance within GA, with a split of 63% men and 37% women overall. In particular, there are very few women represented in senior management positions, with only ~24% of senior level staff (EL2 and above) being female. While this trend is not unusual in science organisations, GENGA is working to level the playing field and ensure that there are equal opportunities for every employee, irrespective of gender, sexuality or any other personal attribute.
The objectives of the network are to:

1. Raise awareness and promotion of gender equity and equality;
2. Promote and facilitate a community for sharing ideas, experiences, and interests;
3. Develop and maintain stakeholder relationships;
4. Facilitate networking, social and professional development opportunities;
5. Celebrate the contribution of women in GA to science and the Australian Public Service.

Through events, forums and training, GENGA seeks to provide a sense of compassion, care, empowerment and respect through supporting GA employees of all genders with their own development, as well as providing a forum to promote all causes supporting staff and their families.

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Distribution and mineralogical association of Au at the Kanmantoo Cu-Au deposit

Booth M[1], Lilly R[1], Rolley P[2]
[1]University Of Adelaide, [2]Hillgrove Resources, Kanmantoo operation

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

The Kanmantoo Cu-Au mine, operated by Hillgrove resources, has had an extended history of production since the 1800s. The deposit is situated within a complex system of shear zones on the axial plane of a synform. There is little consensus on the paragenesis and structural controls of the Kanmantoo Cu-Au deposit, with models varying from a meta-exhalative syngenetic seafloor feeder system to an epigenetic metamorphic and intrusive-related origin.
Mineralisation is hosted within the Kanmantoo group, a 7-8 km thick series of sedimentary rocks, locally metamorphosed to amphibolite facies and deposited under seismically active conditions. The Kanmantoo group has long been considered to represent a shift in depositional history within the Adelaide fold belt.
No empirical work has been completed specifically on Au mineralogy or paragenesis within the Kanmantoo deposit. This study aims to increase understanding on the mineralogical association and spatial distribution within the ore system. Results will be compared to data from other Au deposits within the Adelaide fold belt to determine whether Au distribution at Kanmantoo is representative of Au mineralisation on a district scale.
Drill core samples have been collected from the various ore lodes within Kanmantoo Cu-Au mine, and optical petrology, secondary electron microscopy- mineral liberation analysis (SEM – MLA) and Mineral Insights 'gold sniffer' have been completed to identify free Au grains. Laser ablation (ICP-MS) analysis will also be completed to determine trace element composition of samples and identify relationships between Au bearing minerals, sulphide minerals and host rock.

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Geophysical data in South Australia

Heath P[1], Katona L[1]
[1]Geological Survey of South Australia

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Philip Heath is senior geophysicist with the Geological Survey of South Australia, where he has worked for the previous 10 years. Prior to this he worked as a processor and operator with Canadian Micro Gravity. He was awarded his doctorate from the University of Adelaide in 2007.

South Australia is a region which has proved rich with mineral wealth. Despite the challenge of a layer of regolith covering much of the state, a rich history of geophysical data acquisition for mineral exploration has helped locate many mineral deposits. From gravimetric experiments in the 1940s, the beginning of airborne magnetic surveying in the 1950s and radiometric surveying in the 1970s, the emergence of airborne electromagnetic technology in the 1980s to the beginnings of airborne gravimetry in the early 2000s, I highlight a small sample of the wealth of information that is available for exploration decision making in SA.

The South Australian government has been a world leader in regional-scale acquisition programmes to provide geophysical data to exploration companies statewide. The SAEi (South Australian Exploration initiative), TEiSA (Targeted Exploration initiative South Australia), and PACE (Plan for Accelerated Exploration) programmes helped boost exploration in the state, and as PACE ends with the largest ever airborne acquisition programme – the Gawler Craton Airborne Survey – we're seeing trends in the exploration sector that may lead to the discoveries of the future.

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Compositional Variation of Tuff Marker Beds at the Mount Isa and George Fisher Deposits; Implications for Origin and Mineralisation

Redden G[1], Lilly R[1], Taylor D[2]

[1]1. A.W.E.S.O.M.E.S Department of Earth Sciences, The University Of Adelaide, [2]Mount Isa Mines

Biography:

Currently completing honours (geology) at The University of Adelaide with a project working with Mount Isa Mines Copper Operation (MICO) and George Fisher Mines (GFM). Summer vacation work at MICO, enabled collection of Tuff Marker Bed (TMB) samples from different areas within the ore systems. The project questions the TMB paradigm, and the origin of potassium enrichment at MICO and GFM. Upon completion of the project I will be joining the MICO geology team as a graduate mine geologist.

Mount Isa and George Fisher mines are located within the Proterozoic Mount Isa Inlier, North West Queensland. World-class resources of Cu, Pb and Zn are hosted within the carbonaceous Urquhart Shale (1655 Ma). Texturally different ores within close proximity has driven decades of research and numerous models based around syngenetic or epigenetic origin. For half a century, cherty beds with cross-fractures and a highly potassic composition have been relied upon for constraining sequence stratigraphy, understanding the tectonic evolution of the Mount Isa Inlier and ore genesis. These distinctive layers were identified as Tuffaceous Marker Beds (TMBs) at Mount Isa Mines by Croxford (1964). TMB's provide the only indication of proximal volcanism associated with sedimentation, which is a line of evidence used to support a syngenetic sedimentary exhalative model of ore formation.
However, significant lateral variability exists, and TMB horizons can be compositionally and visibly unrecognisable over scales of cm to km. This project questions the TMB paradigm, and the origin of potassium enrichment in the Urquhart Shale at Mount Isa and George Fisher. Initial optical and SEM-MLA petrography has identified potassic enrichment distal to TMBs as well as accessory apatite and rutile, suggesting a more complex history of hydrothermal alteration than previously thought. Minalyzer XRF data of drill core samples was obtained to quantify potassium enrichment within TMBs and adjacent sedimentary layers. LA-ICP MS will be used to further investigate compositional variation across TMBs and to date accessory minerals, establishing geological constraints on TMB and ore formation.

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Recognition of Pan-African-aged metamorphism in the Fisher Terrane, central Prince Charles Mountains, eastern Antarctica

De Vries Van Leeuwen A[1]
[1]*University of South Australia*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
PhD Candidate at the University of South Australia with interests in metamorphic petrology, geochronology, tectonics and crustal heat production.
The focus of my PhD is to further understand the importance of crustal heat production as a driving force for metamorphism.

The Fisher Terrane, located in the central region of the Prince Charles Mountains, east Antarctica, evolved during the Mesoproterozoic as a volcanic arc system. U–Pb detrital zircon geochronology reveals that metasedimentary rocks from within a metasedimentary–metavolcanic package outcropping at Fisher Massif were deposited after c. 1300 Ma, and contain detritus derived from the Rayner–Eastern Ghats region. This suggests that the Fisher Terrane was not an isolated oceanic arc but rather formed on the same tectonic plate as the Rayner Complex. Metapelitic schists from within the same metasedimentary package yield metamorphic U–Pb monazite ages of c. 530–505 Ma, corresponding to the regionally recognised Neoproterozoic to Early Cambrian Pan-African Event. This event has not been previously recognised in the Fisher Terrane, and demonstrates that Pan-African-aged metamorphism affected all parts of the Prince Charles Mountains. Calculated phase equilibria modelling constrains the metamorphic conditions during this event to 2.5–4.0 kbar and 550–615 °C, corresponding to apparent thermal gradients of 146–220 °C/kbar. Such conditions are plausibly related to metamorphism taking place in an extensional back-arc setting that was subsequently inverted and thickened via continental collision during Gondwana amalgamation.

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Online opals, mobile meteorites, and virtual visits: using Google Arts&Culture to share Geoscience Australia’s collections with the world

Falster G[1], Petkovski S[1], Schroeder N[1]
[1]*Geoscience Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Georgy completed her undergraduate studies in geology at the University of Adelaide, where her Honours research was focused on sedimentology and carbonate isotope geochemistry. She worked for Santos Ltd for two years before returning to university to undertake a PhD with Dr Jonathan Tyler, using several geochemical methods to reconstruct past climate change in southern Australia. She is currently a participant in the Geoscience Australia graduate program, where she is undertaking a rotation in the Collections and Visitor Services team.

Geoscience Australia (GA) houses a world-class array of mineral, meteorite, and fossil specimens within the National Mineral and Fossil Collection. Numerous fascinating specimens are on display in the foyer at GA, alongside historical maps and geoscientific equipment. The collection also contains specimens that are fragile or highly valuable, and therefore not suitable for public display. Many of the specimens have great scientific, historic, and aesthetic value, but the physical collection is not easily accessible to the majority of the Australian population.

Since 2016, collaboration with the Google Cultural Institute has enabled GA to showcase some of our rare and valuable specimens, on the Google Arts and Culture (A & C) platform. Examples of our current digital exhibitions include ‘Gems from the Safe’ – featuring some of our most rare and valuable specimens, that were previously not visible to the public – and ‘Australian Opals’, which showcases GA’s spectacular collection of Australia’s national gemstone. We have also recently augmented the Google A & C exhibitions with Google’s ‘walk-through’ feature, which uses the Streetview technology to allow users to view the foyer display from anywhere in the world.

These digital displays are an important step forward in reaching a much wider audience, and take advantage of new technology to help keep GA’s rich geoscience heritage in the spotlight.

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Creation of 3-D geological model on a geographical information system (GIS) platform

Ng P[1]
[1]*John Holland*

Biography:
Peter is a geotechnical engineer with both contracting and consulting experience. He has gained invaluable site and design experiences initially in Hong Kong and subsequently in Melbourne on the International Tunnelling award- winning projects including Northern Sewerage Project (NSP) and the Melbourne Main Sewerage Replacement Project (MMSR).
In 2017, Peter was employed in the mega-tunnel project -West Gate Tunnel Project as a contractor designer's site supervisor role where he involved in technical, engineering, geotechnical, inspection and quality assurance of the project.

A Geographic Information System (GIS) is a powerful tool to lets us visualize, analyze, and interpret spatial data to understand its relationships, patterns, and geological features. My research aims to explore the use of GIS to build up a representative geological model from site investigation and field data and provides an easy channel for regular updating of the geological model based on actual field observations and mapping during construction.
The purpose of this paper is to discuss the GIS application in building up of a Three-Dimensional (3D) Geological Model based on a critical analysis of geological information collected in a tunnel and a foundation project. This includes the creation of different geological models and compares the ground models created during the Ground Investigation and Construction stage.
Through the versatility of sophisticated GIS software, it is easy to visualize the 3D relationship of various geological strata. In turn, geologists can make educated guesses and interpretation of some complicated geological feature. The engineering and construction team can then visualize the potential problematic geological areas to incorporate measures to tackle them during construction and in the long term.
It is concluded that ground model is highly dependent on the quality of the available data and any conclusions drawn from it must be based on prior interpretative analyses conducted on the data available from the desk study and Ground Investigation (GI) stage.

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Proxies of the supercontinent cycle and the case for Pannotia

Nance R[1], Murphy J[2]
[1]Ohio University, [2]St. Francis Xavier University

TS1 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Damian Nance is Distinguished Professor of Geological Sciences at Ohio University. A native of Cornwall, he completed his PhD at Cambridge in 1978. In 1982, Nance and fellow department member, Tom Worsley, proposed the supercontinent cycle, a concept he and research colleague, Brendan Murphy, have since developed using the peri-Gondwanan terranes of the circum-Atlantic. Nance has also examined the Pleistocene glacial and neotectonic record of Mt. Olympus, Greece, and is an authority on 19th century Cornish mining history. He is editor of Lithosphere, past-editor of GSA Today and serves on the editorial boards of Gondwana Research and Geoscience Frontiers.

Disagreement about the existence of the late Neoproterozoic supercontinent Pannotia highlights the limitation of defining supercontinents simply on the basis of size, which, for pre-Pangaean supercontinents, is difficult to determine. In the context of the supercontinent cycle, however, supercontinent assembly and break-up, respectively, mark the end of one cycle and the beginning of the next and can recognized by the tectonic, climatic and biogeochemical trends that accompany them. Hence supercontinents need only be large enough to influence mantle circulation in such a way as to enable the cycle to repeat. Their recognition need not rely solely on continental reconstructions, but can also exploit a variety of secular trends that accompany their amalgamation and break-up. Although the palaeogeographical and age constraints for the existence of Pannotia remain equivocal, the proxy signals of supercontinent assembly and break-up in the late Neoproterozoic are unmistakable. These signals cannot be readily attributed to either the break-up of Rodinia or the assembly of Gondwana without ignoring either the assembly phase of Pan-African orogenesis and the changes in mantle circulation that accompany this phase, or the reality that Gondwana cannot be a supercontinent in the context of the supercontinent cycle because its break-up coincides with that of Pangaea.

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The Helium and Hydrogen potential of the Amadeus Basin

Cassidy E[1], Gusterhuber J[2], Menpes S[2]
[1]The University Of Adelaide, [2]Santos

TS2 - 3.2.3 Petroleum and its co-products & 3.2.5 Geoscience aspects of the storage of energy related waste, Room R2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Eilidh is an Honours student at The University of Adelaide. Over the summer of 2017-18, Eilidh worked as a vacation student at Santos, focussing on a hydrogen and helium study for the Onshore Northern Territory Exploration team. This talk will present the results of that work.

The Amadeus Basin preserves some of the highest helium concentrations ever recorded in any sedimentary basin. The Mt Kitty-1 and Magee-1 petroleum exploration wells recorded helium concentrations of 8.96% and 6.27%, respectively. These two wells are also the only two wells in the basin to penetrate the Heavitree Formation and basement beneath evaporites of the Gillen Formation.

Understanding the generation, migration and entrapment of the helium has been and still remains a challenge. In this presentation we identify and correlate global analogues of the Amadeus helium and hydrogen play to better understand these processes.

Helium isotopes studies suggest a crustal origin for the helium in the Mt Kitty-1 well. This suggests that the source of the helium is long term release of radiogenic 4He from uranium and thorium bearing minerals within the fractured granitic basement. Helium migration is thought to have occurred in two stages. Phase 1 is dependent on the mass ratio of solid to fluid, which governs the fluids ability to provide a suitable sink for any noble gas. The preferential movement from solid to fluid phase will continue until equilibrium is achieved. Carrier gases (nitrogen and methane) are critical for Phase 2 migration from the granite source rock. Due its small size and chemically inert properties, trapping helium can be difficult. The Gillen Formation evaporites in the Amadeus Basin play an important role in trapping and preserving significant and unique helium gas concentrations.

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Getica CCS Demo Project

Anghel S[1]
[1]GeoEcoMar

Biography:

Senior scientific researcher

Gravity / Magnetic data processing & interpretation
Gravity / Magnetic data results interpretation: gravity / magnetic maps for archaeologigical investigation (Geosoft Oasis Montaj™,
Integrated interpretation of gravity & magnetic maps aiming to enhance deep / near-surface knowledge on the investigated area;
Hydrographic Surveys-lacustrine single-beam bathymetric surveys - Ceeducer Pro
Marine geophysical exploration
Geophysical monitoring technology for CO2 sequestration
Contribution to the evaluation of possible CO2 storage sites in Romania
Contribution to the dissemination of CCS knowledge in Romania
Contribution to the preparation of the first CCS project in Romania

Getica CCS is a government-initiated demonstration project, officially supported and coordinated by the Ministry of Economy.Environment and endorsed by the Global CCS Institute from Australia.
Location: Oltenia region(TURCENI Energy Complex) - the most energy intensive region at national level, responsible for about 40% (24.5Mtpa* CO) of the total amount of CO emissions at national level.
Getica CCS Demo Project is an integrated CCS project, comprising the full chain: capture, transport and storage of CO2.The selection of potential CO2 storage sites was made based on all the data that were made available by oil and gas companies, comprising 241 2D seimic lines and 141 well information packages, geological cross-sections, geological and geophysical maps and data from literature. The selection was made by considering an investigation area of 50 km radius around Turceni.The analysis of the available data concluded that the best solution for storage would be the Sarmatian formation.The interpretation of seismic lines and of the well logs, combined with the information extracted from cores and outcrops, lead to the selection of 7 potential storage sites.A more detailed analysis of the collected data conducted after the preliminary selection of 7 sites concluded that the best suitable storage sites are Zone 5 and Zone 1. For these sites the selected storage solution is deep saline aquifer. The static and dynamic modelling performed for each of the sites lead to a first characterization of their associated storage complexes to be completed and finalized during the Appraisal.

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Trace element signatures in the Noril'sk-Talnakh deposits as possible indicators for magmatic sulphide prospectivity

Schoneveld L[1], Barnes S[1]
[1]*CSIRO*

TS8 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Louise graduated with honours from James Cook University in Townsville then, received her Ph.D. from the Australian National University in 2018. She has studied trace element partitioning in experimental samples and the trace element compositions of silicate and oxide minerals in ore deposits via laser ablation ICP-MS. She is currently a postdoctoral fellow at CSIRO in Perth, where she is working on using trace element signatures to indicate prospectivity for magmatic sulphide deposits while also operating the laser ablation ICP-MS.

The Noril'sk-Talnakh deposits are a super-giant Cu, Ni and platinum group element (PGE) resource located in the north-western corner of the Siberian platform. This prime example of magmatic sulphide mineralisation represents an ideal case study for large resources of this type. Australia's share of the world wide Ni resource was 23% in 2014; however, it is thought that Australia remains highly prospective for magmatic sulphide deposits under cover.

Trace element signatures in silicate and oxide phases are being studied by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) to identify mineralogical and geochemical signatures that can serve as proximity indicators for deposits of this style. The clinopyroxene in Noril'sk-Talnakh are highly zoned oikocrysts, usually with chromium and aluminium rich cores which reduces towards the rims. This change is mirrored by inverse changes in rare earth elements (REEs) and titanium, which are concentrated in the rims. This chemical zonation has been mapped on the XFM beamline at the Australian Synchrotron, allowing fine scale zonation to be imaged in multiple grains on the scale of entire thin sections. Accessory chromite in the host intrusions has two chemical populations: those enclosed within clinopyroxene are iron poor, while those associated with sulphide or interstitial to the crystals are much richer in iron and Ti. The most Ti-enriched silicate phases are associated with segregation vesicles containing other Ti-rich phases such as rutile.

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Volcanological Characterization of the mount Bambouto caldera (Cameroon Volcanic Line, Central Africa)

Zangmo Tefogoum G[1], Nkouathio D[2], Kagou Dongmo A[2], Gountié Dedzo M[1]
[1]University Of Maroua, [2]University Of Dschang

Biography:
Ghislain ZANGMO TEFOGOUM has been Research and Teaching Assistant in the University of Dschang from Mach 2010 to February 2012. From March 2012 to date he is teaching in the University of Maroua where he became in May 2017 Senior Lecturer in the Department of Earth Sciences. He obtained the Ph.D degree in Earth Sciences at the University of Dschang in December 2016. During the 9th International Conference on Geomorphology held in New Delhi in November 2018, he has been co-opted as member of the Executive Committee of IAG. His research is focused in the Applied Volcanology and Geotourism.

The mount Bambouto is a polygenetic stratovolcano of the Cameroon Volcanic Line; situated at about 200 km North-East of mount Cameroon. It presents a lager elliptical caldera (16 km x 8 km) at the summit. This caldera is opened to the Western part of the volcano and culminates at 2743 m (mount Meletan) which is the climax of the whole volcano. The Bambouto volcano evolution took a broad period of time precisely from over 19 to 0.5 Myr including the caldera collapse. This phenomenon has been ruled by several tectonic and volcanic processes. The Mount Bambouto Caldera (MBC) floor appears much dissected by a stairs-like morphology ruled by several lineaments. The petrographic data recorded show that the MBC is made up of tuffs and ignimbrites, trachytes, mugearites, basalts and phonolites. In this work, a comparative approach between geomorphological, structural, dynamical, petrographical and geochronological data of the MBC and those of other calderas characterized by some authors notably Wood (1984), Vincent (1994), Lipman (2000), Cole (2005)… led us to characterize the MBC. It results that, the MBC is an ignimbrite type collapse caldera built by blowing up at the beginning following by the intravolcanic piecemeal collapse. Moreover, using the classification criteria of the Collapse Caldera Data Base (Geyer and Martí, 2008) the tectonic setting of the MBC is extensional continental rifting. Moreover, it is S and MS type caldera.

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The Mount Isa Cu-Pb-Zn interface – Syngenetic, Epigenetic, or both?

Cave B[1], Lilly R[1]
[1]*University Of Adelaide*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I am a first year Phd student researching the formation of giant Cu-Pb-Zn deposits. I completed my Honours (First class) at The University of Adelaide on the Ernest Henry IOCG deposit, of which involved geochronology and the trace element analysis of apatite. My future research will focus on the George Fisher Pb-Zn (Ag) deposit, and Cu-Pb-Zn deposits in the Yunnan province, China.

The Mount Isa system is a globally significant resource of Cu, Pb and Zn. Pb-Zn (Ag) mineralization is strata-bound, consisting of sphalerite and galena. Cu mineralization occurs as chalcopyrite, and is hosted in a non-conformable silica-dolomite breccia, often spatially below Pb-Zn mineralization. Pb-Zn and Cu orebodies commonly inter-finger each another, but rarely overlap.
The origin and style of mineralization at Mount Isa is still heavily debated. Some authors suggest Cu and Pb-Zn mineralization occurred synchronously in an epigenetic zoned carbonate replacement system. Others suggest that the Cu-Pb-Zn is syngenetic, forming in a SEDEX style environment with Cu-mineralization representing the feeder pipe. A third, and widely accepted model suggests the Pb-Zn deposit is syngenetic, whilst Cu-mineralization is epigenetic, and unrelated to earlier Pb-Zn mineralization.
Despite the enormous amount of research into the deposit, there has been little direct investigation into the interface between Cu and Pb-Zn mineralization. This study will examine the interface between Cu and Pb-Zn mineralization on multiple levels of the deposit. A detailed petrographic study will examine any changes in the textures of sulphide and gauge minerals (including monazite, apatite and rutile) across the interface. This will be accompanied by a geochemical examination of these minerals, MLA mapping, and multiple mineral geochronology. Differences in textures, ages and trace element geochemistry in the minerals across the interface will be used to assess the conditions they formed in, and help answer the question: “is Cu and Pb-Zn mineralization syngenetic, epigenetic or both?

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The Ernest Henry Inter-lens. Geology, apatite geochronology and trace element analysis; Implications for a reviewed deposit model.

Cave B[1], Lilly R[1], Glorie S[2], Gillespie J[2]

[1]Academics With Exploration; Studies Of Mount Isa and the Eastern Succession (A.W.E.S.O.M.E.S), Department of Earth Sciences, The University of Adelaide, SA, 5005, Australia , [2]Centre for Tectonics, Resources and Exploration (TRaX), Department of Earth Sciences, School of Physical Sciences, The University of Adelaide, Adelaide SA-5005, Australia

TS2 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

I am a first year Phd student researching the formation of giant Cu-Pb-Zn deposits. I completed my Honours (First class) at The University of Adelaide on the Ernest Henry IOCG deposit, of which involved geochronology and the trace element analysis of apatite (this presentation). My future research will focus on the George Fisher Pb-Zn (Ag) deposit, and Cu-Pb-Zn deposits in the Yunnan province, China.

The Ernest Henry IOCG deposit is the largest known Cu-Au deposit in the Eastern Succession of the Proterozoic Mount Isa Inlier, NW Queensland. Cu-Au mineralization is hosted by a K-feldspar altered breccia, bound by two pre-mineralization shear zones. Previous research suggests Cu-Au mineralization and the ore-bearing breccia formed simultaneously through a single explosive/implosive event, facilitated by the mixing of fluids at ~1530 Ma. However, the preservation of a highly deformed, weakly mineralized, pre-mineralization structure (the Inter-lens) within the orebody indicates this model must be reviewed.

The paragenesis of the Inter-lens consists of albitization; apatite-garnet-calcite-quartz veining/alteration; biotite-magnetite alteration; K-feldspar-hornblende alteration; Ore-stage mineralization and post-mineralization alteration.

Apatite from apatite-garnet-calcite-quartz veining/alteration produce U–Pb ages of 1584 ± 22 Ma and 1587 ± 22 Ma, suggesting the formation of apatite, and the maximum age of the Inter-lens is synchronous with D2 deformation of the Isan Orogeny and regional peak-metamorphic conditions.

Metasomatized apatite reveals; (1) a depletion in REEs evenly, corresponding with an enrichment in As; (2) a preferential LREE depletion. This reflects the presence of multiple fluids, or a temporal/spatial difference in the pH of a single fluid.

The deposit experienced at least two hydrothermal events, with the first event related to metamorphism (~1585 Ma) and a subsequent event related to the emplacement of the nearby (~1530 Ma) Williams-Naraku Batholith. Brecciation resulted from competency contrasts between ductile meta-sedimentary rocks of the Inter-lens and surrounding shear zones against brittle meta-volcanic rocks comprising the ore-bearing breccia, providing a permeable pathway for ore-bearing fluids.

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Deep sea minerals on the Norwegian Continental Shelf, North Atlantic - preliminary results of the manganese crusts

Bering D[1], Gilje S[1], Brekke H[1], Sandstå N[1], Stenløkk J[1]
[1]*Norwegian Petroleum Directorate*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dag Henry Bering, cand. real., is educated as a structural geologist at University of Bergen, Norway. He has experience as a researcher at the same place. For the last 28 year he has had various positions at the Norwegian Petroleum Directorate, i.e.section leader, geoscience co-ordinator, and is now project leader for the directorates work related to mapping and evaluation of sea bed minerals on the Norwegian Continental Shelf

Seabed minerals have been known to exist in the deep parts of the Norwegian Sea, due to long term research by the University of Bergen (UiB). A number of sulphide deposits are detected along the Mohns Ridge, both as active smokers and as extinct gravel pits. Manganese crusts are found over large areas in the deep part of the Norwegian Sea. In a long-term research partnership with UiB, the Norwegian Petroleum Directorate (NPD) has mapped and sampled these deposits, and analyses of manganese crusts will be presented.

Chemical analyses of the crusts reveal an interesting difference compared with other deposits from the Atlantic and the Pacific. The manganese crusts in the Norwegian Sea fall in two groups in terms of their lanthanide content. While one group has twice the amount found in Pacific and other Atlantic, the other group has less. Both groups contain substantially higher concentrations of lithium and scandium. The chemistry conforms in general with a hydrogenetic origin, even though the high lithium content may indicate some hydrothermal influence. The high lanthanide group, has a greater proportion of yttrium, and is richer in the whole series of REEs. Now one should investigate what causes of these chemical characteristics, and how this knowledge can be used for continued mapping of the quality and extent of the resources. Similar studies are also needed for the sulphide deposits, which will include testing methods for the various types of data and sampling techniques required.

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Relevance of engineering geological models in modern tunnel design and construction

NASH T[1], Estrada B[1]
[1]*Pells Sullivan Meynink*

TS6 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Tim graduated from the University of Canterbury in 2003 with a bachelor degree in geology and a masters degree in engineering geology. In 2004, Tim started his career as a consulting Engineering geologist working on the Lane Cove Tunnel project. In 2006, Tim worked for five years on mining civil infrastructure projects in Western Australia before returning to Sydney in 2011 where he has since worked on major tunnels, road and rail infrastructure projects as a Principal Engineering Geologist.

It has long been recognised in the field of mined and driven tunnel design that the engineering geological model is fundamental in recognising the likely ground conditions that would be encountered along the alignment. Likewise in construction of mined tunnels in particular, validation of the engineering geological model and therefore design assumptions as tunnelling progresses has hitherto formed a significant component of fit-for-purpose tunnel design.

While recent advances in technology including numerical modelling and 3D analyses allow a more rapid assessment of the engineering behaviour and design of tunnel openings, is the engineering geological model still a fundamental component of tunnel design? This paper sights a recent tunnel project in soft Triassic shales and sandstones in Sydney to demonstrate the relevance of the engineering geological model in modern tunnel design and construction.

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Observation of basement proxies for mineral provinces in the Gawler Craton aided by satellite gravity data interpretation

Motta J[1], Betts P[2], de Souza Filho C[1], Armit R[2], Curtis S[3], Thiel S[3]
[1]Institute of Geosciences, University of Campinas (UNICAMP), [2]School of Earth, Atmosphere and Environment, Monash University, [3]Geological Survey of South Australia - Department for State Development

TS7 - 3.1.2 Making better exploration decisions through an integrated geoscience approach & 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
João Motta has a BSc degree in Geology (2011) and a Master degree (2015) by the State University of São Paulo (UNESP, Brazil).
He is currently a PhD candidate at the University of Campinas (Brazil) working on the application of long wavelength satellite-only Earth Gravity Models into the mineral systems research and exploration.
His research focus is the integrative application of geophysical methods for building robust geological models of the lithosphere, specifically the deep crust, to constrain the location of major mineral deposit districts. That was motivated by an early career in the metals exploration industry.

Mineral deposits result from multiple overlapping planetary-scale processes. Geophysical data acquired at the global scale assists our understanding of their formation. Satellite gravity data-sets image the deep crustal architecture in an unprecedented way. In this context, we examine satellite-derived Earth gravity models to map variations in density throughout the Iron Oxide-Copper-Gold (IOCG) Olympic and Central Gawler Gold provinces of the Gawler Craton. Through integrated analysis of the regional gravity response with magnetics, seismic, magnetotellurics data, we interpret the deep crustal architecture of the craton and establish its relationship to the mineral provinces.
Combined interpretation of the gravity information and low-pass filtered magnetic data shows a series of regional-scale discontinuities in the craton, which bound three distinct crustal blocks. Seismic information corroborates the existence of the major boundaries. A 3D resistivity model shows that the interpreted discontinuities control the resistivity structure, with IOCG deposits concentrated over regions of decreased resistivity, and Gold-only deposits over regions of higher resistivity. Sm-Nd model and zircon crystallisation ages support the interpreted density framework as the three crustal blocks which have slightly different isotopic evolutions, and deposits occur near boundaries between more evolved and more juvenile crust. Fractal dimension analysis of the location of mineral deposits also suggests that both mineral provinces share a structural framework.
These findings reveal that satellite gravity can reveal deep-level structures that potentially acted as regional fluid pathways in continuum IOCG-Gold only mineral systems. Such information may be used in predictive models for continent-scale mineral prospectivity.

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Structural and Sequence Stratigrahic Analyses of Olawah field, Niger Delta, Nigeria.

Ogunfolabo T[1]
[1]*Federal University Of Technology*

Biography:
I am Geophysicst with proven skills in this direction. I graduated from University of Ilorin (Geology), Federal University of Technology, Akure (Mtech. Petroleum Geophysics), IWCF (Level 1), Prince2 (associate) and datbase administrator.

Stratigraphic and structural analyses of Orlawah field, Niger Delta were carried out with the aim of evaluating the hydrocarbon potential of the field. A suite of wireline logs and 3D seismic data were quality controlled and processed. Computation of petrophysical properties of reservoir units identified from log data (i.e porosity, permeability and volume of shale) from well-established equations was executed. Lithologic interpretation and hydrocarbon reservoir identification were carried out using gamma ray and resistivity log responses. Log sequence evaluation was done by the analysis of log amplitude and stacking patterns of facies succession. Identification and mapping of network of eleven faults from seismic sections using seismic attributes such as amplitude, reflection geometry and frequency were carried out. The internal reflection configuration of the sequences were studied using physical properties of the seismic events; reflection geometry, continuity, amplitude and frequency to establish the genetic relationship of seismic lithofacies and general stratigraphic architecture influencing reservoir properties in the area of study. Lithostratigraphic and chronostratigraphic correlations were done using the principle of similarities in log responses and rock boundaries. This utilized key stratigraphic surfaces; maximum flooding surface and sequence boundaries in the subdivision of subsurface rock units into depositional sequences. Seismic sequence analysis using reflection termination patterns which are erosional truncation, toplap, onlap and downlap were used for the identification and mapping of the depositional sequences.

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An Elemental Analysis of Musgrave Province Pseudotachylite Breccia Melt vs. Wall Rock

Connelly D[1], Sikder A[2], Hill T[3], Brum [4], Liu X[2]

[1]MAPCIS Research, [2]Center for Environmental Studies (CES), Virginia Commonwealth University , [3]Bruker AXS Inc, [4]Olympus Scientific Solutions Americas

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Graduated as a pharmacist from the University of Sciences Philadelphia, Pennsylvania. The passion for geologic sciences is self taught specializing in the subject of bolide impacts specifically one impact known as MAPCIS. My travels to collect samples has taken me to the wilds of Australia, Canada, Mexico, Israel, USA and South Africa. I have multiple papers and presentations. I have presented at many Geologic Society of America conferences, the 4th International Palaeontological Congress Mendoza, the 34th International Geological Congress (IGC) Brisbane, the 35th International Geological Congress (IGC) Cape Town.

Introduction: Researchers interpret Musgrave Province pseudotachylite breccia (PB) as generated seismically despite large volume deposits. Musgrave PB deposits are up to 5km wide and run for 300km with 4% to 10% melt. Seismic origin was postulated based on proximity to the Woodroffe Thrust Fault (WFT), plus multiple generation PBs found in Musgrave samples. Seismic interpretation persists though PB deposits are radial to a suspected impact and 40km from the WTF along with multiple generation PBs occurring at known impacts.
Goal: Differentiate Musgrave PBs, impact vs. seismic through elemental analysis within melt and wall rock, as well as comparing to known impact PBs.
Methodology: Analyzed Musgrave PBs. and PBs from Sudbury, Canada and Vredefort, SA. PGEs were assayed using nickel sulphide (NiS) fire assay procedure. Elemental mapping by µ-XRF was used to comprehend the connection of the elemental composition of the pseudotachylite melts and wall rocks. X-ray Diffraction (XRD) analysis of separated pseudotachylite melts were also conducted by an Olympus transmitted XRD instruments, using a Cobalt source, to validate results of elemental analysis.
Results: PGE assay revealed concentrations of iridium orders of magnitude higher than expected in continental crust in Musgrave samples. Melt and wall rock Ir concentrations were higher, closer to the impact center. The Musgrave Ir concentrations were equal to or higher than found in Sudbury or Vredefort samples. Spectrometry revealed concentrations of iron and cobalt to be significantly higher in the Musgrave pseudotachylite melt as compared to wall rock.
Conclusion: Musgrave PBs may be impact generated.

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DEHYDRATION ROCKS AS SOURCE GENESIS GEOFLUIDS, HYDROCARBONS, DIAMONDIFEROUS STRUCTURES, MUD VOLCANOES AND FIELDS OF PRECIOUS METALS IN VARIOUS REGIONS EARTH

Harutyunyan A[1]
[1]*National Polotechnical University Of Armenia*

Biography:
CURRICULUM VITAE

Name: Dr. Albert V. Harutyunyan.

E-mail: avhk2011@gmail.com

EDUCATION

1971 – 1975 Post – graduate, Institute of Physics of Earth, Moscow

CURRENT AREA OF INVESTIGATION
1. Seismic waves and density of rocks and minerals at high thermobaric conditions
2. The processes in the association of rocks in thermobaric conditions
3. Approximation and investigation of the gas and fluids released during these tests
4. Structure, composition and evolution of the Earth crust
5. Mechanism of formation deep geological structures and ophiolites
6. Formation and migration of deep crystal fluids
7. Genesis hydrocarbons by inorganic ways

Processes of serpentinization and deserpentinization in the Earth crust have a certain role , when forming various geological structures, and also at genesis of geofluids, hydrocarbons and diamondiferous kimberlites both in oceanic, and in continental crust. Owing to tectonic processes, during geological time, relicts of serpentinezd rocks have appeared at various depths of continental crust. Owing to tectonic processes there is an increase of thermobaric parameters which lead to process of deserpentinization (dehydration) of rocks with release of hydrogen and hydrogen-containing components. Process is followed by explosion which promotes formation of diamonds from carbon-containing components. Secondary explosions can be provoked by explosions of the emitted hydrogen.

Reactions between hydrogen and carbon containing components lead to formation of hydrocarbons. Geofluids and hydrocarbons in the mixed state by deep faults migrate to the top horizons of crust, collect in jointed granites and in rocks, having collection properties, forming deposits of hydrocarbons. Thus, the serpentinized relicts of oceanic crust preserved in continental crust can be considered natural ''hydrogen bombs'' which provoke earthquakes of various intensity.

In regions, where sedimentary rocks are shipped on big depths (20-25 km), at migration and meeting of geofluids with clay rocks the mud centers with formation of a mud volcanism on the Earth's surface are formed.

The precious metals (gold, silver, platinum, etc.) which are in paleo oceanic water are preserved at various depths of continental crust. At migration in the top horizons, geofluids take and lift precious metals, with the subsequent formation of geothermal fields.

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The Effects of Supercontinent Size on the Global Mantle Structures

Zhang N[1], Li Z[1], Huang C[1]
[1]Curtin University

TS3 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
I am a research fellow doing the global geodynamics in Curtin University. My research interests include the supercontinent dynamics and large slow shear velocity Provinces in the lower mantle.

The sizes of supercontinent/supercratons are increasing with geological time. However, it is not clear how this trend influences the evolution of the global mantle structures. We investigate this effect with a 3D numerical spherical shell model. Our investigation addresses two major questions: 1) what is the critical size of a continent for upwelling structures generating beneath? And 2) what is the critical size of a supercontinent for promoting a globally spherical harmonic degree-2 mantle structure?

Our results show that a continent size less than 10% of Earth's surface area can automatically produce a return upwelling under the continent, which is largely subjected to the lower mantle viscosity structure. When the continent size keeps increasing to 18%, a global degree-2 mantle structure appearing while it is not stable, very sensitive to the yield stress of oceanic lithosphere.

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Roof, walls and underside of the Strathbogie batholith as revealed by field mapping

Phillips N[1]
[1]*University Of Melbourne; Stellenbosch University (rsa); Phillipsgold P/l*

Biography:
Neil Phillips is active in teaching and research through the University of Melbourne and Stellenbosch University in South Africa. He has led the Melbourne Geology of GOLD course since 1996; and was the editor of the AusIMM's 2017 Australian Ore Deposit monograph. Apart from gold, his field and research focus has been granite of central Victoria involving the mapping of the Strathbogie batholith. This work involves collaborations with John Clemens, Janet Hergt and Sandy Cruden.

The 370 My Strathbogie batholith comprises undeformed cordierite-bearing granite that has intruded Paleozoic metasedimentary rocks and Late Devonian felsic volcanic rocks of central Victoria. The batholith is emplaced at very high levels, possibly 1 km depth, and is discordant with surrounding shale and sandstone hornfels. The boundary of granite with hornfels extends 200 km and is known to within 100-500 m accuracy from geophysics and historical mapping.
Current field mapping has isolated the granite boundary to better than 20 m (usually 0-5 m) along the 200 km, and at elevations from 150 to 900 m above sea level. This elevation difference allows the tightly constrained boundary to be overlain on contours to reveal the district-scale geometry. Conclusions arising from this mapping include:

- The roof of the granite is defined by a near-horizontal to dipping contact with overlying hornfels where there are pegmatite dykes, aplite, tourmaline and vugs;
- The walls of the batholith are any of vertical, steep, shallow, outward dipping and inward dipping;
- The underside of the batholith is revealed by intervals where the contact is horizontal, and granite overlies hornfels;
- Even where the boundary is seemingly curved, it is made up of variably-oriented straight sections of 20 m to 20 km length;
- The batholith is not a steeply-plunging cylinder, but a near-horizontal sheet(s);
- The thickness of the granite is at least several 100 m in places, but nowhere does the mapping confirm that it must be over 1km thick.

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Improved Earth imaging beneath the ice cover of Antarctica using passive seismology: circumventing the problem of strong reverberations

Pham T[1], Tkalčić H[1], Tauzin B[1,2]

[1]Research School Of Earth Sciences, The Australian National University, [2]Laboratoire de Géologie de Lyon: Terre, Planètes, Environnement, Universite Claude Bernard Lyon 1, Universite de Lyon, Ecole Normale Superieure de Lyon, CNRS

TS1 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:

I am a PhD student working under the supervision of A/Prof. Hrvoje Tkalčić. My main research interest is to utilise and improve waveform cross-correlation methods to systematically analyse a large pool of seismograms recorded several hours after large earthquakes, termed as earthquake coda, to extract signals that are sensitive to the Earth's deep interior. I am also interested in using auto-correlation methods to analyse early earthquake records, surrounding the first P-wave arrival and its reverberations – termed as P-wave coda, in various crustal imaging applications.

Seismological studies of crustal structures in Antarctica are challenging because of the presence of a significant ice sheet that covers most of the continent. Strong reverberations due to low values of seismic properties of ice, i.e. density and seismic wave speeds, corrupt converted signals at subsurface discontinuities, and thus make many conventional receiver-based methods, including P-wave receiver functions, troublesome to utilise. Recently, autocorrelation methods that rely on the reflectivity of seismic energy at prominent interfaces have proved as a powerful tool in various crustal imaging applications. Stacked autocorrelations are constructed from seismograms of a single recorder to retrieve local seismic reflectivity underneath the recorder. In this study, we apply the method on a portion of vertical seismograms termed "P-wave coda", which contains the first P-wave arrival from tele-seismic earthquakes and its following reverberations. The selected waveform portion is rich in high-frequency content, so it provides high-resolution illumination in the near-vertical fashion of the ice-solid earth interface and the Moho discontinuity. The feasibility of the autocorrelation method is demonstrated using seismic data retrieved from pilot stations in Antarctica which are deployed over ice and over plain bedrock. This successful demonstration for the ice environment and a generalisation to plain bedrock marks a new way of crustal imaging and promises to circumvent reverberation problems in similar geological settings, including those characterised by distinct shallow layers such as soft sediments or permafrost.

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Marine shale gas development characteristics in complex structure area in China

Jing T[1], Zhao W[1]
[1]Huaneng Clean Energy Research Institute

Biography:
Jing Tieya, graduated from China University of Geosciences with Doctoral degree on unconventional hydrocarbon exploration and exploitation and devote the full energy to developing the shale gas and shale oil program of China. Now, I am a senior engineer in China Huaneng Clean Energy Research Institute.

To study the shale oil development geological characteristics and accumulation mechanism in rifted basins in China. This paper focus on the geological condition and its matching relationship of shale oil accumulation for 3rd Member of Shahejie Formation in Liaohe Western Depression. Sedimentary analysis, core observation and the experiments on mineralogy, geochemistry, oil content and hydrocarbon generation were carried out. The shale formation had experienced rapid subsidence accounting for massive sedimentation of organic-rich shale. The shales developed in the deep and semi-deep lacustrine facies is characterized by high organic matter with an average TOC over 2.0%, main types of I-II1 kerogen and relatively low thermal maturity ranging from 0.4-0.9%Ro due to shallow burial depth and the young deposition epoch, which resulted into oil generation mainly in the formations. Various pore-fractures developed for shale oil-gas storage. Clay is dominated in shales and fragile mineral such as quartz is relative low, which offers a challenge for hydraulic stimulation. Therefore, the geological conditions for shale oil is good matching and the shale oil resource potential is great. The "sweet spots" mainly develop in fracture or brittle mineral zones at a certain burial depth.

Palynolofacies and organic geochemistry investigation of middle to late Eocene sediments from Garo Hills, Meghalaya, India

Raghumani Singh Y[1], Rudra A[2], Priyokumar Singh S[1], Dutta S[2]
[1]Department of Earth Sciences, Manipur University, Imphal, [2]Department of Earth Sciences, Indian Institute of Technology

Biography:
YENGKHOM received his M. Sc. in geology and Ph.D from Kurukshetra University in 1995 & 2002. He is currently working as an assistant professor in the Department of Earth Sciences, Manipur University (M.U.), India since 2007. He was appointed as lecturer in the Department of Geology, Jammu University, India in 2004. He joined M.U. as a faculty member in the year 2007. His research interests include Paleogene palynology and hydrocarbon source evaluation of the north-west and north-east Himalayas. Yengkhom has 18 years' research experience, and has published 34 research papers in peer-reviewed journals. He has supervised several research students.

Geologically, the Garo Hills consists of Precambrian basement complex, Lower Gondwana sediments and Tertiary sediments. The Paleogene successions are represented by Tura, Siju and Rewak formations. The present samples are collected from the Siju Formation which is well exposed in an around Chokpot of West Garo Hills, Meghalaya and is composed of alternation fossiliferous limestones and marls. The assemblage is dominated by dinoflagellate cysts. Besides, a number of marine microforaminiferal linings, bivalves and gastropods also recovered from this succession. The occurrences of benthic foraminifera such as Nummulites spp., in the limestone horizons of this succession indicate middle to late Eocene age. The dinoflagellate cysts are also supported the same age. In addition, a number of biomarkers also documented here is the first such attempt from marl beds of this succession. Overall biomarkers are dominated by hopanoids, n-alkanes, steroids, fernenes and sesquiterpenoids in the saturated fraction. Unsaturated hopanes and steranes indicate the diagenetic immaturity of the organic matter. Dominance of hopanes suggests sufficient bacterial decay. Occurrence of diasteranes (C27-C29) and 4-methyl-diasteranes (C28-C30) indicates the diagenetic transformation of marine and terrestrial organic matter in a clay rich environment. n-Alkanes are bimodal (C10-C34) with dominant C14-C18 even and C25-C31 odd number carbons, derived from marine and terrigenous organic matter, respectively. PAH are indicators burning of terrestrial biomass that was transported into the depositional site. The occurrence of charcoal fragments validates their presence. On the basis of dinocysts and benthic foraminifera are deposited in the nearshore shallow marine environment in condition.

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Bringing rocks to life – outreach activities of the Geological Survey of NSW

Yeats C[1], Meakin S[1]
[1]*Geological Survey of NSW*

TS3 - 5.5 Planning the future of Geoscience & 5.1 Geology in society: geotourism and geoheritage, Room R8, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Chris Yeats joined the Geological Survey of NSW (GSNSW) as Executive Director in 2015, following 17 years as a research scientist and manager with CSIRO. As head of GSNSW, Chris leads a multidisciplinary team of approximately 100 geoscientists who collect, synthesise, manage and deliver geological, geophysical, geochemical and geospatial data to inform the government, resource industry and the community about the state's geology, and mineral, coal, petroleum and renewable energy resources.

In recent years, the Geological Survey of NSW (GSNSW) has been increasingly active in the communication of geoscience to the community. Engaging displays, new products, innovative delivery platforms and a range of public outreach events aim to capture the imagination of the general public, to enhance community understanding of geoscience and geological resources.

The Newcastle Timewalk – a guided geological tour of the Newcastle seashore - has been a popular fixture during National Science Week in recent years. Open days held at GSNSW's office in Maitland are well attended and allow the public to meet staff and gain an understanding of the work being done in the organisation. As part of Sydney Science Festival for National Science Week, the GSNSW drillcore library at Londonderry opened its doors to visitors for 'Stories in Stone', an event that demonstrates how geoscientists analyse and interpret rock features.

Collaboration with other agencies has been critical for successful outreach, by providing access to expertise, equipment, funding and publicity. GSNSW has benefited greatly from relationships with the Geological Society of Australia, universities, councils, schools, museums, libraries, other government agencies, amateur geology clubs, Aboriginal groups, historical societies, tourism offices and local science hubs.

The Port Macquarie Coastal Geotrail was a recent collaborative project in which GSNSW played an important role by developing signage, a free NSWGeoTours app and an educational brochure. There are plans to develop several other geotrails, as resources allow, with an initial focus on the Warrumbungles region and Newcastle.

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Integrated Earth Data Interpretation -
A Recipe for Success in Onshore Frontier Hydrocarbon Exploration

Holmes L[1]
[1]Santos Ltd

TS1 - 3.2.3 Petroleum and its co-products, Room R2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Lance Holmes graduated with a BSc Hons from the University of Natal, South Africa in 1981. Since then he has worked mostly in the oil & gas industry, specialising in regional basin analysis and new venture evaluations. He has worked for several companies on many basins throughout Africa, Australasia, Southeast Asia and the Middle East.

Lance is currently employed by Santos Ltd as a Principal Geologist in the Regional and New Ventures Team. He is tasked with carrying out basin hydrocarbon prospectivity studies and identifying new opportunities.

The interior of Australia hosts a series of vast sedimentary basins, many of which contain significant hydrocarbon resources. Our company has exploration/production interests in several of these basins and has in place defined workflows that address the exploration process. Work commences at regional scale, then proceeds with increasing levels of detail down to prospect level. Initial studies are geared towards defining basin-forming mechanisms, nature of basin fill and petroleum systems development. The main objective is to provide a fundamental basin petroleum framework with which to direct ongoing exploration. A nirvana outcome is to identify the most prospective region/s as quickly as possible, with least exploration spend.

Due to data paucity early on, it is incumbent upon explorers to utilise all available earth datasets to solve the unique geological challenges presented by each basin. Since datasets respond to different geological parameters, it is often difficult to comprehend holistically what the sum is trying to tell us. In our experience, this is optimally addressed through integrated data interrogation/co-visualisation, and we have developed workflows in-house for this. A standard component of the process utilises novel 3D techniques, whereby multiple earth datasets are simultaneously displayed, visually interrogated and interpreted in standard geological mapping packages.

This presentation will include discussion of data types/sources and workflows for data integration and interpretation, illustrated with real-world examples from our extensive onshore exploration program. Much of this is also applicable to other fields of geoscience.

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Spatial Reductive Mineral Exploration of the Charters Towers Province: Coupling Magma Fertility Proxies and Mineralogy Inferred from Satellite LWIR Imagery

Andrews W[1,2], Spandler C[3], Pendock N[4]
[1]Valhalla Geology, [2]RMIT University, [3]Economic Geology Research Centre, James Cook University, [4]DIRT Exploration

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Early career explorationist specialising in modern techniques for Cu-Au porphyry-epithermal systems e.g. GIS/geochemical Cu-Au arc magma fertility studies. Utilising portable spectral devices, and The Spectral Geologist (TSG) software, including the processing of HyLogger data. Strong experience employing pXRF techniques on all aspects of mineral exploration.

The Charters Towers Province (CTP), northern Queensland produced 6 million ounces Au, 1 Moz Ag, and 1, 000 t of Cu metal from 1872 to 1981. This significantly endowed province hosts numerous igneous units including the volcanic late Cambrian-early Ordovician Seventy Mile Range Group and three spatially significant Ordovician-Devonian intrusive centres; 1) Ravenswood, 2) Lolworth, and 3) Reedy Springs Batholiths including the Fat Hen Creek Complex.

Despite relationships between Permo-Carboniferous gold mineralisation and igneous units within the CTP there has been much debate surrounding the causative mechanism(s) or source of vein mineralisation, be it intrusion related or orogenic related. Witt et al. (2017) noted fertility characteristics of intrusives proximal to orogenic gold deposits within the Eastern Goldfields of the Yilgarn Craton, Western Australia.

We utilise whole rock chemistry proxies using Loucks' (2014) igneous fertility vectors adapted for use as a spatial dataset to train long wavelength infrared (LWIR) satellite imagery to generate mineral abundance maps. Five 60 x 60 km cloud free ASTER LWIR images from 2001 were mosaiced to cover the CTP at a 90 m spatial resolution. Temperature/emissivity separations were applied to the mosaic. Fertility vectors were modelled using five LWIR emittance values at each sample location. Sixteen mineral abundances were estimated as latent variables using the deep learning supervised training paradigm (Crawford et al., 2018). This statistical model was then evaluated for each pixel in the image mosaic to produce a fertility map. Combining both complementary techniques we pinpoint mineralised centres and areas of interest.

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Some like it hot: Proterozoic reworking of an Archaean 'craton' driven by high radiogenic heat-producing crust

Curtis S[1], Reid A[1]

[1]Geological Society Of South Australia

TS4 - 1.1.4 Crustal evolution of Archean Cratons, Hall A, October 17, 2018, 11:30 AM - 1:00 PM

Biography:

Stacey Curtis is employed as a Senior Geologist at the Geological Survey of South Australia. For the past decade her work has focused on the tectonic evolution of the Gawler Craton.

Archaean cratons typically represent regions of continental lithosphere which stabilized early in Earth history. Despite being partly composed of Archean rocks, the Mesoarchaean to Mesoproterozoic Gawler Craton does not have the characteristics of a typical Archaean craton. Rather than stabilizing after initial craton assembly like most other Archaean cratons, the Gawler Craton underwent multiple reworking events during the Proterozoic. The c. 1740–1670 Ma Kimban Orogeny affected almost the entire craton, with deformation comprising high T – low P metamorphism, exhumation along regional-scale transpressional shear zones, and bimodal magmatism.

We investigate whether tectonic reworking during the Kimban Orogeny could be a function of the relative enrichment in high heat producing elements that characterises the Mesoarchean substrate of the Gawler Craton. Using a 2D thermal numerical model and applying realistic parameters for crustal heat production, contrained by whole rock geochemistry data, and layer thickness for the pre-Kimban lithospheric column of the Gawler Craton, we find that the distribution of high heat producing elements within the crust is able to simulate the metamorphic conditions attained during the Kimban Orogeny. This suggests that in the Gawler Craton, Proterozoic orogenesis did not require heat produced by crustal thickening or mantle heat input due to lithospheric thinning. In this way we are able to link tectonic styles in southern Australia to that described by previous workers as a 'hot-plate model' for central Australian Proterozoic terranes.

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Tearing the Coompana Province: Was crustal-scale transtension focussed and triggered by transient shortening?

Pawley M[1], Wise T[1], Dutch R[1,2]
[1]Geological Survey Of South Australia, [2]Department of Earth Sciences, University of Adelaide

TS5 - 1.1.6 Proterozoic tectonics, Hall A, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Mark Pawley is a Senior Geologist with the Geological Survey of South Australia, where he is part of the 4D Geodynamic and Metallogenic Evolution team.

The geology of the Coompana Province comprises a long-lived (c. 1600 – 1140 Ma) north-northeast-striking grain, evident from geophysical datasets, which can be traced northward into the Musgrave Province. Structural constraints from the recent drilling program and interpretation of a deep crustal seismic profile across the region indicate a c. 1200-1140 Ma period that was dominated by east-west extension. This was interrupted by minor inversion, which resulted in north-trending upright folding and mesoscopic reverse faults observed in drill core.
However, aeromagnetic images of the region also reveal a prominent, oblique northeast-trending chain of overlapping, ovoidal c. 1150-1140 Ma plutons that are contemporaneous with extension and crustal thinning, but post-date inversion. This suggests a change from pervasive east-west extension to localised extension within a north-east trending corridor up to 75 km wide.
To account for this apparent stress change, we propose the Gawler Craton acted as an indenter during the short-lived period of inversion. The irregular shape of the craton led to dip-slip movement along the north-trending southwestern boundary of the craton, but strike-slip movement along the northeast-striking northwestern margin. Once extension resumed, this strike-slip shear reactivated and reversed to form a sinistral transtensional shear zone, with shearing and extension propagating to the southwest to form the zone of thinner crust. This zone focussed the generation and ascent of magmas to form the pluton chain, further weakening this part of the crust. With this example, we demonstrate how extension can evolve from pervasive to localised, once a tear has been formed.

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MAXIMISING THE BENEFITS OF A 1.6 MILLION LINE KILOMETRE MAGNETIC AND RADIOMETRIC SURVEY. RAISING THE BAR ON ACQUISITION AND DELIVERY

Katona L[1]

[1]*Department of Energy and Mining*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:

Laz Katona has been a member of the Geological Survey of South Australia since 2006 and is the Program Coordinator, 4D Geoscience Atlas of South Australia. Laz's team manages the GIS and Geophysical data outputs of the geological survey, whose role is capture, processing, modelling, analysis and dissemination of pre-competitive geological and geophysical data for mineral explorers and stakeholders working in South Australia. Laz is currently involved in coordinating the largest airborne geophysical survey ever conducted in South Australia while managing projects in spatial data modelling and the development of workflows for GIS mapping, prospectivity and analysis.

In January 2017 the largest airborne magnetic, radiometric and elevation survey in South Australia's history began in the Gawler Craton. The aim of the South Australian Government is to use the survey as an opportunity to achieve best practice in relation to the coordination, landholder liaison, reporting and quality control of the survey, in tandem with collaborative partners at Geoscience Australia. Some of the outcomes include a landholder and stakeholder information website, subscriber email updates, close liaison with field capture teams, timely delivery of survey data and results, and a proactive approach in ensuring the data captured is of consistent, high quality across the entire survey region. The survey is been performed in three stages and each stage provided an opportunity to assess approaches and fine tune requirements. Further value is being derived from the new data by producing and releasing a range of filtered TMI products and depth source models providing mineral explorers with a full set of data products to assist in new mineral discoveries in this world class region. The results are setting a new benchmark for other jurisdictions carrying out similar work.

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Impediments in using science for decision making - case studies from SA

Barnett S[1]
[1]Dept for Environment and Water

TS7 - 3.3.5 Groundwater science for policy development and decision making, Room R5, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Steve Barnett has been involved in the investigation, monitoring and management of groundwater resources in SA for over 40 years, and has contributed technical and policy input into ten groundwater management plans which incorporate a variety of different aquifers and management issues. He is a past-president of Australian Chapter of the International Association of Hydrogeologists

Whilst the concept of using scientific evidence to underpin policy development and decision making is a great concept, there are numerous circumstances where this process does not occur. These circumstances usually involve contentious issues where external influences outweigh the rational decision making process. these influences usually involve opinions (political, public, legal) that are not necessarily informed. Several case studies from SA will be used to illustrate this unfortunate but inevitable trend in today's society.

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Insights into the magmatic and hydrothermal evolution of the Black Swan Succession: Evidence from microchemical and sulfur isotope investigation

Caruso S[1], Fiorentini M[1], Barnes S[2], LaFlamme C[1], Martin L[1]
[1]University Of Western Australia, [2]CSIRO - Mineral Resources Flagship

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Stefano Caruso obtained both bachelor and master degrees
in geology at the University of Milan. In 2015 He started a PhD. at the Centre for Exploration and Targeting of the University of Western Australia. His research aims to improve the understanding of multiple sulfur isotopes addressing the mechanisms underlying the development of isotopic anomalies and their preservation in the Archaean. In particular his research focuses on evaluating the effects
of geological processes on the sulfur isotope signature of sulfide bearing ore deposits.

The Black Swan Succession consists of an Archean bimodal dacite-komatiite association largely dominated by ultramafic cumulates, which host a number of massive and disseminated magmatic sulfide orebodies. Although it was affected by multiple alteration episodes, the low degree of penetrative deformation allowed the preservation of magmatic textures and stratigraphic relationships. In this context, we apply a combined multiple sulfur isotope and microchemical approach to unravel the potential of sulfides to simultaneously retain information about their magmatic and hydrothermal history.
Negative Δ33S signatures in both massive (-0.56‰) and disseminated (-0.66‰) sulfide orebodies indicate the contamination of photolysis-derived sulfur. Komatiite magma assimilated crustal material analogous to the intercalated breccia dacite hosting colloform sulfides, which yield a negative Δ33S signature of about -0.91‰. Conservative estimates indicate that at least 1/3 of the sulfur in the magmatic orebodies derives from crustal assimilation.
Subsequent alteration episodes imparted to the Black Swan Succession a concentric zonation consisting of a serpentinite core and talc-carbonate margins, which is also visible in the Black Swan disseminated orebody. Pyrite in both serpentinite and talc-carbonate samples exhibits a consistent trace element signature suggesting a relative immobile behavior of Ni and Co during the percolation of the talc-carbonate fluids. Conversely, variable δ34S signatures between the two alteration styles support the mobilization of sulfur during talc-carbonation. While the 2‰ range of δ34S values in serpentinite can be attributed to moderate kinetic/equilibrium fractionation processes, the 10‰ range of δ34S values in talc-carbonate suggest that highly oxidizing fluids promoted the mobilization of sulfur as SO2.

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Keeping the deep crust hot: the role of monazite

Williams M[1], Kelsey D[1], Hand M[1], Rubatto D[2], Alessio K[1]
[1]The University Of Adelaide, [2]University of Bern

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Megan Williams is a PhD student at the University of Adelaide, in the fields of metamorphic geology and mineral chemistry. Her current work involves a multi-scale approach to understanding the chemistry of monazite and other REE–Th-bearing phases, and their evolution as a function of progressive metamorphism. Megan's research interests include understanding the links between metamorphic, igneous and structural processes and their consequences for continental evolution, understanding the mechanisms that cause enrichment of the upper crust in heat producing elements, and understanding the effect that high crustal heat production has on the style of metamorphism.

Thorium is one of the major heat producing elements in the crust and its spatial distribution has broad scale implications for the thermo-mechanical evolution of orogens. The tacit assumption has been that partial melting of the lower felsic crust strips Th and transports it and other incompatible elements to the upper crust through the ascent and crystallisation of felsic magmas. However, recent studies have shown that in numerous terranes worldwide residual granulite metasedimentary crust is at least as rich in Th as its lower grade counterparts (Alessio et al. this abstract volume). The main culprit for retaining Th in the metasedimentary part of the lower crust is monazite, which typically constitutes less than 1% of the rock volume but may contain many wt% Th. We have a thorough understanding of the processes that allow monazite to remain stable throughout metamorphic cycles and therefore retain Th deep in the metasedimentary crust. Monazite growth, dissolution and composition can be linked to metamorphic reactions involving major minerals in metasedimentary rocks (e.g. garnet) and well as other accessory phases (e.g. Kelsey et al. this abstract volume). We use detailed analysis of monazite composition and zoning at the microscale to unravel the spatial distribution and concentration of Th as a function of whole rock chemistry and mineral assemblage. Additionally we show that these changes in the composition and distribution of monazite on the microscale can explain outcrop to terrane scale trends in Th distribution.

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You've got the water, but can you save the trees? Using innovative geophysical techniques to inform River Murray floodplain management

Li C[1,2,3], Doble R[1], Heinson G[2], Hatch M[2], Flinchum B[1], Green G[3]
[1]CSIRO Land and Water, [2]University of Adelaide, [3]Department for Environment and Water

TS5 - 3.3.2 New groundwater technologies and approaches & 3.3.5 Groundwater science for policy development and decision making, Room R5, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
As a committed groundwater professional, I have experience in developing, applying and reviewing numerical groundwater models for a wide range of purposes, including water supply, salinity management, engineering design, surface water-groundwater interactions, environmental watering, climate change, managed aquifer recharge, mining and ecology.

To further pursue my passion in groundwater modelling, I am undertaking my PhD at CSIRO and the University of Adelaide with a focus on improving groundwater modelling using geophysics, particularly nuclear magnetic resonance and electromagnetics.

The lower River Murray floodplains are experiencing a substantial health decline, mainly associated with salt accumulation and reduced flooding frequency to vegetation. Environmental watering strategies are being implemented to deliver fresh water to the floodplains, increase soil water availability and reduce salinity. However, the floodplains are commonly overlain by a clay layer which water cannot infiltrate easily. As a result it is important to understand whether this additional water actually improves the floodplain health or is just lost to evaporation. There is also a real need to improve the selection of tools available to non-invasively monitor soil and groundwater conditions on the floodplains.

This study uses an innovative combination of geophysical techniques, primarily surface nuclear magnetic resonance (sNMR) and electromagnetics (EM), to address these questions. EM is used to map the floodplain electrical conductivities and thereby estimate the impact of watering. However, the interpretation of lithology and groundwater salinity based on EM data alone is ambiguous – the more conductive zones can be related to clays, saline groundwater or both. This ambiguity may be improved with additional information from sNMR measurements. sNMR is a geophysical technique that detects groundwater directly and is able to provide estimates of critical hydrogeological parameters, including water content, pore size, porosity, hydraulic conductivity, specific yield and lithology. In this project we have integrated both datasets to better understand the floodplain subsurface structure and its response to watering, ultimately leading to more effective evaluation of various floodplain management strategies that are currently being considered.

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Proterozoic tectonic evolution of North Queensland, Australia: new insights from thermal cooling history

Li J[1], Li Z[1], Pourteau A[1], Jourdan F[2], Volente S[1], Nordsvan A[1]
[1]Earth Dynamics Research Group, ARC Centre of Excellence in Core to Crust Fluid Systems (CCFS), and The Institute for Geoscience Research (TIGeR), Department of Applied Geology, Curtin University, [2]Western Australian Argon Isotope Facility, The Institute for Geoscience Research (TIGeR), Department of Applied Geology, Curtin University

TS7 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
My studying interests including tectonics, thermochronology. I achieved a geological Engineering Bachelor Degree Certificate during undergraduate, and a structural geology master degree in Chinese Academy of Geological Sciences in China, studying a Jurassic basin geometry and tectonic evolution in the Northeast of Erdos Craton, North China. My Ph.D. project at Curtin University focus on identifying the Proterozoic tectonic evolutions in the North East of Australia, by applying 40Ar/39Ar thermochronology and seismic reinterpretation across NE of Australian Craton to elucidate the timing and kinematics of the terrane accretion events along the eastern margin of the North Australia craton during the Proterozoic.

The Proterozoic tectonic evolution of NE Australia has been under debate over the past few decades. Seismic transects across the Mount Isa and Georgetown inliers have led to the identification of concealed Proterozoic terrane boundaries in NE Australia (Korsch et al., 2012). To test for the occurrence of terrane accretion events, the timing and kinematics, we carried out a thermochronological investigation across Mount Isa Inlier into the Georgetown Inlier. Low- to high-grade amphibolite and metasedimentary rocks and granite from both inliers were targeted for amphibole, muscovite and biotite 40Ar/39Ar analysis. Three major tectono-thermal phases have been revealed by muscovite and biotite 40Ar/39Ar results, whereas amphibole results are yet to become available. The central and eastern Mount Isa Inlier samples yielded muscovite and biotite dates ranging between 1480–1450 Ma, except for >1850-Ma basement from a northerly domain, which yielded a biotite age of ca. 1540 Ma. Cooling of the eastern Mount Isa Inlier followed the emplacement of voluminous A-type magmatism at 1540–1490 Ma, but other orogenic domains may preserve the record of cooling synchronous with inlier-scale thick-skinned thrusting at 1580–1540 Ma (MacCready, 2006). In the Georgetown Inlier, ~1550-Ma granite and paragneiss have mica cooling ages of ~1150–1000 Ma, whereas middle Palaeozoic ages (480–425 Ma) were obtained from samples closer to the southeastern edge of the inlier. Late Mesoproterozoic ages may record reworking contemporaneous with Rodinia amalgamation, although the geological expressions remain uncertain. Paleozoic ages are linked with the Silurian–Ordovician Thomson orogeny in eastern Australia and related intrusions in the Georgetown Inlier.

Sampling the anatomy of a continental-oceanic arc system; geochemical evidence for subduction modified lithosphere in the Coompana Province

Dutch R[1,2], Pawley M[1], Wise T[1], Jagodzinski L[1]
[1]Geological Survey Of South Australia, [2]Department of Earth Sciences, University of Adelaide

TS5 - 1.1.6 Proterozoic tectonics, Hall A, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Dr. Rian Dutch is a Principal Geologist and Program Coordinator for the 4D Geodynamic and Metallogenic Evolution team at the Geological Survey of South Australia and Visiting Research Fellow in the Department of Earth Sciences at the University of Adelaide. His work is primarily focused on the Archaean to Proterozoic evolution of southern Australia.

The Coompana Province in southern central Australia, with no known basement exposures, represents a major gap in our data and understanding of Proterozoic Australia. New geochemical and isotopic data from the eastern Coompana Province obtained from the GSSA's Coompana Drilling Project has revealed a long lived magmatic history dominated by subduction and subduction modification processes. Geochemical data from the c. 1615 Ma Toolgana Supersuite suggest formation in a volcanic arc system, while younger c. 1500 Ma, 1150 Ma and 1076 Ma magmatic suites show evidence of reworking and derivation from a subduction-modified and enriched lithospheric column.

Nd isotopic data display a trend towards more isotopically juvenile compositions from east to west, with the eastern units requiring input of a more evolved crustal source, possibly an extended Gawler Craton margin. These trends reflect variations in crustal domains imaged in seismic and magnetotelluric datasets and suggest the eastern Coompana Province records a transition from a thinned continental arc system into an oceanic-dominated arc system.

Recent models have proposed a link between subduction-related magmatic suites of the eastern Birksgate Complex (Musgrave Province) and St Peter Suite (southern Gawler Craton) suggesting that these elements comprise a single contiguous c. 1.64 – 1.6 Ga magmatic arc system outboard of the Mawson Continent during the Mesoproterozoic. This new data from the Coompana Province provides the missing link between these two geographically separated magmatic systems and adds further weight to the proposed model for the amalgamation of the south and west Australian Cratons during the Mesoproterozoic.

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Offshore freshwater: a new freshwater resource or a poorly understood existing freshwater input?

Knight A[1,2], Werner A[1,2], Morgan L[2,3]
[1]Flinders University, [2]National Centre for Groundwater Research and Training, [3]Waterways Centre for Freshwater Management,University of Canterbury and Lincoln University

TS6 - 3.3.2 New groundwater technologies and approaches, Room R5, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Andrew is a PhD candidate at Flinders University studying the behavior of freshwater contained within submarine confined aquifers.
He is particularly interested in the potential onshore-offshore freshwater interactions in coastal aquifers, and how these can improve groundwater management in coastal systems.

Coastal aquifers provide a relatively stable freshwater resource for their overlying communities. However, due to a changing climate and growing coastal populations these freshwater bodies are predicted to become increasing stressed, potentially resulting in seawater intrusion. Freshwater contained within the offshore extensions of some confined coastal aquifers has been proposed as a relativity untouched freshwater source. The degree to which offshore freshwater supplements existing onshore extractions is poorly studied and rarely considered in coastal aquifer management. Using analytical methods in conjunction with available onshore and offshore salinity data, we investigate the likelihood of offshore freshwater influencing present-day onshore salinities. Through the analysis of exiting literature in addition to insights obtained from the analytical modelling, we also present several novel conceptual models describing onshore-offshore freshwater interactions. We demonstrate that where submarine freshwater is known to exist globally, it is likely already influencing onshore water salinities. In all cases studied, modern hydraulic flow regimes are unable to account for the observed submarine freshwater extents, suggesting a paleo-freshwater component. Our work identifies that while offshore freshwater may be an underutilised freshwater opportunity in some regions, in twenty-four of the twenty-seven regions studied onshore pumping is already mining this poorly understood resource.

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Mantle influence on vertical crustal movements of Australian Paleozoic intracratonic basins

YOUNG A[1], Flament N[1], Hall L[2]
[1]The University of Wollongong, [2]Geoscience Australia

TS2 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Alexander Young is a PhD Candidate at the University of Wollongong He received his BAS. Hons from Sydney University in 2011 using paleomagnetic data to model the tectonic evolution of Patagonia throughout the Jurassic and Early Cretaceous. He subsequently worked as a graduate geologist at Origin Energy in Brisbane working in the South Australian exploration team, the unconventional operations team and the onshore Australia petroleum development team. His PhD research is on the relationship between mantle flow and surface processes.

Intracratonic basins are distinct from passive margin basins in that they are large structures formed on old continental lithosphere and away from active tectonic margins. Intracratonic basins have protracted subsidence histories of shape similar to the post-rift phase of passive margins; a rapid syn-rift initial subsidence phase is not systematically present. Intracratonic basins are often tectonically quiescent, which makes them ideal localities to examine the influence of mantle flow on vertical crustal motion in the absence of tectonic activity.
Dynamic topography is the component of Earth's topography induced by mantle flow. It occurs at long wavelength (> 100 km)-small amplitude (~ 1 km) and evolves over tens of millions of years. Recent advances in plate tectonic reconstructions make it possible to model the evolution of mantle convection dynamic topography extending back to Devonian times (410 Ma). We compared the vertical motions predicted by two mantle flow models based on distinct tectonic reconstructions to the published subsidence histories of Australian Paleozoic intracratonic basins. In addition, we quantified the subsidence history of the Cooper Basin by one-dimensional Airy backstripping of sedimentary strata at 14 wells that reached the Pre-Permian basement. The origin of anomalous tectonic subsidence (deviations of tectonic subsidence from forward modelled thermal subsidence) was compared to the Cooper Basin dynamic topography predicted by mantle flow models. Our results suggest that in the Cooper Basin, episodes of early Triassic subsidence and middle Triassic uplift could be related to mantle flow.

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Tectonic reactivation of basement and its control on basin evolution

Pryer L[1]

[1]*Frogtech Geoscience*

TS2 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

Lynn Pryer is the Chief Research Geologist at Frogtech Geoscience, where she has worked for the past 20 years consulting to industry while developing the SEEBASE workflow. The comprehensive workflow developed at Frogtech Geoscience is applicable to all geological systems and investigations and is especially useful for predicting tectonic controls on basin evolution. Lynn holds a BSc and MSc from McMaster University, a PhD from the University of Toronto (Canada, 1993) and completed a Postdoctoral Fellowship at the Research School of Earth Sciences at the ANU. She worked for the geological surveys of Canada and Ontario before moving to Australia.

The structural complexity of sedimentary basins and its relationship to tectonic events is often a major challenge for hydrocarbon exploration. Basin stratigraphy records the basin history, but basin sediments are only recording how the basement responds to tectonic stress and superimposed events often make internal basin structure exceedingly difficult unravel. A solid understanding of basement that underlies the basin is often key to explaining complexity. For example, knowledge of how basement reacts to tectonic stresses is critical for predicting how the basin behaved during extension and continental breakup, or collision and basin inversion, and for illustrating how pre-existing basement structures control kinematics in evolving basins.

Basement terranes globally are dominated by hard cratonic blocks separated by more deformable orogenic belts. How these contrasting rheologies partition strain is the key to basin formation. Basement geology is hidden by overlying basin stratigraphy, but potential field data can see through sediments and can therefore be used to identify characteristic patterns of cratons and orogenic belts. By using potential field data, terranes can be mapped, and their boundaries and major structures delineated by changes in structural fabric, orientation and/or magnitude of magnetic and gravity anomalies. Examples from basin studies conducted over the past 20 years will illustrate how basement structure plays a critical role in basin evolution. Having a robust basement model allows prediction of basin response to tectonic events, which can greatly simplify interpretation of seismic data and help to unravel a basin's stratigraphic evolution.

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Supporting geoscience educators and students – a responsibility of geological surveys?

Meakin S[1]

[1]*Geological Survey of NSW*

TS8 - 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Simone Meakin joined the Geological Survey of NSW (late) last century and spent many years mapping rocks and soils around the state. With an abounding interest and enthusiasm for all aspects of geology, she has worked for many years as a geological editor and is now a manager of a small publications team. In the last couple of years she has become increasingly involved with outreach to the community, especially through events and geotourism initiatives, and enjoys spreading the word of geoscience to all who will listen.

Outreach activities to promote broader community understanding of science and to inspire students to study STEM subjects play a small but important role of the Geological Survey of NSW (GSNSW).

In 2018, a new Earth & Environmental Science syllabus was introduced in NSW for senior high school students. As well as considering renewable resources, there is now emphasis on the economic importance of Australia's non-renewable resources. Students must investigate how direct sampling and remote sensing techniques are applied in exploration, and how rehabilitation is achieved after mining. Teachers have struggled to find supporting educational resources and many have limited geoscience training.

GSNSW has engaged with educators to determine their requirements for the new course, seizing a unique opportunity to contribute balanced and rigorous geoscientific information about NSW geological resources and their sustainable use. Through collaboration with a wide range of organisations including universities, schools, geoscience societies, local and state government agencies, educational organisations and industry, progress has been made in developing educational resources for the community.

This talk will outline some of the GSNSW initiatives designed to engage the public through appealing displays, products and activities to enhance public understanding of geological resources and inspire future geoscientists.

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Australian Seismometers in Schools - Bringing Earth Science to a new Generation

Salmon M[1], Sambridge M[1]
[1]Australian National University, Research School Of Earth Sciences

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Michelle Salmon is the Passive Seismic Science Coordinator for ANSIR. She maintains the onshore passive seismic facility out of the Australian National University (ANU). She runs the ANU seismic field program collecting data across Australia as part of the WOMBAT array. Michelle is also an ambassador for Earth Science outreach and she runs the Australian Seismometers in Schools program.

The Australian Seismometers in Schools program (AuSIS) is a citizen science project that brings real hands on science into the classroom. The program currently consists of 47 research quality seismometers installed in schools around the country. With competing subjects crammed into the school curriculum it is increasingly hard to get a window for students to experience the Earth sciences. AuSIS provides a tool to get students interested the multidisciplinary nature of Earth science, from the physics of wave propagation to tectonics and natural hazards. Having a seismometer in the classroom can provide a real-time link to science and the big geological events in the news like the recent increases in earthquake and magmatic activity at Kilauea. Teaching students to take an interest in Earth science at school provides us with a head start in recruiting our future geoscientist and it provides the community with some level of geoscience literacy. The AuSIS program is currently active in 47 schools around Australia, exposing over 30000 students to geoscience. The data from the seismometers is streamed in near real-time and is available to the public through the Incorporated Research Institutions for Seismology (IRIS) website. This provides a resource for citizen seismologists to monitor their own backyards and provides data for research and hazard monitoring.

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Revised stratigraphy and facies architecture of Cycle 2 and 3 formations of the Drummond Basin and sediment transport implications

Sobczak K[1], Bryan S[1], Fielding C[2], Corkeron M[3]
[1]School of Earth, Environmental and Biological Sciences, Queensland University of Technology, [2]Department of Earth & Atmospheric Sciences, University of Nebraska–Lincoln, [3]School of Earth and Environmental Sciences, James Cook University

TS7 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Kasia Sobczak is an international PhD candidate in Earth Science at Queensland University of Technology. Kasia specialises in sedimentology and basin analysis, and her current research focuses on investigating far-field tectonic events as drivers of provenance change in sedimentary basins. Before moving to Australia, Kasia graduated with BSc and MSc degrees from the Jagiellonian University, Krakow, Poland, where her research focused on sedimentological analysis and hydrocarbon potential of Silurian oil-bearing shales.

The Drummond Basin of central Queensland preserves a large-volume succession of little studied, predominantly fluviatile, coarse-grained, cratonic-derived sedimentary rocks of mid-Mississippian age. Termed Cycle 2, this succession separates mostly volcanic-related (Cycle 1 and 3) successions. The Cycle 1-2 boundary records a distinct, but poorly understood provenance change from intrabasinal volcanism to distal craton-derived sedimentation. The extent (47,000km2) and volume (~282,000km3) of Cycle 2 deposits is unusual, and poses problems regarding sediment sourcing and transport, as very few studies to date have documented such long-distance coarse-grained sediment dispersal. Previous studies interpreted a meandering river system for Cycle 2. In this model, the packages of conglomerate were interpreted as channel lags flanked by sandstone and siltstone being point bar and overbank deposits.

Petrographic, QFL, paleocurrent and facies analyses were undertaken in this study to better understand the nature of the provenance changes, modes of the sediment transport, and depositional environments. These new findings challenge the prevailing facies model. Cycles 2 and 3 are revised to represent a high-energy, poorly-channelised braided fluvial system of substantial size, with minor lacustrine facies. Additionally, Cycle 3 is revised here to largely be a continuation of Cycle 2-style basement-derived sedimentation, rather than recording a resumption of local volcanism, as per prevailing models. Quartz-rich sedimentation in the Drummond Basin was, therefore, more long-lived than previously envisaged, and once established, was not significantly disrupted by volcanism. The drivers for the Cycle1-2 provenance change remain unclear, but one possibility being investigated is far-field influence of the intraplate Alice Springs Orogeny.

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MAPPING THE WORLD DISTRIBUTION OF URANIUM DEPOSITS

FAIRCLOUGH M[1], **Irvine J[2]**, Katona L[2], Slimmon W[3]
[1]International Atomic Energy Agency, [2]Geological Survey of South Australia, [3]Saskatchewan Geological Survey

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Jonathan has more than 18 years experience in the geospatial industry and is currently providing a wide range of support and advice to numerous geoscientific projects within the GSSA on spatial techniques, analysis workflows and map production methods.

The recent publication of the International Atomic Energy Agency map, entitled World Distribution of Uranium Deposits (UDEPO) 2016 IAEA Tec-Doc1843 represents the culmination of work begun in 2015 by the Geological Survey of South Australia in tandem with MoU partner the Saskatchewan Geological Survey in advising the IAEA on a second edition map. The development of the second edition gains further insights into global uranium deposit data and establishes partnerships to advance our understanding of global uranium distribution and quantitative resource assessment. Highlights include, the most comprehensive compilation of 2831 known deposits, a new classification scheme by deposit type, new discoveries as well as disaggregation of previously known resources. Updated generalised world geology with digital terrain shading enhancing geographical relief features; bathymetric tints over marine regions and additional inset maps over some of the most productive Australian geological regions. Map peripherals together with a detailed reference, simplified geology and an index list of 968 named deposits shown were styled and constrained by the customised geology extension software (SAGE) developed by the GSSA. Not only is the map available in hard copy but also the addition of an online pdf version includes enhanced functionality with layers and query capabilities arranged by three groups: Map view, Deposit type and Map peripherals that allow the user to customise views of specific map features. This map provides a valuable decision making tool for a wide variety of global stakeholders interested in existing deposits and in assessing the potential for new uranium discoveries.

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Subsea fresh groundwater: Dispersion effects

Solorzano-Rivas S[1], Werner A[1], Irvine D[1]
[1]*Flinders University*

Biography:
Cristina is a Civil Engineer currently studying her first year of PhD at Flinders University. She is interested in coastal hydrogeology focusing on offshore fresh groundwater. More specifically, her research investigates the important factors that control freshwater-seawater interactions in subsea aquifers. Her objective is to contribute in determining the main influencing factors to the potentially use of this hidden resource.

The widespread occurrence of freshwater under the ocean has been recognised in recent years. The value of this hidden resource as a potential new source of freshwater has renewed the interest in approaches to understand and predict its extent. The most straightforward methodologies to estimating offshore freshwater limits are based on sharp-interface assumptions, which neglect dispersive mechanisms and the offshore circulation of seawater. The difference between sharp-interface and dispersive models has been investigated extensively for onshore coastal aquifers; however, the role of dispersion in controlling offshore freshwater-seawater interactions is not well understood. Our study improves the current understanding of the influence of dispersion on stable offshore interfaces, seawater circulation and fresh groundwater discharge to subsea aquifers. For this purpose, we conduct a series of dispersive numerical experiments in SEAWAT. Results show that dispersion affects the tip (i.e., where the interface intercepts the top of the aquifer) and toe (i.e., where the interface intercepts the bottom of the aquifer) differently. Increasing dispersion causes the toe to advance seaward, as expected; whereas the tip shows a non-monotonic relationship with dispersion. The reason of this different response elucidates the important role of the contrast between the aquifer and aquitard hydraulic conductivities on the offshore freshwater distribution at the top of the aquifer. This study extends our understanding of the significant factors affecting the distribution of freshwater under the ocean.

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Dolerite Dykes Characterisation in the Hamersley Basin and Significance for Groundwater Compartmentalisation

Latscha A[1]
[1]*Rio Tinto*

TS2 - 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Anne-Audrey Latscha joined Rio Tinto Iron in Perth in 2008 and is a Specialist Hydrogeologist Modeller having previously held various roles as Evaluation and Resource Estimation Geologist in Rio Tinto and between 2001 and 2007, she held various roles as Hydrogeologist Consultant in France. In her current role at Rio Tinto, she develops conceptual, analytical and numerical models to support Operations, Studies and Environmental Approvals.

The massive iron ore deposits of the Hamersley Group in the Hamersley Basin (in the Pilbara region of Western Australia) are mined by numerous mining companies and more below the water table resources are being developed. Historically, it was believed groundwater flows unimpeded through the Wittenoom Formation aquifer which may be connected with the orebody aquifers. However, there is increasing evidence for groundwater to be compartmentalised between hydraulic barriers, largely comprising dolerite dyke intrusions, which prevent or limit hydraulic connection.
The Hamersley Basin is dissected by numerous dolerite dykes. Certain dykes act as hydraulic barriers and compartmentalise groundwater, however others maintain groundwater flow-through.
Compartmentalisation can be predicted based on field assessment of the natural groundwater level. However compartmentalisation can initially be masked, especially if saturated detrital cover overlies the bedrock aquifer. Compartmentalisation becomes apparent only upon commencement of dewatering.
Early dolerite dyke characterisation can assist with predicting the role of a dyke as a hydraulic barrier before dewatering commences. The extent of dolerite weathering indicates whether the dyke acts as a hydraulic barrier or not. Weathering results in reduction of intrusion thickness and the creation of secondary porosity, formed as a result of leaching of soluble elements and the formation of highly porous weathered products. Further, delineation of the base of weathering of the dyke assists predictions at which depth compartmentalisation is likely to occur. Determination of these key characteristics of dolerite dykes and potential for compartmentalisation of groundwater should result in more accurate groundwater modelling outcomes.

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Integrating geochemistry, geochronology and geophysics in a single undergraduate subject

White L[1], Flament N[1], Brewer C[1], Chisholm L[1], Jacobs Z[1]
[1]School of Earth and Environmental Sciences, University of Wollongong

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Lloyd White is a Lecturer in Geology at the University of Wollongong (2017–). Before moving to Wollongong, Lloyd was based in the UK as a Postdoctoral Research Fellow with the Southeast Asia Research Group at Royal Holloway University of London. He was earlier based in Canberra – first as a Research Geoscientist with Geoscience Australia (2006–2008). He later moved to the Australian National University to commence PhD studies and a postdoctoral fellowship (2008–2012). Lloyd's research focuses on understanding the evolution mountain belts and plate break-up using a mixture of techniques (e.g., structural geology, geochronology, plate reconstructions).

A recent restructuring of the Earth and Environmental Sciences curriculum at the University of Wollongong led to the creation of a second year subject called "G-Cubed: Geochemistry, Geochronology, Geophysics" in 2017. This multidisciplinary subject scaffolds from introductory level geology, physical geography, archeology and geo-computing classes, and is a core subject in the Geology, Physical Geography and Environmental Geosciences degree programmes. The subject aims to prepare students for a final year capstone experience by integrating geochemistry, geochronology and geophysics to solve problems in geology, physical geography and environmental sciences. Students are introduced to concepts in each of the three "G's". Practicals include the collection of geochemical (XRF, XRD, SEM) and geophysical data (Ground Penetrating Radar), and the students learn about 'real world' applications of geochemical, geochronological and geophysical techniques. A final group project assesses student ability to synthesise and interrogate multiple strands of information pertaining to each of the three "G's".

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Marginal fault systems of the Northern Carnarvon Basin: seismic evidence for multiple Palaeozoic extension events and insights from numerical models

I'Anson A[1], Elders C[2], Rey P[1], McHarg S[2]
[1]Earthbyte Group, University of Sydney, [2]Curtin University

TS1 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Amy I'Anson received her undergraduate degree from The University of Sydney. After 3 years in oil and gas exploration, she returned to complete her Ph.D. at the University of Sydney. She is supervised by Chris Elders at Curtin University and Patrice Rey at the University of Sydney. Her Ph.D. research is focused on the Permian–Carboniferous evolution of the Northern Carnarvon Basin.

Detailed mapping of the geometry and tectono-stratigraphy of Permian and Carboniferous structures of the inboard Barrow, Dampier and Beagle sub-basins of the Northern Carnarvon Basin is possible using regional scale interpretation of publicly available 2D and 3D seismic data. We show two distinct orientations of structures that provide evidence for a poly-phase rift history of the North-West margin during the Palaeozoic. NNE trending faults of the Barrow sub-basin were initiated in the Carboniferous or Devonian but were underfilled, resulting in erosion of the fault block crest and filling of the remnant rift-related topography by conformable sequences of later Permian and Triassic sediments. By contrast, NE-SW oriented faults of the Dampier sub-basin experienced a distinct phase of Permian activity and are unconformably overlain by Triassic sediments. In the Beagle sub-basin, both orientations of structures are present.

Palaeozoic extension was the precursor to multiple episodes of Mesozoic rifting. Mesozoic faults have complex geometries across the basin and are affected by structural inheritance of Palaeozoic fabrics. We use a particle-in-cell finite element code, Underworld, to run a generic set of lithospheric scale models at a very high resolution. We investigate the sedimentation and fault patterns that result from varying the strength of the lower crust and the velocity of extension at a continental margin. In contrast to previous models, the high resolution models allow for detailed analysis of sedimentation and strain patterns under lithospheric extension. Together this work has implications for understanding the geodynamic evolution of poly-phase extensional continental margins.

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SA Land Cover 1987 - 2015

Miles M[1]
[1]*SA Department For Environment And Water*

TS2 - 4.4.3 Geoscience data delivery & 4.4.2 Understanding the Surface, Room R7, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Matt Miles is a geographer and spatial scientist with extensive experience in land and ecosystem mapping practices in South Australia. During a 20 year career within the South Australian Government he has combined a knowledge of landscape sciences and technical capabilities to map and describe landscapes with a deep understanding of the needs of government and policy makers to design, develop and implement tools to support a range of policy and environmental management endeavours. Working for the SA Department for Environment and Water, he strives to continuously modernise tools and processes to support policy and decision making including maps, mapping tools and data management practices. As a principal scientist he works across the agency and at national levels to create systems and products of value to planners, conservationists, land-users, investors and many other stakeholders interested in using and understanding landscapes and environmental assets in South Australia.

A new set of land surface models are available that use satellite imagery to show land cover changes in South Australia. Developed using Digital Earth Australia capabilities, the dataset shows unprecedented levels of detail in changes in South Australia's land cover over 5 year periods between 1990 and 2015. Output layers are at the scale of 25 x 25m pixels and classes include native woodland, hardwood plantations, orchards and vineyards, cropland, water, salt lakes, rocky outcrops, built-up and urban areas. Like any modelled and remotely sensed information, the layers will have some limitations, so it is important to understand the scale of the data and the class definitions for a given application.
A major driver for the creation of this data was the need to track changes in the extent of our native vegetation. Native vegetation cover estimates are higher than historically reported due to new mapping methods picking up smaller patches, creek lines and roadsides. The data also allows us to quantifying the change between classes in order to understand more than simply the change within a land cover class. Results show that the data can describes issues we knew were happening but previously could not measure E.g. conversion of native grasslands to cropping, loss of native wetland vegetation in agricultural landscapes, shrub encroachment back into cleared or grazed pastures. The data is being used to explore impacts of land use change and land cover dynamics e.g. on production systems, groundwater, carbon and more.

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Multistatistical approaches for geochemical assessment of stream sediments and soils of the Mt Coot-tha Nature Reserve, Brisbane - Queensland

Spier C[1], Hou Q[1]
[1]School of Earth and Environmental Sciences - The University of Queensland

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr. Carlos Spier has over 30 years of technical and managerial experience in the mining industry, participating in and managing complex projects in South America, Australia, and West Africa. Skilled in leading technical services and geological exploration for underground and open pit mines, his career experience includes exploration, mine geology and resource estimations of multiple commodities, geometallurgical studies, mine-to-mill reconciliations, project management and project evaluation.
He teaches economic geology, exploration geochemistry and ore body modeling at School of Earth and Environmental Sciences of the University of Queenland and his research interests are in those areas.

The Mount Coot-tha nature reserve is Brisbane's largest natural area, occupying 1600 hectares of open eucalypt forest. During the Great Depression in the 1930s, gold mineralization was discovered within quartz veins that cross-cut the Bunya Phyllite in Mt Coot-tha, with the Brisbane City Council allowing miners to work the area. Mt Coot-tha was also used to store explosives, mines, and torpedoes during World War II. Today, Mt Coot-tha is Brisbane’s largest natural area, with picnic areas and bushwalks.
Geological research carried out by earth sciences students of the University of Queensland in the area comprised stream sediment and soil geochemical surveys. The studies were directed towards environmental conservation and on the understanding of the genesis of the gold mineralizations.
Geochemical exploration based on stream sediment and soil data is a time and cost-efficient method for the identification of geochemically anomalous areas. Multivariate statistical analysis can extract the important information hidden in a large original data group. Therefore, the combination of geochemical exploration and multivariate statistical analysis is an efficient way to identify targets for mineral exploration. It is also strongly applicable in the identification of areas contaminated by pollutants.
The assessment of geochemical data has revealed that neither the historical artisanal gold mining activities nor the storage of explosives has introduced pollutants in the area. Only one small area (< 1 hectare) has arsenic contents above legislation guidelines. This area is associated with a gold anomaly, and its high arsenic content is interpreted as related to natural causes.

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Riversleigh research: an impossibly condensed overview of the last 43 years

Archer M[1]

[1]*University Of New South Wales*

TS2 - 2.4 Ancient and Historical Record of Life in Australia, Room R1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

Mike Archer has been Curator of Mammals at the Queensland Museum, Director of the Australian Museum and Dean of Science at the University of New South Wales where he's now Professor in the UNSW PANGEA Research Group. His research includes the World Heritage fossil deposits at Riversleigh, conservation through sustainable use of native resources and DeExtinction efforts to revive extinct species. He has supervised >85 research students, produced >315 scientific publications and received awards including Fellowships in the Academy of Science and Royal Society of NSW, Eureka Prize for the Promotion of Science and Member of the Order of Australia.

Sir David Attenborough declared that Riversleigh, now a World Heritage-listed natural resource, was one of the four most important fossil deposits in the world. Because Australia has been globally adrift for the last 50 million years, fossils revealed at Riversleigh, which span the last 24 million years, should and do reflect this long-term isolation--in spades. E.g., prior to 1976, only 73 pre-Quaternary mammals were known from all the fossil deposits of Australia. Discoveries at Riversleigh have now more than trebled that number with many groups of living mammals (as well as other vertebrates, invertebrates, plants, stromatolites etc.) often revealing Australian fossil records for the first time. Although primarily the focus of palaeontologists and geologists at UNSW, with more than 100 researchers in 26 institutions and 11 countries collaborating over the last 40 years to make sense of this resource, a prodigious panoply of publications continues to grow. Unexpected discoveries include unique orders of marsupials, new families, hundreds of new genera and species, and even discovery of a related but more remote fossil field, 'New Riversleigh', which is larger than the World Heritage area. Particularly unexpected discoveries involve bizarre cases of preservation including, inexplicably, fossil eyeballs as well as 17 million year old sperm cells complete with nuclei and other subcellular organelles. Ongoing research in palaeontology, palaeoecology, palaeoclimatology, stratigraphy, biocorrelation, geochronology, palaeokarst, elemental signatures and even the finer aspects of palaeoscatology ensure at least another century or three of researchers making extraordinary discoveries in this addictive palaeo-playground.

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How to develop students' problem-solving abilities in Geoscience classes: The case of lower secondary schools in Japan

Kawamura N[1]
[1]Akita University

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
2008 Associate professor of science education. Akita Univ.
2013 Professor of science education, Akita Univ.
2015 Principal of the Associated Junior High School of Akita Univ.

Today, Japanese companies require new employees to possess problem-solving abilities. Hence, in conventional classes, teachers impart a lot of knowledge; however, such knowledge transfer fails because students tend to forget technical information after grade evaluation. Furthermore, because students are exposed to too much knowledge, many of them develop a negative impression about studying science. Considering these situations, the Ministry of Education has stated that problem-solving abilities should be instructed and developed in classes. Hence, science teachers must teach not only how to acquire knowledge but also how to think. In the case of lower secondary schools, students must learn scientific jargon. Additionally, research activities are introduced to promote processing skills. For example, when students study plate movement near the Mobile Belt, they need to collect primary data themselves. However, students are hardly able to collect data from faraway locations, such as the deep sea floor. This remains a difficult area of teaching Geoscience to young students.
The author conducted a new Geoscience class that introduced research activities for young students and found that microfossil samples from oceanic sediments are effective teaching materials for giving information about Japan's elevation levels. By observing oceanic sediments and radiolarian chert from mountainous areas, the students could find the ocean floor raised up to the mountains.
To enable students' problem-solving abilities, it will be important to gather more new materials related to research activities in Geoscience classes.

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Reduction Spheroids from the Tumblagooda Sandstone as Potential Biomarkers for the Terrestrialisation of Arthropods

Fox D[1,2], Spinks S[1], Thorne R[1], Aspandiar M[2], Barham M[2]
[1]CSIRO, [2]Curtin University

TS2 - 2.4 Ancient and Historical Record of Life in Australia, Room R1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
David Fox is a postgraduate student who has just begun a collaborative PhD project between Curtin University and CSIRO titled, "Microcharacterisation of the Controls on Sediment-hosted Copper Mineralisation in the Olympic Domain, South Australia". Through his PhD project David hopes to combine sedimentary geochemistry with advanced resource characterisation techniques in order to better understand the geochemical controls on sediment-hosted copper deposits. David is presenting on soon-to-be published work that he conducted during his honours research project at Curtin University where he analysed the mineralogy and geochemistry of previously unstudied reduction spheroids from the Tumblagooda Sandstone.

Reduction spheroids are small-scale (<30 cm) spheroidal features that are observed in red beds globally. They typically contain a dark metallic central core, with a surrounding pale haematite dissolution halo. Reduction spheroids are of note as their dark central cores are commonly strongly enriched in exotic redox-sensitive metals, such as V, U, Au, and Cu. The prevailing model for reduction spheroid genesis proposes that they are formed through the metabolic processes of dissimilatory metal-reducing bacteria. It is believed that these bacteria consume detrital organic matter in the sediment, using it as a reductant and energy source. These bacterial reductive processes are therefore proposed to be the mechanism for the enrichment of metals in reduction spheroid cores. Due to this formation mechanism, the authors propose that reduction spheroids could be of use as a terrestrial biomarker; providing a proxy for organic matter supply into terrestrial sediments. This is of particular significance within the Tumblagooda Sandstone; an Ordovician-Silurian red bed that records evidence of early terrestrial arthropods through its very rich trace fossil assemblage. Despite this, very few body fossils have ever been recovered from the Tumblagooda Sandstone. As such, it is proposed that the unusually abundant reduction spheroids within the unit may be a product of a thriving terrestrial animal biota providing an abundant supply of detrital organic matter into the sediment during its deposition. These abundant reduction spheroids may therefore represent the fossil record for some of the earliest terrestrial arthropods on Earth.

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How the interaction between global mantle flow and lithospheric structure shapes Earth’s dynamic topography and volcanic expressions.

Davies R[1]
[1]The Australian National University

TS3 - 1.1.1 Decoding Earth’s supercycles: from the core to the crust, Hall C, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
I have developed advanced computational tools for simulating geodynamical Earth processes and have applied these tools to significantly enhance understanding of the dynamics, structure and evolution of Earth’s mantle, and its expression at the surface. My current research focusses on the mechanisms underpinning intra-plate volcanism including (geologically) recent volcanism on the Australian continent, the force-balance governing tectonic plate motions at Earth’s surface, and the dynamical interpretation of seismic images. Among other awards, I received the 2014 Outstanding Young Scientist Award from the Geodynamics Division of the European Geoscience Union and the 2018 Hales Medal from the Australian Academy of Sciences.

Mantle convection is the engine driving our dynamic Earth: it is the principal control on Earth's thermal, chemical and geological evolution. Convective circulation within the mantle induces transient deflections at Earth’s surface -- commonly known as dynamic topography – which influences a number of surface processes. Furthermore, the interaction of mantle flow and shallow lithospheric structure plays a key role in governing intra-plate volcanism. Here, I present a series of global mantle convection models, computed within the Fluidity computational modelling framework, which reveal how different flow components, including large-scale global mantle flow and shallower flow regimes, such as edge-driven convection and shear-driven upwelling, contribute to Earth’s dynamic topography and volcanic expression. Results help to bridge the gap between the predictions of previous models of mantle flow and more recent observational constraints on dynamic topography. They also imply a key role for lithospheric structure in dictating the location and characteristics of many of Earth’s intra-plate volcanic provinces.

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The influence of rock sample preparation on clinging fines and the TIR spectral signature

Rost E[1], Hecker C[1], van der Meer F[1]
[1]*University Of Twente*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Evelien is pursuing a PhD degree in the field of geological remote sensing. She works at the the faculty of geo-information science and earth observation (ITC) at the University of Twente in the Netherlands. Her work focuses on the influence of geological sample surface differences on thermal infrared spectroscopy. She studies and quantifies the effects of surface roughness, sample preparation methods and crystallographic orientation on the measured spectra, and their effects on the projected sample composition. To study these effects she uses various laboratory based thermal infrared spectrometers, SEM and quantitative XRD.

Increased surface roughness of rock samples influences the TIR spectral signature resulting in loss of spectral contrast and spectral shape changes. The spectral shape changes can be attributed to hyperfine particles (1 – 20 µm), also known as clinging fines, which are known to introduce volume scattering resulting in transmission of incident rays through the encountered particles. However, the effect of rock sample preparation on clinging fines abundance and the accompanying spectral signature changes has not yet been properly established.
The research presented here studies and quantifies the correlation between sample preparation and clinging fines abundance and its effect on the TIR spectral signature. We applied ultrasonic cleaning to samples with various surface roughness's (split, saw and polish) of three rock types: a pure quartz sandstone, a quartz sandstone that also contains kaolinite, and a medium grained gabbro. TIR measurements where conducted on the non-imaging Bruker Vertex 70 FTIR reflectance spectrometer, which measures in directional hemispherical reflectance (DHR). To determine the abundance of clinging fines at the surface we obtained scanning electron microscopy (SEM) images.
The results of this study show that optically rough surfaces contain high abundances of clinging fines and are therefore increasingly affected by volume scattering at specific weaker transmittance bands in the spectra. Furthermore, ultrasonic cleaning reduces these effects by decreasing clinging fines, showing that sample preparation influences the spectral signature shape as a result of clinging fines abundance.

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The Canadian Experience with Public Geoscience in Fostering Innovation in Mineral Exploration

Villeneuve M[1]
[1]*Geological Survey Of Canada, Natural Resources Canada*

TS3 - 5.5 Planning the future of Geoscience & 5.1 Geology in society: geotourism and geoheritage, Room R8, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
In 2010, the author was manager in charge of Canada's Targeted Geoscience Initiative, a geoscience program to foster industry innovation in the search for deep mineral deposits. Since 2016, he has been Director responsible for minerals science at the Geological Survey of Canada.

Since 1842, a foundational principle of the Geological Survey of Canada (GSC) has been delivery of its geoscience as a public good, which is equally and readily accessible to everyone independent of ability to pay. While Canada's public geoscience is used by mineral exploration companies to target their exploration dollars in areas with the highest probability of success, but it can also drive advances in exploration methodology by enhancing the ability to target the footprint of mineral deposits. As an illustration, in 2010, with the renewal of the fourth phase of the Targeted Geoscience Initiative (TGI), Canada shifted the national minerals geoscience program from a focus on characterizing mineral deposits to a process-oriented, ore systems approach that provides scientific knowledge for industry use in innovating their exploration programs towards discovery of deep deposits. Reflecting on the last 10 years of TGI, this talk will highlight the successes, lessons learned and continuing challenges in grounding an industry transformation with new geoscientific knowledge. The talk will also present a look to the future – a future where the GSC remains focused on innovation, with adaptable programming oriented towards industry needs, and through collaborations with Indigenous peoples, communities, academia and other governments. Canada's competitive advantages rests upon strategically evolving government approaches to meet the challenges presented to the mineral industry by today's complex global economy.

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The Women in Earth and Environmental Sciences Australasia Network (WOMEESA)

Handley H[1], on behalf of WOMEESA
[1]*Macquarie University*

TS5 - 5.1 Geology in Society: geotourism and geoheritage & 5.6 Diversity in the Geosciences, Room R8, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Heather Handley is an Australian Research Council Future Fellow and Associate Professor at Macquarie University in Sydney. She is Co-Founder and President of the Women in Earth and Environmental Sciences Australasia Network (WOMEESA)

Heather's research interests include: (i) the integration of field volcanology and volcano geochemistry, (ii) magma genesis at subduction zones (petrological, mineralogical, geochemical and isotopic perspectives) (iii) timescales of magmatic processes using U-series isotopes and elemental diffusion in volcanic minerals, (iv) behaviour of U-series isotopes during weathering and erosion and the U-series constraints on the formation age of sediments, (v) geochemical investigations into contaminated land and water.

The Women in Earth and Environmental Sciences Australasia (WOMEESA) Network arose at the inaugural Dorothy Hill Women in Earth Sciences Symposium in November 2017, identifying a need to bring together women in Earth and Environmental Sciences throughout Australasia. The network officially launched on International Women's Day, 8 March 2018. WOMEESA aims to create a unified network of women working in academia, industry and government and support women at all career stages. WOMEESA aspires to: 1) Develop new nodes in the region without current support and link to existing networks and societies, 2) Facilitate greater collaboration between academia, government and industry in these fields, 3) Provide role models of women in Earth and Environmental Sciences, 4) Provide key support for women in the early stages of their career and those with carer responsibilities, 5) Raise awareness of current gender equity issues, 6) Develop strategies to support indigenous Australasians, 7) Promote the importance of Earth and Environmental Science research and activities carried out by women through social networks and the media. Current initiatives and activities include networking events and workshops, a blog, a member spotlight webpage, a podcast series and promotion of the network throughout Australasia. At 15 June 2018 WOMEESA has 236 members. www.womeesa.net

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A multi-environmental tracer study quantifying deep recharge to the Hutton and Precipice Sandstone and detecting cross-formational flow, Surat Basin, Queensland

Suckow A[1], Deslandes A[1], Meredith K[2], Raiber M[3], Taylor A[1], Gerber C[1]
[1]CSIRO, [2]ANSTO, [3]CSIRO

TS2 - 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Axel is the manager of the Environmental Tracer Laboratory (ETL) at CSIRO Land and Water. He manages the only facility able to measure all noble gas concentrations in groundwater on the southern hemisphere. He has 30 years of experience in geochronology and isotope hydrology. His special skill is the interpretation of multi-environmental tracer datasets to understand complex aquifer systems.

Field investigations were undertaken to study a complex multi-aquifer system in the Surat Basin, Queensland. This project was conducted within the Gas Industry Social and Environmental Research Alliance (GISERA) to better characterise and understand the sustainability of deep groundwater and the potential impacts of the Coal Seam Gas (CSG) industry on important groundwater resources. Multiple environmental tracers (major ion chemistry, 18O, 2H, 3H, 13C, 14C, 36Cl, 87Sr/86Sr and stable noble gases) were used to estimate recharge rates and flow velocities in the Hutton and Precipice Sandstone aquifers.
Apparent groundwater ages using 14C were contradictory to those for 36Cl by a factor of ten in the Hutton Sandstone aquifer. It was possible to resolve this discrepancy by describing the aquifer as a large-scale 'dual porosity' system with less than 30% of its thickness conducting effective groundwater flow and the remainder being stagnant. This model allowed for the first time to quantify the effective deep recharge rate for this aquifer. Local occurrences of water exhibiting high helium concentrations indicated vertical upward movement of deep groundwater along faults.
Available data for the Precipice Sandstone from pumping tests and re-injection of CSG produced water suggests high hydraulic conductivities. New tracer measurements were in agreement, confirmed these high groundwater velocities and allowed the first estimate of deep recharge into this aquifer. The Precipice Sandstone represents an important fresh water resource to support future development of the cattle industry in the region.

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A new atmospheric time series for the application of 85Kr as atmospheric and ideal groundwater tracer in Australia

Suckow A[1], Deslandes A[1], Gerber C[1], Kersting A[1,2], Schlosser C[3], Bollhöfer A[3]
[1]CSIRO, [2]Institute of Environmental Physics, [3]Federal Office for Radiation Protection (BfS)

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Axel is the manager of the Environmental Tracer Laboratory (ETL) at CSIRO Land and Water. He manages the only facility able to measure all noble gas concentrations in groundwater on the southern hemisphere. He has 30 years of experience in geochronology and isotope hydrology. His special skill is the interpretation of multi-environmental tracer datasets to understand complex aquifer systems.

The radioactive noble gas isotope 85Kr is the most robust tracer for the water cycle on time scales of decades. Noble gases do not undergo chemical alteration, a complication that exists for the classical tracers CFCs and 14C. Analysis using isotope ratios tolerates some loss of the gas fraction, a problem for the application of 3H/3He, CFC and SF6. Subsurface production, a problem for SF6 in much of Australia, is negligible for 85Kr. Atmospheric bomb-tritium is too low in the southern hemisphere for routine use of 3H/3He as a water dating tool. 85Kr fills these gaps and is equally applicable on the southern and northern hemisphere.
Despite these advantages, application of 85Kr was hampered by measurement capacity and the lack of an input function for the southern hemisphere. A CSIRO-Bfs collaboration established a new time series of atmospheric 85Kr, comprising over three years of weekly integrated samples from Adelaide. Combining the northern hemisphere data with old atmospheric data for all southern hemisphere stations allows the quantification of inter-hemispheric exchange. This enables the use of 85Kr as a powerful and robust groundwater tracer for travel times of decades.
Classical radiometric methods for the measurement of 85Kr typically require water samples of several hundred litres. The recent development of Atom Trap Trace Analysis (ATTA), however, allows the measurement of 85Kr on sample sizes of 5-10L and drastically increases throughput, creating an outlook similar to the transition of radiocarbon dating from radiometric counting to Accelerator Mass Spectrometry (AMS) some decades ago.

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Age estimates of groundwater in western Dead Sea catchment based on bomb peak environmental tracer data

Wilske C[1,2,3], Suckow A[3], Roediger T[1], Geyer S[1], Weise S[1], Merchel S[4], Rugel G[4], Pavetich S[5], Merkel B[2], Siebert C[1]

[1]Helmholtz Centre for Environmental Research GmbH - UFZ, [2]TU Bergakademie Freiberg, [3]CSIRO Land and Water, [4]Helmholtz-Zentrum Dresden-Rossendorf, [5]Australian National University

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:

Cornelia Wilske studied Geo-Engineering and Applied Geosciences at the Technical University of Berlin, Germany. She started a Phd project in 2011 at the UFZ and investigates the western aquifer system of the Dead Sea by application of a tracer combination (REE, stable isotopes and dating parameters).

The aquifer system of the western side of the Dead Sea is investigated on groundwater recharge, groundwater flow velocities and potential mixtures. The two main limestone aquifers are of Cretaceous age, exposed in the recharge area and show karst characteristics with high transmissivities and flow velocities. Discharge is into springs in the Lower Jordan Valley and Dead Sea region. We use a multi-environmental tracer approach, combining anthropogenic bomb-derived $^{36}Cl/Cl$, Tritium and the anthropogenic gases SF_6, CFC-12 and CFC-11, CFC-113 to cover the recharge period from the 1950s to recent and to estimate components in the aquifer system that were recharged less than about 70 years ago. By application of lumped parameter models, we derived residence times in the unsaturated zone, tested several age distributions and verified young groundwater components from the last 10 to 30 years. The data can only be explained assuming also an admixture of an old groundwater component, older than about 70 years, the age of which cannot be further quantified with our tracer data.

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Integrating stratigraphic analysis and biostratigraphy to reconstruct Late Paleozoic carbonate platform architecture

George A[1], Anderson K[1], Henderson C[2]
[1]The University of Western Australia, [2]The University of Calgary

TS2 - 2.4 Ancient and Historical Record of Life in Australia, Room R1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Annette has broad-ranging interests and expertise in basin analysis, petroleum reservoir characterisation and outcrop analogues, carbonate geology, deep time environmental change/mass extinctions. Current research activity with colleagues, post-doctoral researchers and graduate students focuses on onshore and offshore WA basins ranging in age from Paleoproterozoic to Holocene, and northern Thailand terrane amalgamation, magmatism and basin evolution. Despite living in Australia for 30 years, she still supports the All Blacks.

Tropical Late Paleozoic carbonate platforms are important records of paleotectonic setting and paleoclimate and, in many parts of the world, host significant petroleum accumulations. The well preserved Late Devonian reef complexes of the Canning Basin developed in an active extensional setting that also controlled the interplay of carbonate deposition and siliciclastic sediment flux. Reconstructing the complex stratal architecture of these platforms has been significantly aided by integrating stratigraphic, sedimentological and paleontological data. Biostratigraphic data have been key to establishing depositional ages leading to identification of: (i) phases of platform development across the basin margin; (ii) regional relative sea-level changes affecting the basin margin; and (iii) coeval shallow and deep water facies through the history of platform development and demise. This is particularly important in the Canning Basin where disparate parts of multiple reef complexes are preserved. The lessons learnt in the Canning Basin platforms have been applied to Carboniferous (Pennsylvanian)–Middle Permian carbonate platforms of northern Thailand. Although well-exposed in the Loei-Phetchabun Foldbelt (LPF), these platforms have been folded and faulted through Permo–Triassic and younger orogenic events. Systematic field mapping has discovered conodonts in slope facies and widespread boundstone facies (typically as mounds and allochthonous debris). Integration of these data with stratigraphic–sedimentological data and faunal distribution patterns, has led to interpretation of a multiphase platform history in which changes in platform style and stratal architecture, e.g. in response to tectonic events, can be placed. These models provide an analog for giant gas reservoirs in the nearby subsurface.

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Correlation between inferred strength and apparent degree of weathering in felsic pyroclastic rocks.

Fityus S[1], Torok A[2]
[1]The University Of Newcastle, [2]Technical University of Budapest

TS7 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Dr Stephen Fityus has a BE(civil), a BSc(geology) and a PhD from the University of Newcastle. He is currently a Professor in the School of Engineering at the University of Newcastle. He teaches Engineering Geology, Soil Mechanics and Geotechnical Design. His wider research interests include the behaviour of residual and expansive clay soils, rockfall phenomena and rockfall risk mitigation, and slope stability in dipping strata. More recently, his research has focussed on the geomechanical behaviour of mudrocks and mine waste rock. He is the current National Chair of the Australian Geomechanics Society

Pyroclastic rocks have been widely exploited around the world as construction materials due to their reasonable strength and ease of workability. Sirok castle in Hungary was originally constructed from a dacitic pyroclastic (tuff) rock, and following hundreds of years of deterioration, it is now being restored. A survey to assess the condition of the rock in many areas utilised visual assessment, Schmidt hammer measurements and unconfined compressive strength (UCS) testing of cores. A good correlation between average Schmidt hammer strength values and weathering condition was established, although specimen values for the same apparent degree of weathering varied considerably. UCS values and degree of weathering also correlated well, although UCS values inferred from the Schmidt hammer typically overestimated the directly measured UCS values by between 25% for slightly weathered rock to 300% for extremely weathered rock. It was noted that the effect of apparent weathering on strength decreased as weathering increased, particularly when assessed by the Schmidt hammer. This is likely to be due, to a significant extent, to the insensitivity of the Schmidt hammer to very weak materials and its failure to differentiate strength meaningfully in extremely weathered soft rock materials. From density data derived from tested cores, a good correlation was also established between bulk density and strength, suggesting that strength might be usefully inferred from measured bulk density. The data were useful to support an assessment of slope instability risk around the castle.

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Mineralisation in the Northern Stavely Arc, Victoria

Smith M[1]

[1]*Austpac Resources NL*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:

Mike Smith is General Manager Exploration Exploration at Austpac Resources NL. He has engaged in the exploraion for a wide range of mineral commodities over the past 40 plus years in Australia and portions of the western Pacific, Europe and South America, He is a Registered Professional Geoscientist in the Fields of Mineral Exploration and Geophysics. His society affilliations are FAIG, FGSA, Hon MASEG.

The 2013 - 2017 work of Geoscience Australia and the Geological Survey of Victoria reports that the Stavely Arc in western Victoria developed during west-directed subduction along the eastern margin of Gondwana in the Cambrian (Schofield et al 2018). The study identifies this setting as favourable for a range of arc-related mineral systems such as porphyry, epithermal and volcanic-hosted massive sulphide systems.

The Stavely Arc is almost entirely obscured by young sediments of the Murray Basin. This terrain has undergone relatively little uplift, and potential arc-related mineral systems are likely to be preserved under the sedimentary cover.

A mud-rotary drillhole with a diamond tail was recently completed in the northern Stavely Arc under the government's “TARGET” program aimed at stimulating exploration interest in Western Victoria. The core consists of intensely altered basalt containing local silica-pyrite-sphalerite mineralisation with anomalous gold. Textural and sulphur isotope characteristics favour a likely VHMS origin for this mineralisation.

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Industry take-up on real-time geological data

Lundström A[1], Sjöqvist A, Artursson M
[1]*Minalyze*

TS7 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Founder of the company Minalyze AB. M.Sc Industrial Engineering and Management

Automated solutions that replace repetitive and labour-intensive work tasks in the mining and exploration industry exist. The automated solutions generate consistent, high-quality data, still the industry acceptance and adoption are low.

Minalyze develops geolytical drill core scanners, which provide high-resolution images, RQD, structural orientation, specific gravity, and geochemistry from the same scan. Data that improve the daily workflow and decision-making.

Being a small start-up company in this industry is challenging. The factors Minalyze have identified as the keys to crossing the chasm and increasing the acceptance are:
- Ecosystem support
- Technology suppliers' responsibility

An ecosystem of industry-related actors collectively has to be willing to take on the role as early adopters, leading the way for the rest of the industry to follow. If everyone is waiting for a technology to become mature, we will not see any mature new technology in the mining industry. In Australia, an ecosystem of governmental actors and research institutes exists, which is enabling technological advancements.

A technology supplier needs to understand why the industrial actors are hesitating to incorporate new and improved solutions. It is also the technology supplier's responsibility to connect and integrate with existing infrastructure. For technologies enabling digitalisation, a data transparency approach is also a requirement.

Metamorphism and exhumation of basement gneiss domes in the Quadrilátero Ferrífero: Proterozoic reworking of an Archean dome-and-keel province

Cutts K[1], Lana C[1], Alkmim F[1], Farina F[2]
[1]Universidade Federal De Ouro Preto, [2]University of Geneva

TS3 - 1.1.4 Crustal evolution of Archean Cratons, Hall A, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Kathryn Cutts is presently a post-doctoral researcher at the Universidade Federal de Ouro Preto in Brazil. Her research interests are metamorphic petrology, in situ geochronology, Archean geology and plate tectonics.

Dome-and-keel provinces result from conditions unique to Archean geology. The Quadrilátero Ferrífero in Brazil has been identified as a dome-and-keel province for more than three decades. The prevailing model for formation suggests that it was formed in the Paleoproterozoic, during the Rhyacian Transamazonian orogeny, in contrast to typical Archean dome-and-keel provinces. This study unravels metamorphic conditions for the Quadrilátero Ferrífero and contributes to the scarce metamorphic data available for dome-and-keel provinces. A garnet-gedrite-bearing schist from the edge of the Bação dome has a clockwise P-T path reaching 8-9 kbar and 650-700 °C with a zircon age of ca. 2775 Ma. A coarse-grained clinopyroxene-bearing migmatite from the dome core has peak P-T conditions of 5-7 kbar at 700-750 °C. Zircon obtained from leucosomes give U-Pb ages of ca. 2730 Ma. Fine-grained epidote, titanite and amphibole occurs on the rims of the coarse clinopyroxene. This fine-grained assemblage produces peak conditions of 8-9 kbar at 550 °C corresponding to a titanite age of ca. 2040 Ma. The Archean metamorphism is contemporaneous with migmatisation and minor plutonism throughout the domes. Plausibly this is a result of partial convective overturn. The Paleoproterozoic event is interpreted as a reactivation of the dome-and-keel formation structures during the Rhyacian orogeny, involving younger sedimentary successions and forming a metamorphic aureole, effectively obscuring the older event. The Paleoproterozoic reactivation was likely only possible because of the presence of the earlier structures and resulted in a cryptic record for the Quarilátero Ferrífero dome-and-keel province.

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Evidence for a >90 Myr Palaeoproterozoic tectonothermal cycle at the southern margin of the North Australian Craton

Reno B[1], Weisheit A[2], Beyer E[2], Thompson J[3], Meffre S[3]
[1]Northern Territory Geological Survey, [2]Northern Territory Geological Survey, [3]University of Tasmania

Biography:
Barry is a senior geologist at the Northern Territory Geological Survey working on basement terrains in central Australia and in the Top End. Barry has a PhD in geology from the University of Maryland at College Park. Prior to joining NTGS, Barry was a postdoctoral research scientist at the University of Copenhagen, and a research scientist at the Geological Survey of Denmark and Greenland.

The Aileron Province, at the southern margin of the North Australian Craton (NAC), has previously been interpreted to preserve evidence for multiple, short-lived tectonic events during the Palaeoproterozoic (e.g. Yambah and Strangways events). Here we present new integrated petrochronologic, metamorphic, and structural constraints on Palaeoproterozoic tectonics from the northeastern Aileron Province suggesting that this part of the NAC instead experienced a single, >90 Myr tectonothermal cycle during the Palaeoproterozoic. This tectonothermal cycle initiated during intrusion of bimodal magmas into a continental back-arc basin sedimentary sequence starting at ca. 1.79 Ga. Near-continuous igneous intrusion over the subsequent ca. 40 Myr in an extensional environment supported high-thermal-gradient metamorphism, with up to UHT granulite facies conditions and pressures up to 1.0 GPa. The resultant thermal weakening of the crust led to the development of a crustal-scale shear zone system that accommodated relative movement between individual, 500-1000 km^2-scale tectonic domains. Relative vertical movement between the domains is indicated by a near-peak-temperature, isothermal change in pressure during the period 1.77–1.75 Ga. Strike-slip movement along the shear zone system was caused by a switch to a transpressional stress regime after ca. 1.75 Ga, also marking the end of the highest-temperature phase of the metamorphic cycle. Deeper crustal domains were exhumed to ~0.4 GPa, and were at the same relative crustal level by ca. 1.73–1.69 Ga. The new interpretation of a single tectonothermal cycle in the Palaeoproterozoic has implications for tectonic regime operating at the southern margin of the NAC during the Proterozoic.

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Applying GIS in regional sedimentary basin evaluation studies

Jupp B[1], Stuart-Smith P[2], Woodfull C[2], Collings P[3]
[1]SRK Consulting, [2]SRK Consulting, [3]Minerals Australia; Hancock Prospecting Pty Ltd

TS6 - 3.1.2 Making better exploration decisions through an integrated geoscience approach, Hall E2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
*Ben Jupp has over ten years' experience specialising in geology and 3D geological modelling and currently works as a Senior Consultant at SRK Consulting. He has worked on various projects inclusive of multi-scale mineral and oil and gas prospectivity studies, structural mapping and 3D geological modelling at both deposit and regional scales. Previous to this Ben has worked with the Queensland Geological Survey and the Predictive Mineral Discovery*CRC at both Monash University and Geoscience Australia. During this time he focussed on regional 3D architectural and mineral systems studies of Northwest Queensland and the McArthur Basin.*

GIS was initially used by geologists as a map making tool and as a digital light table to compare and contrast datasets. However, with the ever increasing development of software tools and with more utilization of these systems by geologists, GIS has become fundamental in managing and understanding exploration datasets throughout the exploration project life cycle. GIS provides geologists with the tools to integrate, process, compare and contrast, numerous disparate datasets and from each of these we can analyse spatial relationships and create a variety of predictive maps that mimic potential mineral or petroleum systems. In early stage exploration, GIS provides: a rapid and cost effective way to evaluate exploration areas; build understandings of the subsurface geology; and a basis for developing 3D models, and economic potential prior to investing in expensive data acquisition campaigns. This paper discusses how through GIS integration and analysis of publicly available government and historic exploration datasets, detailed structural and geological interpretations and basin evaluations can be achieved. This presentation will draw on recent interpretations conducted within the Proterozoic South Nicholson Basin and Beetaloo Basin in the Northern Territory.

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Locating hidden terrane boundaries in East Antarctica with detrital feldspar Pb isotopes

Mulder J[1], Halpin J[2], Daczko N[3], Meffre S[4], Orth K[4], Thompson J[4], Morrissey L[5]
[1]School Of Earth, Atmosphere & Environment, Monash University, [2]Institute for Marine and Antarctic Studies, University of Tasmania, [3]Department of Earth and Planetary Sciences, Macquarie University, [4]ARC Centre for Excellence in Ore Deposit Studies, University of Tasmania, [5]Faculty of Earth Sciences, University of Adelaide

TS4 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Jack's research interests include petrochronology, metamorphic petrology, plate reconstructions, and supercontinent cycles. His current research focuses on using detrital minerals to reconstruct the tectonic evolution of continents and to understand processes that bias the sedimentary record

The assembly of eastern Gondwana involved the amalgamation of Indo-Antarctica and Australo-Antarctica along the Kuunga orogen. The location of the suture or sutures between Indo-Antarctica and Australo-Antarctica within the Kuunga orogen remains debated as key geological relationships are concealed beneath ice. The most recent interpretation identifies the 'Mirny Fault' as a key suture between crust of Indo-Antarctic and Australo-Antarctic affinity. However, sparse exposure of bedrock in this region precludes traditional geological characterisation of the crust on both sides this structure.

Here, we test the Mirny Fault as a key suture between Indo-Antarctica and Australo-Antarctica using Pb isotopes of detrital feldspars from offshore sediments referenced to new and compiled feldspar Pb isotopic data from onshore exposures of Indo-Antarctica and Australo-Antarctica. The feldspar Pb-isotope signature of Indo-Antarctica forms a broad population with $^{207}Pb/^{204}Pb$ ratios of 15.5—16.1 and $^{206}Pb/^{204}Pb$ of 17—19. In contrast, Australo-Antarctica has a feldspar Pb-isotope signature characterised by a tight cluster of $^{207}Pb/^{204}Pb$ (15.5—15.8) and $^{206}Pb/^{204}Pb$ (16.5—17) ratios, which is distinct from Indo-Antarctica. Locally-derived Holocene sediments offshore of the Mirny region contain detrital feldspars with Pb-isotope compositions recording a contribution from both Indo-Antarctica and Australo-Antarctica.

The presence of Australo-Antarctic and Indo-Antarctic crust near the Mirny Fault supports the interpretation of this structure as a fundamental terrane boundary. We interpret the Mirny Fault as the key suture between Indo-Antarctica and Australo-Antarctica and trace this boundary into the interior of East Antarctica to connect with an inferred Gondwanan-aged suture within the Gamburtsev Subglacial Mountains.

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Using XRF to Evaluate and Improve TIR Hyperspectral Unmixing.

Green A[1], Gordon G[2], Mauger A[2]
[1]OTBC, [2]GSSA

Biography:
Andy Green has been involved with airborne and space-borne geophysics and remote sensing for longer than he cares to remember. He started remote sensing and image processing research with CSIRO at high frequency and gradually migrated fourteen orders of magnitude down-frequency to work on airborne EM systems. Now his research has reverted almost to childhood as he is back working in the area of his PhD in infra-red spectroscopy. He says he is excited and privileged to be able to be a small part of the development of HyLogging technology.

With the advent of thermal infrared hyperspectral scanning of drill core the opportunity to deliver quantified mineral proportions derived from spectral information calibrated with ancillary laboratory results is coming closer to fruition. In this study the results from HyLogger-3 and XRF analysis by Minalyze CS were compared with conventional assay results for major elements (Al, Si, K, Ca and Fe) for the hole MSDP11 in South Australia.
The HyLogger mineral proportion estimates from TIR unmixing algorithms were first converted to elemental proportions using standard stoichiometric formulae for each mineral. The element wt% results from the Hylogger and Minalyse were resampled to match the From/To sampling of the assay results and all three were plotted as a function of depth down-hole. Using the assay results as "Truth" the Hylogger/Assay correlations and the Minalyse/Assay correlations were compared to assess the performance of the two methods.
Minalyse results were well correlated with Assay results except in a domain of intense weathering. The Hylogger results were also poorly correlated in this region but the availability of the geochemistry enabled us to confirm the value of a new type of mixing model for these quartz/kaolin assemblages. With the exception of a magnetite rich domain the Hylogger performed almost as well as the Minalyse XRF in the rest of the hole.

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Mineral potential mapping for pre-competitive data delivery in NSW Zone 54

Ford A[1], Downes P[2], Fitzherbert J[2], Partington G[1], Blevin P[2], Greenfield J[2], Peters K[1]
[1]Kenex Ltd, [2]Geological Survey of New South Wales

TS6 - 3.1.2 Making better exploration decisions through an integrated geoscience approach, Hall E2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Arianne is a Senior GIS Analyst at Kenex Ltd in New Zealand and her expertise is in GIS, and the application of spatial statistics and computational techniques for mineral exploration targeting and resource classification. She has more than 10 years previous experience as an academic working on research problems for the mineral exploration industry and government organisations. She holds an Honours degree in Computer Science and a PhD in Economic Geology, both from James Cook University in Australia, and has previously held research positions at the University of Western Australia and James Cook University.

A collaborative project between the Geological Survey of New South Wales (GSNSW) and Kenex Pty Ltd was undertaken to evaluate the mineral potential of MGA Zone 54 in NSW as a continuation of GSNSW's ongoing program of mineral potential mapping across the state, which commenced in the southern New England Orogen in 2017. The results of the Zone 54 project will deliver a pre-competitive geoscience data package that will be used to guide mineral exploration and land-use planning in the region.

Prior to modelling, the available datasets were reviewed and updated by GSNSW to ensure accuracy and that relevant attribute information was present. Using a mineral systems approach, models were developed for Broken Hill Type Pb-Zn-Ag and IOCG mineralisation in the Curnamona Province, and Orogenic Au and VHMS mineralisation in the Delamerian-Thomson Orogens. The component processes in the mineral system models were translated into mappable targeting criteria. The key predictive variables, mapped using geological, geochemical, and geophysical datasets, were determined using spatial statistics. Mineral potential maps were generated for each mineral system using a weights of evidence approach. Area-frequency analyses show model efficiencies between 88-99%, which indicate almost all training points used to represent evidence of the mineral system being targeted are predicted within a small area. A comprehensive spatial data table outlining the details of the mappable targeting criteria and the results of the spatial data analysis, and maps of the key predictive variables were delivered, along with the mineral potential maps as a pre-competitive dataset for public release.

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Basin–basement contacts as base metal exploration targets: Evidence for mineralising basin brines in central Australia

McGloin M[1], Whelan J[1], Kendrick M[2], Mernagh T[2], Maas R[3]
[1]Northern Territory Geological Survey, [2]Australian National University, [3]University of Melbourne

TS7 - 3.1.2 Making better exploration decisions through an integrated geoscience approach & 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Matt is a geologist from the NTGS and works on a range of mineral systems in central Australia. Before NTGS, he researched uranium, rare earth and IOCG mineralisation in the Mount Isa Inlier. Previously Matt has worked for uranium, nickel, gold and copper exploration companies in Australia and Zambia.

The Amadeus and Georgina basins of the Centralian Superbasin are commonly labelled prospective for base metals yet no economic base metal mineralisation has been discovered. Using central Australia as an example, the concept that economic base metal mineralisation could exist in areas where basinal fluids interact with suitable basement source rocks is explored.

Large fluorite–quartz±carbonate±barite vein systems that host chalcopyrite mineralisation were studied. Fluid inclusion, and halogen, noble gas and rare earth isotopic data suggest that these veins formed when younger basinal brines mineralised older Palaeoproterozoic-aged rocks on basin–basement contacts. The data are most simply explained by evolved fluids that originally formed by subaerial evaporation of seawater beyond the point of halite saturation. Fluid inclusions had salinities from 24–60 wt% NaCl equivalent and temperatures between 90–400°C. Field relationships indicate that some veins are Cambrian-aged or younger. Sm-Nd fluorite dating of one vein system yielded a geologically plausible age of 530 ± 22 Ma.

One interpretation of the results is the possibility of a widespread hydrothermal mineralising episode at ca 635–490 Ma. The range of halogen and 40Ar/36Ar ratios are similar to those reported in MVT Pb-Zn deposits, but the studied mineral system appears to be hotter and amenable to Cu rather than Pb–Zn mineralisation. The results open up potential exploration space on basement–basin contacts; likewise, areas of overlying basin with suitable source rocks (eg rift zones, metal-rich detritus) remain suitable targets for exploration, providing these areas can be mined at economically explorable depths.

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Establishing geochemically appropriate sampling media in the critical zone of South Australia – a 4D journey through datasets and geology

Petts A[1], Krapf C[1]
[1]*Geological Survey Of South Australia*

TS7 - 3.1.1 Effective exploration and discovery under cover, Room R2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Anna Petts graduate from the University of Melbourne with Honours in 2002, and completed her postgraduate degree with the Cooperative Research Centre for Landscape Environment and Mineral Exploration (CRCLEME) and the University of Adelaide, in 2008. Her PhD research in regolith mapping and surface geochemistry took Anna across the Tanami Desert, to Tanzania and all around Australia, and she has continued working interstate as well as in South Australia during her time in the mineral exploration industry. Anna is now Program Coordinator at the Geological Survey of South Australia, leading the 'Characterising South Australia's Cover' team.

The 'critical zone' or regolith, is the near surface environment in which complex interactions between rock, soil, water air and living organisms occur. It includes many types of potential sampling media that have been or can be utilised for exploration, mining and environmental surveys. While geochemical data is obtained from a wide variety of sampling media, the quality of these data can vary from region to region and there is a pressing need to determine geochemical baselines for media such as soil and calcrete geochemistry, plant biogeochemistry, and groundwater chemistry, especial when various datasets are utilised and compared against eachother. These baselines show the average chemical values and variations, and can be used to understand the chemistry of the local area when interpreting a plant, soil, or calcrete survey, or for evaluating local variations in the chemical responses of plants, soil and water for environmental monitoring. This study reviews the available sampling media for regolith geochemistry recorded in databases of the Geological Survey of South Australia (GSSA). Accurate and efficiently modelled surface chemistry can map underlying basement and delineate possible buried mineralisation. This should be done in combination with an understanding of landscape setting, however, as this can have a large impact on results. Therefore, we also propose to couple sampling media evaluations with regolith-landform mapping to constrain geomorphic effects on any model. An evaluation of the quality of the datasets supports GSSA's role to provide accurate, reliable and fit for purpose data for stakeholders within a 4D geological framework.

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Assessing the controls on global contourite distribution: implications for reconstructing bottom water activity

Thran A[1], Dutkiewicz A[1], Spence P[2,3], Müller D[1,4]
[1]EarthByte Group, School of Geosciences, University of Sydney, [2]Climate Change Research Centre, University of New South Wales, [3]ARC Centre of Excellence for Climate System Science, University of New South Wales, [4]Sydney Informatics Hub, University of Sydney

TS4 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Amanda is interested in deep sea sedimentation patterns and ocean modelling. Following her Honours work at the University of Sydney studying the tsunamigenic submarine landslides on the Queensland continental slope, Amanda began a PhD project in 2016 with the EarthByte group under the supervision of Dr. Adriana Dutkiewicz and Prof. Dietmar Müller. In collaboration with the Climate Change Research Centre at UNSW, she is currently interested in linking global ocean circulation models with the distribution of contourites in the deep sea.

Contourites, or sediment drifts, are anomalously high accumulations of deep-sea sediment. Though reworking by vigorous bottom currents are generally thought to be responsible for their formation, their more precise causal mechanisms are not yet fully understood. Using a comprehensive database of 267 modern features and an eddy-resolving ocean sea-ice model, we show that global contourite distribution closely corresponds with stronger simulated bottom currents. Results reinforce the previous consensus that global meridional overturning circulation exerts a first-order control on contourite distribution. Also echoing the present consensus, topography exerts strong control on sediment drift distribution. However, we find that average annual bottom current speeds are marginally higher over contourites (2.2 cm/s) in comparison to the rest of the ocean (1.1 cm/s), falling well below thresholds required to re-entrain silt-sized sediments. In comparison, bottom currents fluctuate more frequently and with greater intensity over contourites, suggesting that intermittent, high-energy bottom current events (i.e. benthic storms) may play a central role in sediment erosion, transport, and subsequent drift accumulation. We identify eddies as a major driver of bottom current fluctuations, where eddy kinetic energy in the bottom layer of the model is over three times higher in areas with contourites. Our results also highlight the potential role of upper ocean dynamics in contourite sedimentation through the direct influence of deep eddy circulation. These results imply that the contourite record should be interpreted in terms of a bottom current's susceptibility to experiencing periodic, high-speed current events.

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Could meteorite bombardment have kick-started the plate tectonic machine?

O'Neill C[1]
[1]*Macquarie University*

TS8 - 1.5 The solar system and beyond, Hall C, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Craig O'Neill is the director of the Macquarie Planetary Research Centre.

The identification of multiple spherule beds in the meso-Archaean has provided critical constraints on bombardment rates, and have been associated with the inception of tectonics in the Kaapvaal at 3.2Ga. This date is very close to many estimates for the onset of plate tectonics from geological and geochemical arguments.

Previous geodynamic models incorporating impact effects suggested that meteoritic bombardment may have driven temporary subduction events in the Hadean, which would have affected crustal production and magnetic field strength. Interestingly such studies have suggested that smaller impacts (<100km diameter bodies) may have generated tectonic effects, if they disrupted lithosphere already susceptible to overturns.

Here we extend these models to explore the known impact rate for the Mesoarchean. We incorporate estimates for dated impact size and velocity, based on spherule bed characteristics, in evolving models of mantle convection under Archean thermal conditions. We explore the effect of impactor size and velocity, but also lithospheric thickness and lithospheric gradient. For the constrained size of impactor (20-100km) responsible for these spherule beds, the success of impacts in generating tectonism strongly related not just to size, but also lithospheric gradient. The development of lithospheric gradients has previously been indicted in subduction initiations, -we suggest that cooling of the Earth up to the Mesoarchean allowed the development of significant lithospheric gradients for the first time (as suggested by the appearance of cratonic roots) - and that moderate impact fluxes may have provided the impetus for subduction initiation on a maturing Earth.

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On the validity of the 2.5D assumption when modelling airborne electromagnetic data

Annetts D[1], Hauser J[1]
[1]*CSIRO*

Biography:
David Annetts has been with CSIRO since 2007. A forward-modeller by inclination, he has researched the application of frequency and time-domain electromagnetic prospecting methods to marine CSEM, CO2 sequestration, uranium and groundwater exploration, and maintains interest in CSIRO's Bayesian Lithological Inversion initiative.

Recently, regional airborne electromagnetic surveys have been commissioned with intra-line spacing of the order of 20 km. Such surveys have led to renewed interest in the 2.5D approximation where the response of 2D geology is modelled using a 3D prospecting system. From practical point of view the underlying assumption is that geology only changes in the direction of the survey line. Specifically, this means that finite-length, off-flight line, non-perpendicular and non-bisected conductors are all modelled in the same manner as flight-line bisected, 2D conductors. This motivates testing the validity of the 2.5D approximation using public-domain modelling codes to model responses of finite-length and 2D targets respectively. We compare forward model responses of finite-length targets to those of 2D targets for a range of target sizes and orientations and discuss the characteristics of finite-length targets that can and those that cannot be adequately represented with a 2.5D approximation. Differences in late-time decay characteristics between finite-length and 2D targets suggest that the later should not be used to model finite-length targets in moderately resistive cover settings (e.g. those with regolith resistivity greater than 10 Ωm). This suggests that a more efficacious approach to the detection of discrete targets from surveys with large intra-line spacing in such regimes is to invert for finite-length rather than 2D targets which is the underlying assumption of 2.5D modelling.

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Australian space and planetary capabilities: Implications for Earth Sciences

O'Neill C[1]
[1]*Macquarie University*

TS1 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
A/Prof Craig O'Neill is a geodynamicist and planetary scientist, and champions these disciplines relentlessly in the National Committee of Earth Sciences/AAS.

One of the fundamental drivers in the development of Space technology has been planetary exploration, and Earth monitoring.

From the inception of the space-race, to missions today, planetary science has been the impetus to the capabilities that underlie the current commercial space industry. Today planetary science continues to drive the capability of space technologies through the demanding requirements of Solar-System exploration missions, and orbiting astronomical telescopes.

Likewise, the monitoring of the Earth from space has dominated orbital capabilities from 1960s with the launch of TIROS, the first NASA weather satellite. This capability exploded in the 1990's with the development of the Earth Observing System program, which led to expanded capabilities not just in satellite imagery, but also Radar (eg. ERS-1, including inSAR – capable of measuring minute ground variations), gravity (Grace, GOCE – monitoring hydrosphere and ice sheet change), and spectrometry (pioneered by TOMS - Total Ozone Mapping Spectrometer (TOMS), which mapped the hole in the ozone layer).

Today, the use of satellite data permeates every field in Earth and Environmental sciences, and underpins our national prosperity in mining and exploration, reservoir modelling, geohazards mapping and prediction, land use, vegetation changes, agriculture, and water resources. Investment in this infrastructure critical for real-time monitoring capabilities. Planetary science technology has likewise driven science forward, from space technology, to precision geochemical measurements, and the upcoming decade is a critical period for investment in these capabilities.

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Age and trace element composition of detrital zircon grains from Mesozoic terranes in New Zealand

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D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
I am undertaking a PhD at the School of Earth and Environmental Sciences, University of Queensland. I utilised fieldwork, structural geology, stratigraphy, geochronology, geochemistry and remote sensing to improve our understanding of the Paleozoic-Mesozoic tectonics and crustal architecture of the southwest Pacific (Zealandia).

Permian to Cretaceous supra-subduction tectonostratigraphic units, which formed along the eastern margin of Gondwana, are preserved in eastern Australia (Tasmanides) and in the continental basement of the southwest Pacific region (Zealandia). These terranes are exposed in New Zealand and New Caledonia but their original positions and tectonic configurations along the eastern Gondwana margin has been modified in the course of subduction, backarc extension, and seafloor spreading. In order to better understand the tectonic configuration of the eastern Gondwana margin, we present new U-Pb detrital zircon ages and trace element concentrations from nineteen samples from the Permian-Cretaceous Dun Mountain-Maitai and Murihiku terranes in New Zealand. Samples from the Permian-Triassic Dun Mountain-Maitai Terrane display unimodal age spectra dominated by detrital zircon ages between ~275-240 Ma, with a single maximum peak at 260 Ma. In contrast, samples from the Permian-Cretaceous Murihiku Terrane consist of both unimodal and polymodal age spectra, dominated by detrital zircon ages of ~300-165 Ma, with age maxima at 265 Ma, 240 Ma, 230 Ma, 190 Ma and 175 Ma. Trace element abundances indicate that the majority these zircon grains crystallized from a granitoid source. Noticeable differences in Ce/Ce* and Eu/Eu* abundances suggest that zircon grains crystallized from magmas with different petrogenetic histories/sources. Our new results suggest that the Dun Mountain-Maitai most likely occupied a restricted fore-arc position adjacent to the New England Orogen of eastern Australia. The Murihiku terrane also developed in restricted but different fore-arc basin, and recorded Devonian-Cretaceous magmatism characteristic of the Median Batholith in New Zealand.

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Seismicity, Minerals, and Craton Margins: The Lake Eyre Basin Seismic Deployment

Eakin C[1], **Sambridge M**[1], Salmon M[1]
[1]Research School of Earth Sciences, The Australian National University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Malcolm Sambridge is currently a Professor in the Research School of Earth Sciences at the Australian National University. His research contributions have been in geophysical inverse problems across the Earth Sciences and in particular seismology. His research involves the development and application of techniques for geophysical inference; seismic wave propagation; imaging of the internal structure of Earth; robust inference from Earth science data; computational geophysics and numerical algorithms.

Starting later this year a new AuScope seismic experiment (using ANSIR instruments) will transform seismic data coverage across South Australia and Lake Eyre Basin, coinciding with additional geophysical surveys in the region such as AusLAMP. The array of 40 seismometers will eradicate a major gap (or blind spot) in the national seismic network. A range of seismic imaging techniques will be applied allowing for the nature of a suspected continental weak zone between the Gawler Craton and Lake Eyre Basin to be determined. Not only is this weak continental boundary associated with a recent surge of seismic activity, but is also home to some of the most valuable mineral resources in Australia (e.g. Olympic Dam, the world's largest uranium deposit, and the 4th largest copper deposit).

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Overview of the CSIRO Noble Gas Tracer Laboratory at Waite Campus

Suckow A[1], **Deslandes A[1]**, Gerber C[1], Kersting A[1,2], Smith S[1,3], Mallants D[1]
[1]Commonwealth Scientific and Industrial Research Organisation , [2]Institute of Environmental Physics, [3]Utah Geological Survey

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
At CSIRO Alec Deslandes has been involved in building and testing the first facilities in Australia to measure noble gases and radioactive noble gases in water samples.

Noble gases are ideal tracers for water since they show no chemical alteration, an advantage versus the classical tracers CFCs and ^{14}C. CSIRO Environmental Tracer Laboratories at Waite Campus since 2017 operates the only stable noble gas facility in the southern hemisphere, measuring He, Ne, Ar, Kr and Xe on water samples. A few hundred samples have been measured for a dozen projects across the continent, providing information on dating old groundwater (He), recharge temperatures (heavy noble gases) and infiltration conditions (Ne). They informed groundwater flow velocities up to the scale of hundreds of kilometres, recharge rates, inter-aquifer connectivity, and groundwater - surface water interaction.
Presently we expand our capabilities in several directions:
1) Measuring the less abundant stable noble gas isotopes (e.g. ^{3}He, ^{21}Ne), in hand with increased sensitivity and decreased sample size. This requires a high resolution mass spectrometer (Helix MC, late 2018).
2) Field-based measurement: A membrane-inlet mass spectrometer (MIMS) is in development allowing dissolved gas measurements (N_2, Ne, Ar, Kr) within minutes.
3) Measurement of the radioactive noble gas isotopes allowing studies on time scales of decades (^{85}Kr), centuries (^{39}Ar), and millennia to one million years (^{81}Kr). We developed and tested a new generation of large volume field-based gas sampler, we operate a laboratory-based purification system preparing pure Ar and Kr from 40L gas, and we develop a gas proportional radiometric counting system (due 2019). These are coupled with the Atom Trap Trace Analysis development in Australia, which will be based at the University of Adelaide.

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3D models integrating geology and geophysics stimulate exploration in Tasmania

Bombardieri D[1], **Duffett M[1]**, Xie J[2]
[1]Mineral Resources Tasmania, [2]Yunnan Tin Australia TDK Resources Pty Ltd

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
After undergraduate study at the University of Adelaide, Mark Duffett came to the University of Tasmania in 1992 to do Honours in geophysics. He stayed until 1998, eventually gaining a PhD. Following this he variously researched, taught and otherwise worked at Charles Darwin University, the Northern Territory Geological Survey and CODES; on projects ranging from saltwater crocodile nesting habitat prospectivity mapping to regional potential field acquisition, interpretation and modelling in northern Australia, the African Copperbelt and Tasmania. Since 2009 he has been Senior Geophysicist at Mineral Resources Tasmania.

Recognising that improving exploration success rates will require better geometric understanding of how geological evolution controls mineralising processes, Mineral Resources Tasmania has been adding geophysically constrained 3D models to its suite of precompetitive geoscience products.

A regional model of the heavily mineralised terranes in central west Tasmania was constructed in 2013, synthesising decades of previous exploration, academic and Geological Survey work. The new model's geophysical response indicated an area of unexplained low gravity. This feature was confirmed and refined by subsequent new data acquisition. Its interpretation as a subsurface granite intrusion remained robust through a range of 3D magnetic and gravity modelling parameters.

Probabilistic inversion indicated the top of the granite to be most likely just over 1000 metres below the surface, in an area obscured by Quaternary cover. Country rock modelled in the vicinity of the interpreted intrusion consists of variably serpentinised ultramafics, limestone and mafic volcano-sedimentary sequences. This situation indicates prospectivity for several mineralisation styles known to occur in the region, including Renison/Mt Lindsay carbonate-replacement tin/skarn and Avebury-style nickel.

The area is under exploration title held by Yunnan Tin since before this work commenced. The new information prompted further gravity and AEM surveys, followed by a drillhole designed primarily to test the granite interpretation. TCGA-01 penetrated about half the serpentinised ultramafics modelled above the granite before being stopped by technical difficulties associated with a (predicted) major fault. Hylogging of the core has identified carbonates near the bottom consistent with a distal hydrothermal system. Follow-up exploration is ongoing.

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Patterns of Proterozoic tectonism in central and South Australia from detrital zircon and rutile geochronology

Verdel C[1], Campbell M[2], Ward J[2], Allen C[3]
[1]School of Earth, Environmental and Biological Sciences, [2]School of Earth and Environmental Sciences, University of Queensland, [3]Institute for Future Environments, Queensland University of Technology

TS6 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Charles Verdel's research interests include the Neoproterozoic stratigraphy of central and South Australia.

Spatial and temporal fluctuations in the detrital zircon record of Neoproterozoic-Cambrian strata in central and South Australia are tied to regionally important periods of tectonism and magmatism. Major sources of detrital minerals in the Neoproterozoic-Paleozoic basins of central Australia (the Centralian Superbasin) include Paleoproterozoic and Mesoproterozoic crystalline rocks of the Arunta and Musgrave Inliers. We add new detrital zircon and rutile U-Pb results from central Australia, and we place them in the context of a wealth of previously published detrital zircon data from central and South Australia. The bulk of detrital rutiles from a Cryogenian glacial deposit in the eastern Amadeus Basin of central Australia are roughly 1.9 to 1.0 Ga and seemingly reflect periods of metamorphism in the Arunta Inlier to the north. A significant shift in trace element compositions of central Australian detrital zircons occurred between 1.8 and 1.6 Ga, corresponding with a previously reported shift in zircon Hf isotope composition and the likely formation of late Paleoproterozoic/early Mesoproterozoic subduction zones between the North and South Australian Cratons. The initial appearance of appreciable ~1.1 Ga, Musgrave-derived zircons in central and South Australian basins ranged from latest Mesoproterozoic in parts of the Amadeus Basin, to Cryogenian in the Adelaide Rift Complex, to Ediacaran in the Georgina Basin. The variability in initial appearance of the ~1.1 Ga zircon population is probably related to multiple periods of uplift of the Musgrave Inlier during Neoproterozoic to Cambrian orogenic events that are marked by regional-scale unconformities in the various basins.

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High-resolution paleochannel reconstruction using deep learning approaches

Jiang Z[1,2], Mallants D[1], Peeters L[1]
[1]CSIRO Land & Water, [2]Jilin University

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
I am interested in the subsurface heterogeneity characterization from local to the regional scales. I used sedimentary process model and geostatistical methods to describe the distribution of hydraulic conductivity (K) in an aquitard. I now try the deep learning approaches to image the aquifers in high-resolution, and will use it in the APY Land to constrain the regional groundwater model and also in fractured media for effective geothermal energy exploitation.

Capturing the subsurface heterogeneity at regional scale (tens to hundreds of kilometers) is challenging due to the high cost to collect data at high resolution. Airborne geophysical survey offers a unique tool to obtain geophysical properties of the shallow subsurface, e.g. electrical conductivity, density and seismic velocity. An effective approach to convert these geophysical measurements into geological structures such as palaeochannels is still under development. We here introduce the super-solution convolutional neural network (SRCNN) methodology to convert the electrical conductivity resulting from airborne electromagnetic surveys to a high-resolution binary palaeochannel. The SRCNN is trained and tested based on a synthetic training dataset, where palaeochannels are generated from digital elevation model (DEM) data. Electrical conductivities (EC) corresponding to the channels are generated by Archie's equation and are blurred by downsampling and geostatistical interpolation. EC images in the training dataset are expected to include the possible errors induced by AEM survey, inversion and interpolation. After a model training step, SRCNN can identify these errors. We tested whether SRCNN can reclassify the EC values from an initial skewed Gaussian distribution into a bimodal distribution with data near zero and one. Based on such bimodal distribution, the threshold value to define the channel and non-channel elements can be better defined. We here demonstrate that SRCNN can also reconstruct the connectivity of the channels. Moreover, SRCNN is able to train the relationship between pixel-based EC and channel image, and works well to upscale the low-resolution EC values to a high-resolution channel image.

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Rainfall-triggered landslides from the 'Tasman Tempest' and ex-Tropical Cyclone Debbie storms, March-April 2017 in Auckland, New Zealand

Brook M[1]

[1]*The University Of Auckland*

Biography:

Dr Martin Brook is Senior Lecturer In Applied Geology at The University of Auckland. Prior to this role, he was based at Golder Associates in Brisbane, working on ground investigations in the mining and civil sectors in QLD, WA, NT and NSW. He also worked on site investigations in the oil industry in the Middle East. He now teaches and supervises from 1st year to PhD level on a range of engineering geological topics, and undertakes bespoke consultancy for industry clients.

Annually, the south-west Pacific experiences tropical cyclones that bring large amounts of rainfall, causing flooding, landslips and infrastructure damage. In March 2017, tropical cyclone Debbie hit the Queensland coast dumping 747 mm of rainfall within 2 days, leading to multiple shallow landslides in the Gold Coast/northern New South Wales region. The same weather system subsequently crossed Auckland, New Zealand on 5 April, dumping 168 mm of rain in 24 hours. Auckland had already been affected by the "Tasman Tempest" in March, which brought 454 mm of rain in 5 days. Shallow landslides occurred during or soon after both these storms, caused by shear failure due to increased porewater pressure. A field investigation at several sites in Auckland identified landslide and geological characteristics. Landslides predominantly occurred in: (1) bedding plane failures in Miocene Waitemata Group sandstones, as well as slumps and earthflows in (2) Waitemata Group weathered residual soils, (3) late Quaternary Tauranga Group sediments, and (4) man-made fill. The slumps and earthflows tended to be to a depth of 2-6 m. Some of these failures, and their characteristics, are detailed here. Particular focus is also given to the Rawene Slip on Auckland's North Shore, where, after progressive deformation of a carpark surface over several months, two landslides occurred, in October and November 2017. At this residual soil/fill slump-earthflow complex, progressive failure along a weak surface, affected by dynamic loading from piling-induced vibrations at a nearby construction site may have decreased the shear strength of the residual soil and fill.

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The impact of the Great Barrier Reef on tsunami propagation

Thran A[1], Brune S[2], Webster J[3], Dominey-Howes D[4], Harris D[5]
[1]EarthByte Group, School of Geosciences, University of Sydney, [2]GFZ German Research Centre for Geosciences, [3]Geocoastal Research Group, School of Geosciences, University of Sydney, [4]Asia-Pacific Natural Hazards and Disaster Risk Research Group, School of Geosciences, University of Sydney, [5]School of Earth and Environmental Sciences, University of Queensland

TS3 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Mandi is interested in deep sea sedimentation patterns and ocean modelling. Following her Honours work at the University of Sydney on tsunami modeling of submarine landslides on the Queensland continental margin, Mandi began a PhD project in 2016 with the EarthByte group under the supervision of Dr. Adriana Dutkiewicz and Prof. Dietmar Müller. In collaboration with the Climate Change Research Centre at UNSW, she is currently interested in linking global ocean circulation models with the distribution of geomorphological features in the deep sea.

Marine habitats, such as coral reefs, are thought to provide natural protection against coastal hazards. The Great Barrier Reef, the world's largest coral reef ecosystem, has long been speculated to provide the northeastern Australian coastline with a regional first line of defence against hazards such as tsunamis. However, the effect of a reef ecosystem's smaller-scale structural complexity on tsunami attenuation tends to be overlooked. Previous work has demonstrated that coral reefs effectively attenuate wind wave energy, but their impact on tsunami waves is less understood. Using a fully nonlinear Boussinesq wave model, we simulate a series of hypothetical tsunami events to examine the impact of the reef on tsunami propagation across the northeast Australian continental shelf. We find that for both a co-seismic source and a landslide source, the structural complexity introduced by coral cover reduces final run-up estimates. Moreover, our results are consistent with previous findings which suggest that the larger-scale bathymetric complexity of the Great Barrier Reef plays a significant role in blocking incoming wave trains. We also note the importance of using high-resolution (~50 x 50 m) propagation models that are capable of resolving more complex wave behaviors that are incited by the reef platforms. Results imply that the recent degradation and decline of the Great Barrier Reef ecosystem may impact its ability to protect against future tsunami events. Uncertainties remain surrounding the impact of shifting coral community assemblages on benthic structural complexity, and thus, the Great Barrier Reef's buffering capacity.

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Rare earth element geochemistry of Australian Neoproterozoic carbonate and implications for extreme climate change

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D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I am a BAdvSc(Hons) student at The University of Queensland and am completing my Honours thesis 'Rare earth element geochemistry of Australian Neoproterozoic carbonate, and implications for extreme climate change.' By combining field observations with geochemical analyses, my work aims to shed light on the complex environmental changes that occurred during the Neoproterozoic Era.

The Neoproterozoic Era (1000 to 541 Ma) was a period of extreme environmental change, the records of which are geochemical data from shallow water Neoproterozoic carbonate. Here we present a detailed rare earth element (REE) analysis of well-exposed Neoproterozoic and Cambrian carbonate from the Amadeus Basin (central Australia), Flinders Ranges (South Australia) and King Island (Tasmania). Together, these stratigraphic successions comprise a nearly complete record of Neoproterozoic environmental geochemistry and provide insight into the redox state of Neoproterozoic Earth, the influence of glacial meltwater on carbonate precipitation, and Neoproterozoic-Cambrian paleoenvironmental changes experienced by the Centralian Superbasin. REE patterns indicate that Neoproterozoic and Cambrian strata from the Centralian Superbasin were generally deposited in a restricted marine environment that was largely anoxic during Tonian, Cryogenian, late Ediacaran and early-to-middle Cambrian time. High ΣREE of Cryogenian cap carbonate from the Amadeus Basin are interpreted to reflect an increased detrital mineral flux following the early Cryogenian (i.e., "Sturtian") glaciation, which may have spurred the development of critical oligotrophic communities. New REE data from the basal Ediacaran Cumberland Creek Dolostone of King Island provide evidence for an episode of ocean oxidation in the wake of the terminal Cryogenian (i.e., "Marinoan") glaciation. In the context of the global REE dataset, these findings are most consistent with transient Neoproterozoic ocean oxygenation.

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Reassessing the amalgamation of Proterozoic Australia by redefining the Mesoproterozoic evolution of the Rudall Province

Payne J[1], Tucker N[1], Morrissey L[1], van Wijk C[2], Roche L[2], Szpunar M[2], Neroni R[2]
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TS5 - 1.1.6 Proterozoic tectonics, Hall A, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Justin Payne is a Senior Lecture at the University of South Australia with interests in isotope goechemistry, geochronology, evolution of the continental crust and its mineral systems, and the Ediacara biota.

The Tabletop Domain in the Rudall Province, Western Australia, has long been considered to be a pivotal terrain for reconstruction models of Proterozoic Australia. The domain has traditionally been considered to record a distinct magmatic and metamorphic history to the neighbouring Talbot and Connaughton Domains which were linked to the West Australian Craton. Recent studies have demonstrated all three domains share a common Paleoproterozoic history (e.g. Tucker et al., 2018) and similar isotopic compositions (Kirkland et al., 2013; Maidment, 2017; Tucker et al., 2018). In this study we present new data for a series of previously undescribed Mesoproterozoic and Neoproterozoic magmatic events in the Tabletop Domain and surrounding regions. This includes a ca. 1500 Ma felsic suite, a ca. 1180 – 1160 Ma felsic suite and a ca. 970 Ma mafic intrusive. We also present new data for ca. 1300 Ma mafic and felsic intrusives that expand the compositional range of intrusives associated with the previously described Camel Suite. Together with the ca. 1590 Ma Krackatinny Suite these data highlight seemingly divergent magmatic histories between the Mesoproterozoic evolution of the Tabletop Domain and the remainder of the Rudall Province. This result, and the spatial distribution of the new events, raises the possibility of fundamental boundaries existing within the Rudall Province that are not related to the now dominant Camel-Tabletop Fault.

Kirkland et al. (2013). Precambrian Research, 235.
Maidment, D. W. (2017). Report 161, 95 p. Perth, WA: GSWA.
Tucker et al. (2018). Australian Journal of Earth Sciences. ttps://doi.org/10.1080/08120099.2018.1479307

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Evidence for hot orogeny at the Archean-Proterozoic boundary from the P-T-t history of mafic granulites, South India

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D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Priyadarshi has recently moved to Monash University, Australia after completing his PhD from Ruhr-Universität Bochum, Germany. His research interest includes the application of petrology, diffusion chronometry (geospeedometry) and geodynamic modeling to understand the Precambrian crustal evolution and lithosphere dynamics. Some of his recent work includes- deciphering the styles of plate tectonics and the resultant continental recycling processes/rates during Archean, quantifying the exhumation/cooling histories of granulitic terrane of Southern India.

When, and in what form, plate tectonics started on the Earth is still an unresolved question. The major hindrance to the viability of plate tectonics on the early Earth comes from higher mantle temperatures, which reduces the strength and increases the buoyancy of the lithosphere [1]. However, thermomechanical modeling shows that plate tectonics features were likely viable, such as repeated shallow slab break-offs [1] and large-scale peeling-off (delamination) during collision-accretion [2]. Direct information about these latter processes can be retrieved from the P-T-t record of orogenic belts [3]. We found evidence of deep crustal burial (~800 °C, ~13-14 kbar) within an early-Paleoproterozoic (~2.48 Ga) orogenic belt in southern India. Diffusion chronometry indicates that rocks from this belt cooled from ~800 °C (peak) to ~650 °C, at ~5-30 °C/Myr. These cooling rates at high temperatures are an order of magnitude lower than those calculated from the rocks of modern orogens, including the Higher Himalayas [4]. This suggests that the Archean/early Paleoproterozoic granulites cooled within hotter ambient orogenic structures compared to the present-day colder orogens. Our results show that plate tectonics features, such as collision, deep burial and exhumation of crustal rocks, were operating during the Archean-Proterozoic transition, although the thermal structures of such old orogens were different than the modern ones.

[1] van Hunen and van den Berg (2008), Lithos 103, 217-235, [2] Chowdhury et al. (2017), Nat Geosci 10, 698-703. [3] Brown (2007), Int Geol Rev 49, 193–234. [4] Sorcar et al. (2014), Contrib Mineral Petrol 167(2), 957.

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The Evolution of a Common Language for Petroleum Resource Classification and Management

Pribyl B[1]
[1]Santos

TS3 - 3.4 Resources sustainability – responsible investment and management, Room R2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Barbara is the Reserves and Resources Manager for Santos Ltd and has over 20 years' experience as a geologist and managing reserves and resources in the Australian and International oil and gas industry. Barbara is a Fellow of the Centre of Ethical Leadership, University of Melbourne. She has been a member of the Society of Petroleum Engineer Engineers (SPE) Oil and Gas Reserves Committee (OGRC) since 2014 and Joint Technical Editor of the annual Reserves/Asset Management edition of the Journal of Petroleum Technology.

The ability to distil complex scientific issues into plain English is a challenge faced by all who work in natural resources and communicate findings and meaning to the broader community. The benefit of a common set of definitions and framework describing resource uncertainty and risk evolved during the 20th century and continues today. A number of different frameworks arose in response to local or industry specific requirements. In today's globalized economy it is more important than ever to have a common framework of applicable standards. Those standards must also respond to increasing societal demand for recognition of a broader range of factors, including environmental and public benefit, which must also be considered in estimating project risk and confidence. A modern and comprehensive framework that can be applied broadly and consistently is beneficial for all stakeholders including international financial, government, regulatory, industry and reporting entities.
The United Nations Framework Classification (UNFC) offers a modern system, applicable to a broad range of applications. It evolved from solid fuel and mineral commodities to petroleum, uranium, injection and now includes renewable energy and anthropogenic resources. Concurrently, the Petroleum Resources Management System (PRMS), which is the petroleum system widely used in the oil and gas industry and is mapped to the UNFC, has been undergoing an update planned for release in 2018.
The future state of both systems is to be maintained evergreen and incorporate new best practices, provide interpretational guidance, and be the premier classification and management standards.

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Engineering geology and strata control at Carborough Downs underground coal mine, Bowen Basin, Australia

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Biography:
Dr Martin Brook is Senior Lecturer in Applied Geology at The University of Auckland, where he teaches and supervises students from 1st year to PhD. Prior to this he was an engineering geologist at Golder Associates in Australia, working in the mining and civil sectors across NSW, QLD, WA, SA and NT.

Developing an accurate geotechnical model and realistic delineation of variation in rock mass conditions are important prerequisites for slope stability analyses, tunnel design, mine planning and risk management. Rock mass classification schemes such as Rock Mass Rating (RMR), Coal Mine Roof Rating (CMRR), Q-system and Roof Strength Index (RSI) have been used for a range of engineering geological applications, including transport tunnels, “hard rock” mining and underground and open-cut coal mines. Often, rock mass classification schemes have been evaluated on subaerial exposures, where weathering has affected defect characteristics and intact strength. The focus of this evaluation of the above classification schemes is an underground coal mine in the Bowen Basin, central Queensland, Australia, 15 km east of the town of Moranbah. Rock mass classification was undertaken at 68 sites across the mine. Both the target coal seam (Leichhardt Seam) and overlying rock show marked spatial variability in terms of RMR, CMRR and Q, but RSI showed limited sensitivity to changes in rock mass condition. Relationships were developed between different parameters with varying degrees of success. A mine-wide analysis of faulting was undertaken, and compared with in situ stress field and local-scale measurements of joint and cleat. While there are no unequivocal relationships between rock mass classification parameters and faulting, a central graben zone shows heterogeneous rock mass properties. The corollary is that if geological features can be accurately defined by remote sensing technologies, then this can assist in predicting rock mass conditions and risk management ahead of development and construction.

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Eastern Gondwana breakup as viewed from northern Zealandia

Boston B[1], Gallais F[1], Nakamura Y[1], Fujie G[1], Kodaira S[1], Miura S[1], Hackney R[2], Kaiho Y[1], Aoike K[1], Saito S[1]
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TS4 - 1.1.1 Decoding Earth’s supercycles: from the core to the crust, Hall C, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Brian Boston is currently a postdoctoral researcher in marine geophysics at the Japan Agency for Marine-Earth Science and Technology. He received his Ph.D. in geology and geophysics from the University of Hawai‘i at Manoa and a B.S. in geology and geophysics from the University of Wisconsin at Madison.

Northern Zealandia records the Late Cretaceous continental rifting and breakup of eastern Gondwana that led to its isolation from eastern Australia. To study this poorly constrained breakup, we used multi-channel seismic reflection data and wide-angle seismic velocity constraints to determine how continental rifting and breakup occurred in northern Zealandia. These results show that two known blocks of continental crust, the Dampier Ridge and Lord Howe Rise, are separated by oceanic crust beneath the Middleton Basin. The sediment depositional pattern between these continental blocks indicates that the breakup of eastern Gondwana first started at the Middleton Basin and later jumped to the west to open the Tasman Basin. Multibeam bathymetry data show a range of seafloor features on the Dampier Ridge and seismic data image basements ridges that reach the seafloor. These ridges strike either N–S or NW–SE, perpendicular to the inferred opening direction of the Tasman Basin. A similar bi-modal alignment of sedimentary basins and faulting has been inferred from previous work on the Lord Howe Rise and suggests a regional stress change linked to the two-stage breakup of eastern Gondwana. The breakup first involved E–W extension in the Middleton Basin and on the Lord Howe Rise, followed by NE–SW extension during formation of the Tasman Basin.

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Trace element concentrations in ore minerals: implications for ore genesis and mineral processing

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[1]The University Of Adelaide, [2]BHP Olympic Dam

TS8 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Ph.D. Imperial College, London (1988)
Currently Professor and Deputy Director Australian Research Council Research Hub for Australian Copper-Uranium.
My principal research interests are ore forming processes and ore deposits, sulphide mineralogy and solid state chemistry, trace element deportment in ore minerals; Uranium and REE mineralogy and geochemistry, mineralogy of minor elements, processing of complex ores, analytical technologies for: nano- to micron-scale observation.

Distributions of trace elements within geological materials can be readily obtained using contemporary instrumentation offering precise measurement of concentrations to below one part-per-million at the micrometre scale for many elements, and providing visualisation of spatial distributions at scales from single grains to drillcores. Quantitative trace element data and element 'maps' of selected sample areas can contribute to genetic models, constrain conditions of formation, and can help track successive geological events that have impacted on complex ore deposits. An adequate understanding of the deportment of elements of interest, whether as discrete minerals or incorporated in the crystal lattice of host minerals also carries implications for design and optimization of processing strategies. Examples include the role played by pyrite and arsenopyrite as carriers of 'invisible gold', or of chalcocite and bornite as silver hosts. In copper ores, deleterious (penalty) elements such as As, Sb, Bi, Hg, and Pb may be mostly, or exclusively, hosted within common base metal sulphides. Efforts to understand patterns of equilibrium partitioning between co-existing minerals are thus valuable and enable prediction of likely hosts. Increased demand for a range of commodities with high-tech applications but which seldom occur as discrete minerals (In, Ga, Ge) has introduced new impetus to exploring the deportment of trace and minor elements in hypogene ores. Similar approaches can highlight the mineralogical hosts for potentially valuable by-products, e.g., Se, Te or Co from copper ores, or identify hitherto unrecognised resources e.g. significant concentration of critical elements in common minerals such as garnet or epidote.

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Phase equilibria of Th+Y+REE distribution in Earth's crust

Kelsey D[1], Spear F[2], Williams M[1], Hand M[1]
[1]University Of Adelaide, [2]Rensselaer Polytechnic Institute

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
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One of the crucial tools of the modern petrologist in the 'petrochronology' toolkit is calculated phase equilibria, and it is widely recognized that one of the 'frontier' aspects of phase equilibria is to fully incorporate accessory minerals into such calculations. The work that has been performed to date involving accessory minerals in calculated phase equilibria is largely laborious due to the calculations concerning accessory mineral solubility being external to the phase equilibria software, rather than an integrated internal feature of the phase equilibria software. To attempt to create an adaptive, systematic and fully quantitative phase equilibria calculation framework we have revised and extended the thermodynamic model framework of Spear & Pyle (2010) and Spear (2010) to include Th, Ce, Y, P, F, La, involving the accessory phases monazite, xenotime and apatite. The addition of Th+La is new, motivated by the companion work of Alessio et al. and Williams et al. (both this abstract volume), and the phase equilibria framework allows for quickly and easily quantifying the effect of progressive metamorphism on accessory mineral stability and the distribution of trace elements. We present preliminary phase equilibria models incorporating all the above elements and use these to propose ways in which this toolkit can be used to investigate a large range of petrogenetic problems concerning partially melted rock systems. This work provides a new way for links between accessory and major elements to be established and therefore adds to the arsenal of tools available for modern petrologists in undertaking 'petrochronology' analysis.

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Genesis of the Nolans Bore REE deposit

Anenburg M[1], Mavrogenes J[1]
[1]Australian National University

TS4 - 3.1.5 Technology metals and minerals – the importance of non-traditional commodities in the evolving economy & 3.1.6 New frontiers in ore system research, Room R2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Michael Anenburg is a PhD student at the Research School of Earth Sciences, Australian National University. His work consists both experimental petrology and study of natural samples. His interests include rare earth element deposits and carbonatites.

Nolans Bore is a REE ore deposit located in the Northern Territory, Australia. It consists of fluorapatite veins, surrounded by selvages of diopside±hyalophane±titanite. The REE were originally hosted in the fluorapatite crystal structure, but were later redistributed in-situ to a variety of REE carbonates, phosphates and silicates. Allanite and calcite are important but volumentrically negligible minerals in the deposit.
The Nolans Bore mineral assemblage is consistent with formation by carbonatite metasomatism, as shown experimentally. A REE–P-rich carbonatite reacted with the silicate wall rocks, metasomatising it to form fluorapatite and diopside. The carbonatite melt then migrated elsewhere, leaving little textural evidence of its former presence.
The Nolans Bore mineral assemblage formed in three stages: (1) REE-rich fluorapatite, diopside, hyalophane, and titanite by direct carbonatite–silicate reaction, (2) REE-poor fluorapatite, allanite, ekanite, and calcite by hydrothermal fluids exsolved from the carbonatite, and (3) formation of epidote and alteration of primarily fluorapatite and calcite by later hydrothermal fluids unrelated to the carbonatitic magmatism.
Nolans Bore serves as an example for two important processes: (1) hydrothermal alteration that obscures the original igneous origin the deposit, and (2) metasomatic mineralisation of REE via carbonatite metasomatism. Thus, the role of hydrothermal REE mobility is overemphasised as it only allows local redistribution of the REE.

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Environmental tracers and geology to investigate groundwater recharge and conceptual model uncertainties in the Pilliga area (Surat Basin, NSW)

Raiber M[1], Suckow A[2], Deslandes A[2], Gerber C[2]
[1]CSIRO, [2]CSIRO

TS2 - 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Matthias is a Senior Research Scientist at CSIRO Land and Water. He has a background in geology and hydrogoelogy and his work focuses on the integration of multiple lines of evidence to study the hydrodynamics of aquifer systems ranging in scale from catchments to sedimentary basins, He has joined CSIRO in 2013, and was a postdoc with QUT and NCGRT prior to joining CSIRO.

The Pilliga Sandstone is an important aquifer in the Coonamble Embayment within the Surat Basin in NSW. A proposed coal seam gas (CSG) development in the underlying Gunnedah Basin has raised major environmental concerns as depressurising the coal seams of the Gunnedah Basin can potentially propagate into the Pilliga Sandstone and other aquifers as well as surface water features. The risk can only be quantified with a thorough understanding of these adjacent aquifers and their degree of connectivity (or lack thereof) with the gas reservoir.

This study has assessed the hydrogeology of the Pilliga area and analysed environmental tracers (major ions, tritium (^{3}H), stable isotopes ($^{18}O/^{2}H$), ^{14}C, ^{36}Cl, noble gases, dissolved methane concentrations and $^{87}Sr/^{86}Sr$).

The results of multiple tracer were combined into a consistent interpretative and quantitative assessment. It was then possible to derive a first estimate of natural historical groundwater flow velocities prior to modern human influence, which thus enabled us to estimate recharge into the deeper Pilliga Sandstone. Based on several lines of evidence derived from the hydrochemical and environmental tracer data, two significantly different flow pathways were identified within the study area, a fast groundwater flow path in the southern part and a much slower path in the central part of the Coonamble Embayment.

The integration of multiple lines of geoscientific evidence has highlighted remaining knowledge gaps that require further investigation. These are in particular related to inter-aquifer connectivity, the connection between aquifers and the CSG formations and the presence or absence of fluid-transmitting geological structures.

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Investigating aquifer compartmentalisation in the Daly River Basin, Northern Territory

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[1]Geoscience Australia, [2]Aarhus University, [3]Northern Territory Department of Natural Resources, Environment, The Arts and Sport

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Anna Haiblen is a Graduate Geologist at Geoscience Australia. She completed a BSc (Advanced) (Honours) at the Australian National University, worked on a groundwater resource assessment project at the International Water Management Institute in Laos, and undertook a research-based MSc in Canada before starting at Geoscience Australia. Her research interests include hydrogeology, landscape evolution, and glacial hydrology.

Groundwater in the Daly River Basin is predominantly extracted from the Oolloo Dolostone Aquifer. This aquifer supports agricultural water consumption, and is important for groundwater-dependent ecosystems, tourism, and indigenous culture. The Oolloo Aquifer is currently conceptualised as being continuous throughout the Daly River Basin. However, evidence of localised compartmentalisation is apparent in regional airborne electromagnetic and hydrogeological data. Neogene tectonism may have resulted in a northwest-southeast trending, strike-slip fault zone cutting across much of the Daly River Basin. Aquifer compartmentalisation has implications for recharge, discharge, groundwater-surface water interactions and the direction and velocity of groundwater flow.
We investigate whether structural compartmentalisation is affecting the Oolloo Aquifer using new and existing airborne electromagnetic and airborne magnetic data, borehole geophysical data and stratigraphy, ground magnetic resonance data, and hydrogeological and hydrogeochemical data. Geomorphic and morphotectonic mapping is also undertaken. These data allow us to characterise the Neogene fault system in the region, and to assess the permeability and transmissivity of structures that may be responsible for aquifer compartmentalisation. We also use these data to better understand groundwater-surface water connectivity and to assess the potential for managed aquifer recharge schemes to replenish extracted groundwater resources. Our results can be used to inform future groundwater modelling and water allocation planning and to underpin effective and efficient future groundwater use in the Daly River Basin area.

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Utilizing Data Frameworks for Spatial Data

Whiting A[1]
[1]*Geoscience Australia*

TS1 - 4.4.1 The Geoscience of Where, Room R7, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Andrew Whiting has over 15 years experience working within Spatial Information domain.

Andrews major focuses are Business Analysis, Enterprise Architecture and Program Management.

The foundation spatial data framework is an ANZLIC initiative that allows users of spatial data to easily discover and access authoritative government data sets that underpin decision making, service delivery and spatial analysis. Over the last two years, information has been collected and published using a new approach through the structured integration of traditional metadata and business knowledge. The publication of this information, via a cloud based content management system, has allowed users to understand the data supply chain and provenance of national data products, along with the business reason for their existence. Users can now access and interrogate this knowledge using the FSDF LINK (https://link.fsdf.org.au/). This system enables the population of webpage content in a structured way, whilst publishing the information in formats that enhance integration between other catalogues, data delivery systems and emerging technologies, such as Linked Data.

This approach to structuring the information, has allowed maturity frameworks to be developed that target discoverability, access and ease of consumption. These frameworks are important for improving the overall supply of data to users and improving the delivery of data products from custodians. The benefits of using this framework are:

1. enhanced users discovery of authoritative data
2. improved user trust in national data products, and
3. enabled analytics on user interactions with data products through the LINK web interface, which in turn will lead to improved data products.

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Evolution of the structure of the lower mantle over the last billion years

Flament N[1], Young A[1], Williams S[2], Merdith A[3], Januszczak N[4], Muller D[2,5]
[1]GeoquEST Research Centre, School of Earth and Environmental Sciences, University of Wollongong, [2]EarthByte Group, School of Geosciences, The University of Sydney, [3]Université de Lyon, Université Lyon 1, ENS de Lyon, CNRS, UMR 5276 Laboratoire de Géologie de Lyon, [4]De Beers – Exploration Canada, [5]Sydney Informatics Hub, The University of Sydney

TS1 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Nicolas Flament is a DECRA Fellow and lecturer at the School of Earth and Environmental Sciences, University of Wollongong. He graduated in 2010 with a PhD in Earth Sciences from École Normale Supérieure de Lyon, France and The University of Sydney. He was a postdoctoral research associate and postdoctoral fellow at The University of Sydney from 2010 to 2016. His main research interests are in global geodynamics and in the influence of deep-Earth processes on the evolution of Earth's surface.

The evolution of the structure of Earth's mantle is linked to tectonic motions; oceanic lithosphere recycled at subduction zones sinks into the mantle over 150-200 million years, whereas large-scale upwelling preferentially occurs away from sinking slabs. As a result, the relatively stable locations of subduction zones over the past 230 million years wraps around the present-day geometry of two Large Low Shear Velocity Provinces (LLSVPs) under Africa and the Pacific. This relationship has led to the hypothesis that LLSVPs could have been fixed and rigid for hundreds of million years. However, the location of subduction zones is expected to have changed over the past billion years, a time period over which supercontinent Rodinia broke up (between ~800-600 Ma), and supercontinent Pangea assembled (between ~600-330 Ma) and has been breaking up over the last ~175 Ma.

Here, we use a recent tectonic reconstruction extending back to 1,000 Ma as boundary condition of a series of global convection models across which parameters including initial age are varied. We quantify the fit between the present-day structure of the lower mantle predicted by each mantle flow model and inferred from seismic tomography models. We analyse the evolution of the shape and location of model basal thermo-chemical piles, and their spatial and temporal relationship with the dispersal and assembly of supercontinents Rodinia and Pangea. The results of our top-down models suggest a non-uniform deformation of basal thermo-chemical piles over the last 1,000 Myr, with maximum rates of the order of 1.3 cm/yr.

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SHRIMPing beneath the Eromanga Basin: Insights into the evolution of the Thomson Orogen from SHRIMP U–Pb geochronology of basement drillcore

Cross A[1], Doublier M[1], Brown D[2], Folkes C[3], Purdy D[1]
[1]Geoscience Australia, [2]Geological Survey of Queensland, [3]Geological Survey of New South Wales

TS8 - 3.1.7 Studies on the Thomson Orogen, Room R2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Andrew Cross is a senior geochronologist at Geoscience Australia. He has worked on a wide variety of rocks and projects across Australia but has extensive experience over much of Queensland, the Northern Territory and northern New South Wales. He is a SHRIMP U–Pb specialist applying the dating of zircon, monazite, xenotime allanite and uraninite in his work. In recent years much of Andrew's geochronology has been focussed on the Thomson Orogen, analysing both undercover and exposed units across the length and breadth of the Orogen. Andrew completed a PhD at the Research School of Earth Sciences (ANU) in 2009.

The Thomson Orogen of eastern Australia is a major component of the Tasmanides and has historically been poorly understood and overlooked for exploration due to extensive sedimentary cover including the Eromanga Basin. To further understanding and support exploration of this area, Geoscience Australia, the Geological Survey of Queensland and the Geological Survey of New South Wales (NSW) have undertaken a major multidisciplinary geoscientific programme in the southern Thomson Orogen (STO) as a part of the UNCOVER initiative. A major outcome of this project has been the completion of twelve stratigraphic diamond drill holes between 2016 and 2017. SHRIMP U–Pb zircon dating of magmatic and metasedimentary rocks intersected by the boreholes provide new insights into the geological evolution and mineral prospectivity of this region. Geochronology of three intrusive rocks intersected by new boreholes in the NSW part of STO have late Silurian ages of ~425 Ma (Tongo 1), ~421 Ma (Janina 1) and ~421 Ma (Congararra 1). The age of the granodiorite intersected by Tongo 1 is within uncertainty of the intrusion-related Mo-W and later Au-base metal mineralisation at the Cuttaburra and F1 prospects located ~20 km southeast of the Tongo 1 borehole. Additionally, previously unknown volcanic events have been revealed by a dacitic ignimbrite (~387 Ma) in borehole GSQ Eulo 2 (Queensland) and a rhyolite (~395 Ma) in borehole, Milcarpa 1 (NSW). Detrital zircon geochronology has also played an important role in characterising undercover units such as the Werewilka Formation and Nebine Metamorphics, interpreted from geophysical data sets.

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Evidence of Microbial Mats and Prolonged Persistent Photic Zone Euxinia during the end—Triassic Mass Extinction and Recovery in the UK.

Fox C[1], Whiteside J[2], Olsen P[3], Summons R[4], Grice K[1]
[1]WA-OIGC, Curtin University, [2]School of Ocean & Earth Science, University of Southampton, [3]Department of Earth & Environmental Sciences, Columbia University, [4]Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology

TS1 - 2.3 Mass Extinctions, Room R1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Calum Fox completed his MSci Oceanography degree at the University of Southampton in 2015 and is expected to complete his PhD at Curtin University under the supervision of Prof. Kliti Grice in January 2019. Research interests include mass extinction events, biomarkers, organic geochemistry, palaeoclimate, and ocean biogeochemistry. Major work of the PhD includes the biomarker and isotope analysis of the end-Triassic mass extinction and end-Permian mass extinction from European sections.

The end-Triassic mass extinction (ETE) event was coeval with the break-up of the supercontinent Pangea and the associated intense volcanic activity that produced the Central Atlantic Magmatic Province (CAMP) flood basalts. Sediments in the Southwest UK exhibit the iconic ETE organic carbon isotope excursions and were deposited close to the CAMP but remained unaffected by igneous extrusions. Analyses of biomarkers within this region at St. Audrie's Bay and Lilstock captures the lead-up and aftermath of initial carbon isotope excursion and extinction event. We find increases in the abundances of okenane (purple sulfur bacteria), chlorobactane (green pigmented sulfur bacteria), and β-isorenieratane (green sulfur bacteria/diagenetic product of β-carotane) occurring in association with the ETE isotope excursion. Such increases are typically associated with the presence of photic zone euxinia (PZE); a situation in which toxic hydrogen sulphide is periodically present in the sunlit region of the water column. However, due to shallow water depths, finer grained sediment and evidence of microbialites in other regions of the Southwest of England at a similar time period, these increases are attributed to the presence of green and purple sulfur bacteria microbial mats. The recovery of the initial organic carbon isotope excursion also shows increases in the aforementioned biomarkers with the addition of isorenieratane (green brown pigmented sulfur bacteria). Concentrations remain increased throughout the measured recovery section with evidence of persistent PZE over episodic, indicating a prolonged period of PZE during the ETE recovery phase potentially inhibiting recovery of the metazoan communities.

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Case Study - Desk Study and Ground Investigation at the offshore area of Outer Harbour, Adelaide

Cheng M[1], Missen L[1], Haese J[1]
[1]*Arup*

TS7 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Fergus is an engineering geologist with working experience in Hong Kong, China, Australia, Malaysia. He obtained a BSc in HK and a MSc in UK. He has several years of site experience for underground excavation with various excavation method, namely TBM, Drill-and-Blast and open excavation. He has also provided input on ground characterisation for numerous infrastructure and building projects with different geological settings.

Under the support of Arup and BMT, Flinders Ports lodged a development application to widen the existing Outer Harbor shipping channel to accommodate larger vessels in July 2017. The proposal involved dredging 1.55 million m^3 of material along 7 km of channel. During the preparation of the development application, geotechnical risk is identified as one of the major risk on the project, in particular the uncertainty and variation on geological boundaries and geotechnical properties within a short distance within the a project site. This paper is a case study on how a proper desk study and a proper ground investigation can help mitigating the geotechnical risk on a project. It describes the offshore geological setting at Outer Harbour, Adelaide, and the findings from the ground investigation along the navigation channel. The ground investigation campaign included offshore drillings and geophysical survey. This combination of investigation methods of investigation was proven to be successful as major ground risk area was identified. Lastly, further works are also recommended to improve our understanding on the offshore geology for possible offshore infrastructure projects in the future.

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Geochemistry of organic rich shales in the Roper and Isa Superbasins of Northern Australia

Jarrett A[1], Cox G[2], Brocks J[3], Shannon A[2], McLennan S[1], Thorne J[1], Johnson B[4], Vinnichenko G[3], Huston D[1], Champion D[1], Henson P[1]

[1]Geoscience Australia, [2]Adelaide University, [3]The Australian National University, [4]Oxford University

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:

Amber Jarrett is a geochemist working at Geoscience Australia in the Onshore Energy Systems Section.

The Proterozoic was an important eon which saw profound changes in the geochemistry of the oceans and the first appearance and proliferation of complex life [1]. In this study we examine the relationships between organic matter and ocean geochemistry in sedimentary sequences in northern Australia.

The geobiology of the McArthur Basin has been comprehensively studied and characterised. The ca. 1.3 Ga Velkerri Formation within the Roper Superbasin is predominantly ferruginous with episodes of euxinia coupled to enhanced primary productivity [2]. In contrast, black carbonaceous shales of the ca. 1.6 Ga Fraynes and Barney Creek Formations are pervasively anoxic and euxinic [3]. The latter formation is dominated by aromatic isoprenoids, biomarkers for green and purple sulfur bacteria associated with photic zone euxinia [4]. In contrast, little attention has been given to the Proterozoic South Nicholson Basin and Lawn Hill Platforms straddling the Queensland and Northern Territory border.

Here we provide new insights into the paleo-environments of these sedimentary successions based on multi-proxy sedimentary geochemical analyses including biomarkers, isotopes (δ13C, δ15N and δ34S) and trace metals. The results in this study while preliminary at present, demonstrate redox heterogeneity with oscillations between ferruginous and euxinic conditions broadly correlating with increases in total organic carbon content. Complexities remain including potential influences of hydrothermal alteration on the thermal evolution, and mobility and abundances of trace metals in some sections of the basins. The results of this study have implications for early life in addition to targeting areas for mineral and petroleum exploration in northern Australia.

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Groundwater resource development opportunities in northern Australia: investigations of the Grant Group and Poole Sandstone – Fitzroy catchment, Western Australia

Taylor A[1], Harrington G[2], Clohessy S[3], Dawes W[4], Crosbie R[1], Davies P[1], Suckow A[1]
[1]CSIRO Land and Water, [2]Innovative Groundwater Solutions, [3]Department of Water and Environmental Regulation, [4]CSIRO Land and Water

TS1 - 3.3.1 Groundwater challenges and opportunities & 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Andrew Taylor is a hydrogeologist in the Water Resource Management program in CSIRO. His primary research activities include the analysis and interpretation of hydraulic, hydrogeochemical and environmental tracer data sets for characterising hydrogeological systems. Andrew has 12 years of experience in the field and desktop evaluation of hydrogeological systems throughout Australia. His research interests include vadose zone hydrology and coupling environmental tracers, geophysics and hydraulics for characterising and quantifying groundwater flow processes including recharge, throughflow, discharge, groundwater – surface water interactions and inter-aquifer exchange. He is currently leading the groundwater hydrology activity in the Northern Australia Water Resource Assessment.

CSIRO and various partners have just completed the Northern Australia Water Resource Assessment (NAWRA): a major initiative evaluating future water and agricultural development opportunities in three priority regions. A key component of the Assessment was the identification and investigation of prospective aquifer systems. The Grant Group and Poole Sandstone aquifers in the Fitzroy catchment provide the greatest current opportunity for future groundwater development. Targeted investigations of the aquifers included: (i) drilling and construction of 34 bores to improve the current understanding of the hydrostratigraphy, (ii) sampling of 57 bores for environmental tracers (2H/1H, 18O/16O, 87Sr/86Sr, 3H, CFCs (CFC-11 and CFC-12), 14C/δ13C, and 4He) to characterise and quantify groundwater recharge and flow processes, (iii) longitudinal sampling of tracers (222Rn, 14C and 4He) in surface water along reaches of the Fitzroy and Margaret rivers to characterise and conceptualise the spatial variability in groundwater – surface water connectivity, (iv) development of a numerical groundwater model to evaluate the water balance, as well as long-term hydrological impacts from varied hypothetical future groundwater extraction at multiple locations. Key outcomes include: (i) the aquifers can be intersected at economical depths (i.e. <300 m) across large areas coinciding with soils suitable for agricultural intensification; (ii) the aquifers are artesian or close to artesian across large areas, thereby reducing the costs of pumping from the resource; and (iii) the aquifers can support multiple large scale (i.e. 10 to 20 GL/year) groundwater developments, though opportunities may be limited in locations where the aquifers and Fitzroy River are connected.

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Episodic extensional exhumation of the Tso Morari core complex in an intra-oceanic setting prior to the India-Asia collision

Forster M[1], White L[2], Ahmad T[3], Spakman W[4], Lister G[1]

[1]Australian National University, [2]Department of Geology, University of Wollongong, , [3]Department of Geography, Jamia Millia Islamia, , [4]Department of Earth Sciences, Utrecht University,

TS4 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 11:30 AM - 1:00 PM

Biography:

Manager of the Argon Laboratory at ANU. She completed her PhD at Monash University. Her research includes Argon diffusion experiments with a major focus on determining when and how movement in the ductile zone of the Earth occur. Dating deformation and metamorphic events that occur at major zones of collision or extension during Earth's history. Dating deformation and movement zones using Ar/Ar geochronology within the framework of structural geology and microstructure.

Orogeny involves cycles of extreme horizontal stretching interspersed with crustal shortening. We illustrate this with the tectonic evolution of the Tso Morari schist and gneiss dome, exposed at high-altitude at the western end of the Tibetan Plateau, in Ladakh, NW India. This classic Tethyan metamorphic core complex formed as the result of extreme horizontal extension along the northern margins of the closing Tethys. Here we detail the tectonic evolution of the Tso Morari dome, reporting observations concerning the kinematics, sense of shear, and thermal structure in the mantling carapace shear zones. We provide 40Ar/39Ar geochronological data that date the operation of the major crustal shear zones that were in part responsible for the exhumation of these ultra-high-pressure rocks. These results suggest extreme extension at different stages of the exhumation and impact on the interpretation of the large-scale tectonic evolution of this terrane. Bulk rock geochemical analysis of the mafic rocks demonstrates that these eclogitic rocks were once ocean island basalts. The lithosphere-scale extension can be explained if compression during the accretion event led to the formation of back-thrusts that decapitated the north-facing Eocene subduction zone, and evolved into south-facing subduction zones. Roll-back to the north would have juxtaposed the Tso Morari terrane against the Ladakh Batholith, at the same time extending and exhuming these high-pressure rocks. Roll-back of a south-facing subduction zones also provides an explanation for thermal pulses and/or extensional episodes and defines the geodynamic scenario that caused the development of metamorphic core complexes in the north-west Himalaya.

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JORC and CRIRSCO reporting codes: A common framework supporting mining investment

Hunt S[2]

[1]Rio Tinto, [2]Joint Ore Reserves Committee (JORC) Chair

TS3 - 3.4 Resources sustainability – responsible investment and management, Room R2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:

Steve is a geologist with over 35 years' experience across exploration, resource development and mine geology, with 18 of those years in mine based operating and brownfields roles.
Mining geology leaderships roles include Granny Smith (WA) , Kelian (Indonesia), before moving to Lihir (PNG) in 1997 as Chief Geologist.

Since 2004, Steve has worked with Rio Tinto's technical division supporting resource evaluation, mine geology and OBK across multiple commodities, including Resource & Reserve reporting and governance for Rio Tinto's global operations.
Steve joined the Joint Ore Reserves Committee (JORC) in 2005, and was appointed Chairman in December 2013

Minerals reporting codes such as JORC provide the common language and framework for disclosure of mineral developments from exploration through to operations. The minerals industry uses this framework to describe both the risks and opportunities for investment to stakeholders. Stakeholder groups are diverse, making it imperative that the emerging knowledge gained through exploration and development can be effectively communicated, to support investment, stakeholder trust and public confidence.
Each of the major reporting code developments of the last 50 years has its origin in misleading promotion, and in some cases direct fraud. Since JORC's formation (1971), a growing global collaboration has developed CRIRSCO aligned reporting codes, now covering > 80% of global listed mining capital.
Occasionally there are calls to relax the code to allow new commodities or deposit types to be effectively promoted in the market. Early stage new commodity entry is always difficult.
In established commodities, mining, processing and marketing pathways are established, as are investment expectations, leading to less volatility and clearer articulation of development risk. Developers and investors know what to look for.
For new commodity and deposit types, the need for transparent and fulsome disclosure is higher, precisely because there is less specific market understanding when new or unique pathways are still being evaluated. The risks of speculative blowout include regulator backlash, prescriptive rules, black letter law, and loss of the right to self-regulate. Aligned, industry supported international codes have strong momentum, but must remain effective and balanced for the industry to continue to succeed.

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Diamonds and other kimberlitic minerals from the Webb Kimberlite Field, Western Australia

Vasilyev P[1], McInnes B[1], Reddicliffe T[2]
[1]John de Laeter Centre, [2]GeoCrystal Ltd

TS4 - 3.1.5 Technology metals and minerals – the importance of non-traditional commodities in the evolving economy & 3.1.6 New frontiers in ore system research, Room R2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Prok is a Research Associate at Experimental Geochemistry group of John de Laeter Centre. Prior to this he completed his PhD at RSES, Australian National University in 2016 and Bsc, MSc at Moscow State University, Russia.

The Webb kimberlite field is a new diamond play located ~600 km west of Alice Springs in a remote region of the Gibson Desert. Exploration by GeoCrystal Ltd has identified more than 280 'bulls-eye' magnetic features over a ~400 km^2 area. Reconnaissance drilling of some of these features has returned mineral samples of kimberlite affinity, while surface sampling has recovered detrital microdiamonds. The peridotite minerals analysed to date include: (i) G9 garnet predominating over G10; (ii) olivine ranging from Fo_{84}-Fo_{91}; (iii) Cr-diopside (0.8-1.8% Cr_2O_3) and (iv) a broad range of Cr-Al spinel compositions.
A thermobarometric assessment of mineral chemistry data indicates a deep mantle origin (P=45-50 kbar; T=1150-1170°C), and that minerals retrieved from the northern pipes have equilibrated within the diamond stability field. These results seem consistent with observations that microdiamonds recovered during surface exploration are more plentiful in the north. Investigations underway include: (i) Ar-Ar geochronology of phlogopite and (ii) characterisation and analysis of mineral inclusions encapsulated within detrital microdiamonds recovered from Webb

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First Precambrian palaeomagnetic data from the Mawson Craton (East Antarctica) and tectonic implications

Liu Y[1], Li Z[1], Pisarevsky S[1], Kirscher U[1], Mitchell R[1], Stark J[1], Clark C[2], Hand M[3]
[1]Earth Dynamics Research Group, ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS) and The Institute for Geoscience Research (TIGeR), School of Earth and Planetary Sciences, Curtin University, [2]The Institute for Geoscience Research (TIGeR), School of Earth and Planetary Sciences, Curtin University, [3]Department of Earth Science, School of Physical Sciences, University of Adelaide

TS2 - 1.1.1 Decoding Earth’s supercycles: from the core to the crust, Hall C, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Yebo Liu is a PhD student working with Prof. Zheng-Xiang Li. Yebo's PhD research is focused on Precambrian palaeogeography reconstructions and the evolution of supercontinents using palaeomagnetism. The targets of my studies are mostly Proterozoic igneous rocks in Australia and East Antarctica. I’m also interested in the long-term evolution of the Earth's magnetic field.

A pilot palaeomagnetic study was conducted on the recently dated 1.13 Ga (U-Pb, zircon and baddeleyite) Bunger Hills Dykes (BHD) located in the Mawson Craton (East Antarctica). Of the six dykes sampled, three revealed meaningful demagnetization results directing easternly steep downward. The corresponding palaeopole is the first well-dated Mesoproterozoic palaeopole for the Mawson Craton. Discordance between this pole and two existing and roughly coeval poles from Dronning Maud Land and Coats Land (East Antarctica) confirms that these terranes were not rigidly connected to the Mawson Craton at ca. 1.13 Ga. Because the Mawson Craton amalgamated with the West Australian Craton during the Albany-Fraser Orogeny, which finished at ca. 1.2 Ga, the new BHD pole can also be used to constrain the tectonic evolution of Australia. Comparison between the new pole and the Lakeview dolerite pole from the North Australian Craton supports the hypothesis of a ~40˚ late Neoproterozoic relative rotation between the North and West Australian cratons.

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The International Geo Sample Number - Linking Literature, Data, and Samples for Australian Researchers

Klump J[1], Wyborn L[2], McInnes B[3], Bastrakova I[4], Burton A[5], Martin J[5]
[1]CSIRO Mineral Resources, [2]Australian National University, NCI, [3]Curtin University, John de Laeter Centre, [4]Geoscience Australia, [5]Australian National Data Service

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Jens Klump is a CSIRO Science Leader for Earth Science Informatics at the Australian Resources Research Centre in Perth WA. Jens' field of research is data-driven science. Research topics in this field are numerical methods in minerals exploration, virtual research environments, remotely operated instruments, high performance and cloud computing, and the development of system solutions for geoscience projects.

Samples have always been at the heart of the geological sciences. Compared to the infrastructure built in recent years for literature and data, the availability of sample information on the internet still lags behind. Samples are only valuable within their context: without unique identification and documentation, a collection of samples is little more than rocks in a box.

The International Geo Sample Number (IGSN) is designed to provide unambiguous globally unique identifiers for physical samples. Its power lies in creating an internet representation of a sample that can be linked to the data, that were derived from it, to the literature where the sample and the data are interpreted, and to the collection where the sample is curated.

IGSN is interoperable with other identifier systems such as DataCite. IGSN metadata can be aggregated in portals (e.g. the Australian IGSN catalogue http://igsn.org.au), enabling a common access to catalogues of unambiguously identified samples from different agents, thus promoting collaboration across the Earth Sciences.

Australia now has four agencies implementing IGSN: ANDS, Curtin University, CSIRO and Geoscience Australia. IGSN is governed by an international organisation, the IGSN Implementation Organization e.V. (http://www.igsn.org). Membership in this organisation links the Australian IGSN community to the wider international community and at the same time allows it to act locally to ensure that the services offered are relevant to the needs of Australian researchers.

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Subduction-related magmatism of the western Yilgarn: Implications for damp komatiites

Wyman D[1]
[1]*School of Geosciences, University Of Sydney*

TS3 - 1.1.4 Crustal evolution of Archean Cratons, Hall A, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Derek Wyman has studied the links between Archean magmatism, tectonics and mineral deposits for more than 30 years. He developed the initial models of "plume – arc interaction" for the Abitibi belt and was the first person to develop and apply what is now known as the Orogenic Gold Model to Archean deposits. In recent years he has extended his work beyond the Archean and Proterozoic into the Phanerozoic in collaboration with Chinese researchers and to defining the relationships between Mesozoic and Cenozoic mantle plumes, subduction zones and ore deposits with the University of Sydney's Earthbyte group.

In addition to boninites discovered in the western Yilgarn a few years ago, a new study has identified a variety of subduction-related rock types that require a revision to present models that invoke a 2.8 Ga plume as the tectonic driver for the region. Newly identified mafic to intermediate rock types in the southern Murchison Domain include varieties with prominent Zr-Hf troughs that are not accounted for in typical komatiite crustal contamination models. One of the rock types chemically resembles post-Archean Alaskan-type magmas that feature strong fractionation of the REE with high LREE/HREE, pronounced negative Nb-Ta and Zr-Hf anomalies but low normalized Th/La values. Combined with previously reported large-scale intrusions of uncontaminated 2.8 Ga wet magmas and orogenic biotite lamprophyres, the new discoveries require a wet mantle beneath the western Yilgarn between 2.8 and 2.7 Ga. A re-appraisal of reported "Karasjok" type Ti-rich komatiites suggests they are actually arc picrites that have undergone varying degrees of olivine accumulation.
Given the widely accepted evidence for subduction along the east Yilgarn margin at ~ 2.7 Ga, the craton was either partially or totally ringed by subduction zones when mantle plume -derived komatiitic magmatism developed in the Eastern Goldfields. The new insights coincide with growing evidence that komatiitic magmas were slightly damp. These observations and the larger issue of the coincidence of plume and arc style magmas in the Archean can best be resolved if the komatiite-generating plumes were derived from the transition zone rather than merely having passed through it.

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Proterozoic petroleum geochemistry of northern Australia

Jarrett A[1], Bailey A[1], Boreham C[1], Anderson J[1], Carr L[1], Gorton J[2], Lewis C[1], Munson T[3], Troup A[2], Brocks J[4], Vinnichenko G[4], Cox G[6], Johnson B[5], Henson P[1]
[1]Geoscience Australia, [2]Geological Survey of Queensland, [3]Northern Territory Geological Survey, [4]The Australian National University, [5]Oxford University, [6]University of Adelaide

TS1 - 3.2.3 Petroleum and its co-products, Room R2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Amber Jarrett is a geochemist working in the onshore energy systems branch at Geoscience Australia. Amber obtained her PhD in 2014 working on Neoproterozoic geochemistry in the Amadeus Basin and has ten years of geochemistry experience working on predominantly Proterozoic source rocks.

The energy component of Geoscience Australia's Exploring for the Future Programme aims to improve our understanding of the hydrocarbon potential of northern Australia, initially focussing on the Isa and Roper superbasins of the Northern Territory and Queensland. These Proterozoic sedimentary basins have the potential to host both conventional and unconventional (shale and tight gas) accumulations. While the McArthur Basin has been comprehensively studied, little attention has been given to the likely coeval South Nicholson Basin and Lawn Hill Platform that straddle the Queensland and Northern Territory border.

This study aims to better understand the: 1) potential source rocks and reservoir units of the Fickling, McNamara and South Nicholson groups using organic richness, kerogen type, generative ability, maturation, expulsion efficiency and petrophysical and geomechanical properties. Results will be compared to the McArthur Basin, where proven unconventional petroleum systems are currently being explored, and 2) petroleum systems and the timing and preservation of fluids oil stains, and gas from fluid inclusions by completing gas-oil-source correlations.

Approximately 1000 samples from 23 wells intersecting Proterozoic units have been collected and are currently being analysed. Preliminary data indicates a wider extent of high TOC sedimentary rocks that cover a range of thermal maturities from immature to overmature. The results of this study will be used to generate statistics quantifying the spatial distribution, quantity and quality of source rocks, source rock maps and a new insights into the petroleum systems and hydrocarbon prospectivity of northern Australia.

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δ13C of coals from the Moatize Basin, Mozambique: evidence for global carbon isotope anomaly associated with the deglaciation of Gondwana

Van De Wetering N[1], Esterle J[1], Rodrigues S[1], Golding S[2], Ward V[1]
[1]UQ-Vale Coal Geoscience Program, SEES, University Of Queensland, [2]SEES, University of Queensland

TS3 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Miss Nikola Van de Wetering is a HDR Student from University of Queensland.

The terminus of the Late Palaeozoic Ice Age (LPIA) was a period of extreme climatic change, transitioning from icehouse to greenhouse conditions from the Late Carboniferous to Middle Permian. This time period is coincident with the development of high-latitude, peat-forming environments in Gondwana, subsequent to widespread deglaciation. This research presents a high-resolution δ13C record from coals and glacial/lacustrine interburden of the Moatize Basin, Mozambique, deposited during the terminus of the LPIA. From oldest (directly overlaying the glacial Vúzi Formation) to youngest, the average δ13C of the coal seams of the Moatize Formation are as follows: Sousa Pinto seam ($n = 43$), $\bar{x} = -23.4$ ‰ ($\sigma = 0.72$), Chipanga seam ($n = 69$), $\bar{x} = -22.6$ ‰ ($\sigma = 0.66$), Bananeiras seam ($n = 56$), $\bar{x} = -22.5$ ‰ ($\sigma = 0.61$). Results indicate a regionally correlatable, negative δ13C excursion in the lowermost ply of the Chipanga seam (magnitude ~4 ‰) to an absolute minimum of approx. -26.4 ‰ between three (3) sample locations. This δ13C excursion may be correlated with similar-magnitude isotopic excursions identified in age-equivalent sediments of Eastern Australia and China, indicating the possibility of global scale CO2 fluctuations associated with the terminus of icehouse conditions in the Palaeozoic.

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Zircon composition as a fertility indicator of Archean granites

Lu Y[1,2], Smithies H[1], Wingate M[1,2], Evans N[3], Champion D[4], McCuaig T[2,5]

[1]Geological Survey of Western Australia, [2]Centre for Exploration Targeting and Australian Research Council Centre of Excellence for Core to Crust Fluid Systems (CCFS), School of Earth Sciences, The University of Western Australia, [3]School of Earth and Planetary Science /John de Laeter Centre, Curtin University, [4]Geoscience Australia, [5]BHP

TS8 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Dr. Yong-Jun Lu is Senior Geochronologist Isotope Geologist at GSWA, Associate Investigator of ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS), and Adjunct Senior Research Fellow at Centre for Exploration Targeting, School of Earth Sciences, the University of Western Australia. His research ranges from Archean Cratons in Western Australia to Cenozoic porphyry Cu systems in Tibet. He manages the isotopic program at GSWA such as Sm-Nd, Lu-Hf and O isotopes, which are used to tackle various scientific questions such as imaging the lithospheric architecture through cover and understand crustal evolution and mineral deposit formation.

To examine the porphyry Cu fertility of Archean granites, we compiled a geochemical database of 230 dated unmineralized granites in the Archean Yilgarn Craton and collected over 2000 zircon trace element LA-ICPMS analyses. The results show that Yilgarn unmineralized granites including tonalite–trondhjemite–granodiorite (TTG) have lower whole-rock Mg# (<50), Fe2O3/FeO and V/Sc (<6) ratios but higher zircon saturation temperatures (>760 °C) than Phanerozoic Cu-fertile high Sr/Y granites. Yilgarn unmineralized granites also have lower zircon Ce/Ce* (<50), Eu/Eu* (<0.4) and Ce/√(U×Ti) (<0.4) ratios than Phanerozoic fertile granites. These results indicate that Yilgarn unmineralized granites are less hydrous and more reduced than Phanerozoic fertile high Sr/Y granites. We argue that Archean high Sr/Y granites were formed mainly through partial melting of mafic lower crust in the garnet stability field, whereas Phanerozoic fertile high Sr/Y granites were formed by amphibole-dominated fractionation of hydrous mafic magmas. We also present zircon trace element compositions for two causative granite samples from the c. 3.0 Ga Calingiri porphyry Cu-Mo deposit in the South West Terrane of the Yilgarn Craton. Zircons from the Calingiri deposit have distinctly higher Eu/Eu* (median = 0.42-0.52) and 10000*(Eu/Eu*)/Y (median = 6.9-9.4) than the unmineralized Yilgarn granites (median Eu/Eu* = 0.23-0.31, 10000*(Eu/Eu*)/Y = 2.6-5.7), suggesting Calingiri granites are likely more hydrous than other Yilgarn unmineralized granites. Therefore, zircons hold the potential to distinguish fertile from infertile suites for Archean porphyry Cu mineralization and this new technique may rejuvenate the prospectivity of typically weathered or under-cover Precambrian terranes.

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Basin Redox and provenance analysis of the Upper Roper Group, Beetaloo Sub-basin, North Australia

Yang B[1], Cox G[1], Collins A[1]
[1]*University Of Adelaide*

TS8 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
I am a phd candidate in the University of Adelaide. My research project focuses on the the McArthur Basin of north Australia. This work involves investigations into basin provenance, sedimentary formation and basin redox conditions.

The subsurface Beetaloo Sub-basin of the McArthur Basin, northern Australia, comprises a succession of shallow-water, dominantly marine, clastic sedimentary rocks that form the main depocentre of the Mesoproterozoic Roper Group; the volumetrically largest part of the 1000 km-scale outcropping Wilton package. The Beetaloo Sub-basin is unconformably overlain by a set of early Neoproterozoic sandstone to mudstone successions, recently named the Balmain Group.
Whole-rock geochemistry data suggest that the Kyalla Formation (upper part of the Roper Group) was deposited in an anoxic condition, whereas the Balmain Group was deposited in a suboxic environment. This basin redox variation might indicate that an increasing of atmospheric oxygen from the late Mesoproterozoic to the early Neoproterozoic. The Total Organic Carbon enrichment (TOC) has been identified in the top part of the Kyalla Formation. Coupled whole-rock Sm-Nd and Pb-Pb isotope data show that this TOC enriched section also contains higher primary compositions. The covariation of isotope and TOC contents indicates that the juvenile detritus infusion might be the trigger for the TOC enrichment within the Kyalla Formation. Basaltic rocks are phosphorus enriched and the phosphorus is the limit nutrient for bacteria photosynthesis. So the primary productivity would be enhanced with sustained weathering of basalts, and the possibility of organic matter preservation within sediments would be increased subsequently. The Derim Derim mafic intrusions intruded the Roper Group at 1312.9 ± 0.7 Ma. The relevant volcanic rocks probably sourced the basin at about the same time, from the north.

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GSWA geoscience data delivery: where to from here?

Riganti A[1], Bandy S[1], Wallace D[1], Johnson S[1]
[1]*Geological Survey of Western Australia*

TS2 - 4.4.3 Geoscience data delivery & 4.4.2 Understanding the Surface, Room R7, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Angela Riganti is the Content Manager at the Geological Survey of Western Australia (GSWA), focussing on design and management of geoscience databases, and innovations in geoscience data delivery. Her recent work has focused on the Explanatory Notes System (ENS), a digital repository of detailed unit descriptions that integrates stratigraphic relationships with links to all tectonic units and events recognized in Western Australia — ENS underpins the delivery of all maps and digital geology at GSWA.

Over the last twenty years, the Geological Survey of Western Australia (GSWA) has developed systems that deliver geological and resource data and information, including an online GIS-based mapping tool (the award-winning GeoVIEW.WA), a desktop application (GeoMap.WA), and a device-independent GIS mobile app (WA Geology). Built in-house, these systems offer simultaneous viewing and interrogation of multiple datasets, as well as detailed searching and spatial and textual querying of individual departmental databases. The information is updated regularly, new datasets are added, and functionality is constantly developed from users' feedback.

Maintaining the current systems in an ever-changing technological framework is challenging. With the expansion of analytical and computational capabilities, geoscience datasets are growing in volume, size, and complexity, while new types of data are also emerging. This tests the capability to rapidly 'draw' and query multiple datasets, as encountered with detailed geology (1:100 000 scale) or high volumes of graphic content (e.g. field photos). A powerful online 3D viewer that allows detailed analysis of the models is proving elusive. Interrogation of multiple-format datasets (e.g. government-mandated exploration data) requires considerable investment in data mining capabilities, and demand must be met to make large datasets available on mobile devices for offline work. Call for integration of internal datasets with those generated by external organizations (e.g. geochemistry and geochronology) is mounting, but needs to address issues of inadequate metadata, source identification and data reliability. Nevertheless, it is imperative that all of the above is considered to allow truly statewide datasets to be built and delivered.

410

Does compromised well and bore integrity lead to enhanced inter-aquifer connectivity?

Doble R[1], Peeters L[2], Mallants D[1], Noorduijn S[3], Turnadge C[1], McCallum J[4], Wu B[5]
[1]CSIRO Land and Water, [2]CSIRO Mineral Resources, [3]Flinders University of South Australia, [4]University of Western Australia, [5]CSIRO Energy

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Rebecca has been working in the Water Resource Management Program at CSIRO Land and Water since 2004. Her research interests are in groundwater hydrology, especially recharge and discharge, integrating groundwater models with remote sensing and geophysics data, interactions between rivers and groundwater including flood recharge, hydrogeological impacts of CSG wells and groundwater dependent ecosystems.

Inter-aquifer leakage may be exacerbated where there has been a loss of integrity in coal seam gas (CSG) wells, gas exploration bores have been inappropriately decommissioned, or water bores have deteriorated. This may result in enhanced depressurisation of adjacent aquifers used for water resources, or produce pathways for lower quality water and/or gas from deeper aquifers to migrate upwards, potentially leading to groundwater resource contamination. We identified possible pathways for enhanced inter-aquifer leakage, and provide a rapid assessment of the potential impacts of leaky CSG and legacy wells using conservative, single-phase groundwater flow and solute transport models and heuristic analysis.

Closed form equations were used to determine the theoretical hydraulic, well integrity and failure rate conditions that may lead to observable impacts on groundwater drawdown and water balance. A complementary numerical analysis using the MODFLOW Unstructured Grid model (MODFLOW-USG) and Continuous Linear Network (CLN) package for single- and multi-well analysis were used to confirm the theoretical results for a scenario representing Australian conditions similar to the Gunnedah Basin, New South Wales. The advection-dispersion equation was used to assess the groundwater quality impacts from a single leaky well or legacy bore.

It was found that leaky, partially degraded wells were unlikely to significantly impact inter-aquifer leakage, but that inappropriately decommissioned legacy exploration bores or deteriorated water bores have the potential to enhance communication between aquifers.

411

Evolution of the plate-mantle system since the late Paleozoic Period

YOUNG A[1], Flament N[1], Maloney K[2], Williams S[2,3], Matthews K[2], Zahirovic S[2,3], Müller D[2,3]
[1]GeoquEST Research Centre, School of Earth and Environmental Sciences, University of Wollongong, [2]EarthByte Group, School of Geosciences, The University of Sydney, [3]Basin GENESIS Hub, School of Geosciences, The University of Sydney

TS3 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Alexander Young is a PhD Candidate at the University of Wollongong He received his BAS. Hons from Sydney University in 2011 using paleomagnetic data to model the tectonic evolution of Patagonia throughout the Jurassic and Early Cretaceous. He subsequently worked as a graduate geologist at Origin Energy in Brisbane working in the South Australian exploration team, the unconventional operations team and the onshore Australia petroleum development team. His PhD research is on the relationship between mantle flow and surface processes.

Global plate reconstruction models that anchor past plate motions to the Large Low Shear Velocity Provinces under Africa and the Pacific, assumed to have remained rigid and fixed since Paleozoic times, produce high plate speeds and trench migration rates. When used as a surface boundary condition in geodynamic modelling, these models do not accurately reproduce the present-day structure of the lowermost mantle.
Building upon previous work, we developed a new global plate motion model with continuously closing plate boundaries from 410 Ma to present day, using a Paleozoic paleomagnetic reference frame independent of any geodynamic assumptions. We analysed our reconstruction in terms of surface kinematics and predicted lower mantle structure.
In this new reconstruction, Paleozoic plate speeds are on average ~8 cm/yr, which is comparable to Mesozoic-Cenozoic average rates of ~6 cm/yr. The global median trench migration rate is low; it is ~0.8 cm/yr during the Paleozoic (410-250 Ma) and ~1.1 cm/yr during the Mesozoic-Cenozoic (250-0 Ma).
We use this new tectonic reconstruction as boundary condition of simulations of mantle flow and find that the eastern margin of the African LLSVP margin has moved by as much as ~1,450 km since late Permian times (260 Ma), which challenges the proposed fixity of lower mantle structures. In addition, our new model for the evolution of the plate-mantle system since 410 Ma suggests that South China was proximal to the eastern margin of the African LLSVP during the Permian Period, and not the western margin of the Pacific LLSVP as previously proposed.

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Promising patterns - expression of basement structures through cover and their role as potential pathways through South Australia's critical zone

Krapf C[1], Petts A[1]
[1]Geological Survey of South Australia

TS1 - 3.1.1 Effective exploration and discovery under cover, Hall E2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Carmen is a Senior Geologist at the Geological Survey of South Australia working on characterisig the cover in SA. She is an expert in regolith mapping, as well as sedimentology and geomorphology, and worked in many modern and ancient desert areas around the world.
Carmen is also the current president of the Australian Regolith
Geoscientists Association (ARGA).

South Australia has ample evidence of ancient basement structures that have been reactivated throughout time and interacted with overlying cover sequences. This is reflected in today's landscape by modern day faultscarps and linear structures on the surface. Some of these neotectonic features have previously been described across South Australia. However, new high-resolution digital elevation as well as airborne electromagenetic (AEM) data, in combination with extensive surface, regolith and landform mapping across the State, resulted in more accurate mapping of the existing neotectonic features as well as the discovery of many new ones.
By showing several examples from different geological settings we will demonstrate how a number of deeper basement structural elements are expressed at the surface, as well as how they can be traced through the cover by comparing them to recently acquired AEM data.
These zones can potentially provide fluid pathways for the deeply sourced endogenic fluids to discharge into critical zone and hence can be helpful in depicting possible buried mineralisation though the overlying cover. Hence, it is critical to establish a statewide database that captures these surface features so that they can be related to underlying basement structures as well as defining areas where targeted surface geochemistry sampling should occur.

413

The age and tectonic significance of the Warraweena Volcanics and related rocks

Hack A[1], **Dwyer R[1]**, Collins B[1,2], Hegarty R[3], Gilmore P[3], Huang H[1,4], Whalan S[1], Phillips G[3]
[1]The University Of Newcastle, [2]Curtin University, [3]Geological Survey NSW, [4]James Cook University

Biography:
The presenter completed Honours in 2016 having worked on geochemistry and age of the Louth Volcanics in the Southern Thomson Orogen. He is currently a mineral separation and geochronology research assistant at the University of Newcastle.

Prismatic and magmatic textured zircon obtained from potassic calcalkaline Warraweena volcanics (WV) in two different drillholes have yielded concordant U-Pb emplacement ages 417 ± 3.5 and 414 ± 4.0 Ma and whole rock epsilonNd(t) values of +4.5 and +4.8, respectively. Along strike of the WV drill holes, we obtained zircon U-Pb Devonian ages (~ 411 Ma) from coherent S-type rhyolite flows with whole rocks having highly negative epsilonNd(t) values (-7.8 and -7.9). We refer to these felsic igneous rocks as the Oxley volcanics (OV). The ~411 Ma age constraint is within uncertainty of the WV and suggests the OV represent coeval bimodal magmatism. Importantly, the OV also define a lower Devonian deposition age for the host sequence of predominantly fine-medium grained metasedimentary rocks that appear to be widely distributed in the area based on geophysical characteristics.
Regionally, the WV are temporally, geochemically and isotopically similar to the calcalkaline Louth volcanic (LV) rocks that define a complexly folded belt in geophysical data, located ~100 km to the southwest. Other potentially correlative Early Devonian igneous rocks occur in the nearby Cobar Superbasin and elsewhere in the eastern Lachlan Orogen and are considered to represent the products of a post-orogenic, nascent continental back arc rift system.
Widespread metasedimentary rocks yield a range of maximum depositional age from Early Devonian to earliest Ordovician-latest Cambrian. The absence of complex fabric development typical of known potential pre-Silurian source rocks in the region and conformity with OV flows, where observable, suggests sedimentation was synchronous with volcanism.

414

Heterogeneity in the sub-continental lithospheric mantle: Multiple mantle source components identified from ca. 1590 Ma mafic intrusions, Gawler Craton

Wade C[1,2], Payne J[3], Barovich K[1], Reid A[1,2]
[1]University Of Adelaide, [2]Geological Survey of South Australia, [3]University of South Australia

TS3 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Claire Wade is a senior geologist at the Geological Survey of South Australia who is also undertaking a PhD at the University of Adelaide. Her research is focused on determining the *metal source for iron oxide-Cu-Au, Pb-Zn, Ag and Au-only mineral deposits formed by the c. 1590 Ma fluid system related to the Gawler Range Volcanics and Hiltaba Suite in the Gawler Craton by using a combination of whole-rock, mineral and in-situ mineral geochemical and isotope analysis to map the spatial and temporal variation of crust and mantle reservoirs and the variation among different mineral deposit types.*

Whole-rock geochemical and Nd isotopic compositions of mafic intrusive rocks from the Gawler Craton suggest an enriched and heterogeneous mantle existed at ca. 1590 Ma. Common to most mafic Hiltaba Suite units are enrichment in high field strength elements (HFSE) and rare earth elements (REE), with varying degrees of, but generally negative, Nb-Ta-Ti anomalies, and widely variable Nd isotopic compositions. At least three mantle source components have been identified. These include: Group 1) enriched HFSE and REE mantle with juvenile εNd(i) (0.1–4.2); Group 2) enriched HFSE and REE mantle with negative εNd(i) (-2.7 to -0.2); and Group 3) enriched HSFE and REE mantle, strong depletions in Nb-Ta-Ti and evolved εNd(i) (-8.2 to -3.2). The geochemical composition of Group 3 suggests derivation from an older sub-continental lithospheric mantle (SCLM) with some crustal contamination. This group is found predominantly in the northern Gawler Craton. The geochemical and isotopic character of Group 1 and Group 2 suggest the HFSE and REE enrichment may be a primary source region signature, reflecting a younger and slightly older variably metasomatised SCLM, respectively. Of these, Group 2 are the most abundant, found in the southern and eastern Gawler Craton. Group 1 occurs in the eastern and central Gawler Craton and displays an association with Cu-Au and Au mineralisation, respectively. This compositional and spatial (and temporal) variation in this mantle reservoir may be directly linked to different mineral deposit types that formed contemporaneously and suggest the possibility of multiple mantle sources for the 1590 Ma mafic magmatism.

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Planning for a strong, diverse and inclusive future geoscience workforce

Walker K[1]

[1]Science & Technology Australia, [2]Australian National Commission for UNESCO

TS7 - 5.2 Prediction, process, place: Geomorphology & 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Kylie is CEO of Science & Technology Australia, Chair of the Australian National Commission for UNESCO, and co-Chair of the National Research and Innovation Alliance. She is also a director of the ACT Domestic Violence Crisis Service, and visiting Fellow at the Australian Centre for the Public Awareness of Science. *Kylie is a proud advocate for women in science and technology, most recently creating the Superstars of STEM program. She has worked as a leader in the STEM sector for more than 10 years, and specialises in connecting scientists and technologists with governments, businesses, media and the public.*

Diversity and inclusion is vital to a thriving and resilient sector - but creating a diverse and inclusive sector takes time, energy and strategic planning.

Hear about how planning for equity, diversity and inclusion can benefit the geosciences - not just in individual institutions but across all aspects of the sector.

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Identification of groundwater recharge potential zones using GIS and remote sensing in the Southern Flinders Ranges of South Australia

Clark I[1], Fildes S[1], Ahmed A[1], Somaratne N[2], Ashman G[2]
[1]*School of Natural And Built Environments, University Of South Australia,* [2]*SA Water*

Biography:
Professor Ian Clark is a geoscientist with more than 35 years research and tertiary teaching experience. He carries out research with industry, government and other groups in the areas of environmental management and sustainability. He is currently investigating sustainable management of groundwater resources in fractured rock aquifers. He also conducts and supervises research into teaching and learning in earth system science.

As traditional aquifers become oversubscribed Remote Sensing (RS) and Geographical Information System (GIS) are playing a crucial role in the exploration for new groundwater resources all over the world. The Flinders Ranges region of South Australia is almost completely dependent on groundwater to support the pastoral industry, tourism and domestic users. Except for minor supplies in Recent alluvial deposits, the main groundwater is present in fractured Neoproterozoic – Cambrian metasediments rock aquifers. Based on studies in similar arid to semi-arid regions in other parts of the world this project was designed to delineate potential recharge zones.
The method involved integrating GIS and remote sensing (RS) derived data in a multi-criteria weighted, spatial analysis process. Lithology, lineament density, stream density and slope were considered most significant in this region. The Topographic Wetness Index data were used to incorporate the influence of stream density and slope. Thematic spatial data layers were prepared for each of these influencing factors. Saaty's Analytical Hierarchical Process (AHP) was used to assign weights to each thematic data layer The layers were then integrated using the weighted overlay in a GIS environment to generate groundwater potential and recharge zone maps. The output potential map was further classified into five zones on the basis of their histograms. Available water well data for yield and salinity were then used to test the validity of the outcome.

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Genesis of the Archean–Paleoproterozoic Tabletop Domain, Rudall Province, and its endemic relationship to the West Australian Craton

Tucker N[1,2], Morrissey L[2], Payne J[2], Szpunar M[3]
[1]Department of Earth Sciences, University of Adelaide, [2]School of Natural and Built Environments, University of South Australia, [3]Fortescue Metals Group Ltd

TS5 - 1.1.6 Proterozoic tectonics, Hall A, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Naomi recently completed her PhD focusing on the metamorphic and crustal evolution of Australian-Antarctic Proterozoic margins. She has worked extensively on the Bunger Hills in East Antarctica, the Albany-Fraser Orogen in southern Australia and the Rudall Province in northwest Australia. Naomi is currently working as a research assistant at the University of South Australia in conjunction with Fortescue Metals Group Ltd.

We present the first comprehensive, integrated U–Pb geochronological and Lu–Hf isotopic analysis of the Tabletop Domain of the east Rudall Province. The central Tabletop Domain comprises Archean–Paleoproterozoic gneissic rocks with three main age components. Paleo–Neoarchean (ca. 3400–2800 Ma) detritus in metasedimentary rocks was likely sourced from the East Pilbara Craton. Protoliths to mafic gneiss and metasedimentary rocks were emplaced and deposited during the early Paleoproterozoic (ca. 2400–2300 Ma), and have age and isotopic affinities to the Capricorn Orogen basement (Glenburgh Terrane). Mid–late Paleoproterozoic mafic and felsic magmatism (ca. 1880–1750 Ma) is assigned to the Kalkan Supersuite of the west Rudall Province, and provided the main source of detritus for mid–late Paleoproterozoic metasedimentary rocks in the Tabletop Domain. The Tabletop Domain records evidence for regional, high-grade mid–late Paleoproterozoic deformation (ca. 1770–1750 Ma), and localised, high-grade early Mesoproterozoic deformation (ca. 1580 Ma). The latter was associated with widespread, late-stage greenschist facies alteration.
Previous interpretations that the Tabletop Domain was an exotic crustal element of the West Australian Craton have hinged on the absence of a Paleoproterozoic history, and its seemingly low grade of metamorphism compared with the west Rudall Province. Our new findings indicate that neither of these conditions hold true. The Tabletop Domain experienced a much higher grade of deformation than previously assumed, and the entire Rudall Province shares a similar Archean–Proterozoic geological evolution. Our results confirm an endemic relationship between the Tabletop Domain and the West Australian Craton.

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Moving From Geosystem to Mineral System to Discovery – Research Challenges

Begg G[1,2], Hronsky J[3]
[1]Minerals Targeting International PL, [2]CCFS/GEMOC Macquarie University, [3]Western Mining Services PL

TS1 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Graham Begg has over 30 years in the mining and minerals exploration sector, and a PhD in tectonics and epithermal deposit geology from Monash University. Since 2002 he has also spearheaded collaborative research at Macquarie University, aimed at systematic multi-disciplinary mapping of the architecture and geodynamic evolution of the continental lithospheric mantle and crust, with the aim to facilitate a breakthrough in greenfields exploration discovery. The outputs contribute towards the commercial Global Lithospheric Architecture Mapping (GLAM) product, a framework for area selection in the resource sector marketed by his consultancy Minerals Targeting International (MTI).

The Uncover initiative highlighted the urgent need for a higher level of competency when exploring for blind or covered mineral deposits. Exploration data has many anomalous signals that may be consistent with features related to mineralisation, however the vast majority of these are false positives (i.e. a real anomaly that is not associated with mineralisation). Statistically, discovery probability of success is most sensitive to the quality of the project, i.e. area selection is a critical step.
Mineral deposits are the product of Mineral Systems. We now understand that these systems operate at the scale of the entire lithosphere, and are the outcome of global geodynamic processes that involve sequences of favourable events. A breakthrough in the area selection step of exploration requires increased understanding of all components and contributors to a Mineral System.
Mapping the architecture and geodynamic history of the lithosphere are two of the critical ingredients identified in the Uncover Initiative. The Australian Geoscience community has initiated several data acquisition programs to begin to address this. The anticipated avalanche of new data will bring a new challenge – how better to interpret it? Issues to be tackled include:-
1) The observable highly heterogeneous structure of Sub-Continental Lithospheric Mantle, and the obvious presence of fossilised structures;
2) Identification of steep trans-lithospheric structures and their importance. Such structures are both implied and imaged in other data, but rarely identified in interpretations of crustal seismic data.
3) How metals are mobilised and concentrated in mantle and deep crustal fluid systems.

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Towards a synthesis of the high-temperature Mesoproterozoic evolution of reworked Australian–Antarctic convergent margins

Tucker N[1,2], Morrissey L[2], Hand M[1], Kelsey D[1,3], Payne J[2]
[1]Department of Earth Sciences, University of Adelaide, [2]School of Natural and Built Environments, University of South Australia, [3]Adelaide Microscopy, University of Adelaide

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Naomi recently completed her PhD focusing on the metamorphic and crustal evolution of Australian-Antarctic Proterozoic margins. She has worked extensively on the Bunger Hills in East Antarctica, the Albany-Fraser Orogen in southern Australia and the Rudall Province in northwest Australia. Naomi is currently working as a research assistant at the University of South Australia in conjunction with Fortescue Metals Group Ltd.

The Mesoproterozoic assembly of Australia and East Antarctica is recorded by terranes that formed along the reworked margins of Archean cratons. Together, these terranes form the Musgrave–Albany– Fraser–Wilkes Orogen (MAFWO), and they preserve an orogen-wide record of regional and sustained high thermal gradients, voluminous mantle and crustal melting, and little metamorphic evidence for crustal thickening. These primary observations challenge conventional views on the thermal behaviour of the crust and a simplistic model of continental collision. We present a summary of the spatial, temporal and thermal features of Mesoproterozoic metamorphism and magmatism within the MAFWO to provide clarity on the likely driving forces for thermally-extreme crustal behaviour within the context of continental amalgamation.
High heat flow for a long duration in thin crust suggests that the MAFWO is overall an inherently mantle-driven thermal system, but the thermal driver and tectonic setting for each stage of its evolution is interpreted to have varied. D1/M1 (ca. 1340–1260 Ma) is consistent with extensional accretionary orogenesis and was ultimately controlled by the pre-D1 tectonic geometry of the MAFWO. D2/M2 (ca. 1220–1130 Ma) was pervasive and involved long-lived and remarkably consistent high–ultrahigh thermal gradient metamorphism (~150°C/kbar) in thin and extending crust. Metamorphism was accompanied by voluminous, high-temperature, near-exclusively felsic–charnockitic magmatism with a significant mantle source contribution. D2/M2 is interpreted as the thermal expression of mantle lithosphere removal. Final craton amalgamation occurred prior to D2/M2 and was central to the longevity of anomalous thermal conditions.

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The effect of photo degradation on ground water dissolved organic matter.

Nawzad S[1], Baker A[1], Rutlidge H[1], Andersen M[1], O'carroll D[1], Meredith K[1]
[1]*University Of New South Wales*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I, Sizah Nawzad, am currently a 4th year penultimate undergraduate student at the University of New South Wales studying a combined Petroleum Engineering and Earth Science degree. I am currently involved in groundwater research at the School of Biological, Earth and Environmental Sciences here at UNSW. The research being conducted involves groundbreaking analysis of dissolved organic matter (DOM) in groundwater and how it is affected by photodegradation and how this affects the composition and concentration of DOM within subsurface samples. As the research continues, I hope to develop a relationship between photodegraded DOM and the global carbon flux.

This experiment aims to determine the effect of photodegradation of ground water dissolved organic matter (DOM). Analyses were completed on water obtained from 21 boreholes located in Narrabri’s Maules Creek, Wellington, and Anna Bay (all NSW), as well as surface water samples from Nepean and Macquarie River, NSW. Samples were from differing depths, from both surface water and rainfall recharge, and both losing/gaining conditions. Water samples were photodegraded in clear PET bottles inside a climatron under constant illumination and temperature. Experimentation was continued for 8 days with sub-samples analysed at day 0, 3 and 8 (final day). Samples were then analysed by: (1) excitation emission matrix (EEM) fluorescence spectroscopy and parallel factor analysis (PARAFAC) to determine fluorescence dissolved organic matter (fDOM) component fractions; (2) liquid chromatography (LC-OCD) to identity, quantify changes in size fractions of DOM over the experimentation period. Under our experimental conditions, the results suggest that ground water DOM is photo degradable, but only the fluorescent DOM fraction, and that photo degradation of the fDOM signal is similar in both groundwater and surface water samples. Total DOM concentration and concentration of size fractions showed no significant changes in either surface or groundwater. Our results demonstrate that the fluorescent fraction of DOM is a relatively small component of the total DOM. In essence, the photo degradability of groundwater DOM is important for the understanding of DOM character relevant to the ecology of gaining rivers and the treatment of abstracted groundwater DOM.

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Controls on the Flux of Sedimentary Carbon to the Mantle During the Cenozoic

Clift P[1]
[1]Louisiana State University

TS5 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Peter Clift is a marine geologist who works on tectonic scale mass recycling in subduction zones and the origin of the continental crust. He quantifies the erosion of the continental crust especially in Cenozoic mountain belts using data from marine depocentres and estimates how much of this may be returned to the mantle during subduction and collision. He is interested in the influence that climate change has on this process and how surface processes impact tectonics.

Quantification of the long-term cycling of carbon from the mantle to the surface remains contentious despite its importance in governing the climate and biosphere of Earth. Sedimentary carbon represents a significant part of the budget and can be recycled to the mantle if it reaches subduction zones and is not offscraped into an accretionary prism. I estimate that ~60 Mt/yr is presently being subducted below forearcs. 80% is in the form of carbonate, significantly more than previously estimated. Sedimentary carbon represents around two thirds of the total carbon input at the trenches, the rest being in the igneous crust. An additional 7 Mt/yr is averaged over the Cenozoic as a result of passive margin subduction during continental collision. This revised budget estimates the input and output fluxes within the range of uncertainties, compared to earlier deficits. Degassing from arc volcanoes and in forearcs totals ~55 Mt/yr. A net modern carbon flux to the mantle is probable but this may only date from the Late Jurassic when carbonate biogenic production increased. The efficiency of carbon subduction is largely controlled by the carbonate contents of the sediments, and is partly linked to the latitude of the trench. Accretionary margins are the biggest suppliers of carbon to the mantle wedge, especially Java, Sumatra, Andaman-Burma and Makran because the offscraping is inefficient and the thickness of the trench sediment and trench length are both large. The Western Pacific trenches are negligible sinks of sedimentary carbon.

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AuScope and the decade of predictive geoscience: research infrastructure to support tackling the next generation of Australian geoscience questions

Rawling T[1]
[1]*AuScope*

TS1 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Tim Rawling is CEO of AuScope which is the NCRIS capability that provides research infrastructure to support the earth and geospatial science research community in Australia. Tim is a structural geologist and geophysicist with a background in 3D modelling.

Over the past decade AuScope has invested in research infrastructure in collaboration with our partner universities, state geological surveys, CSIRO and Geoscience Australia.

AuScope's provision of equipment, data and analytics to geoscience researchers has driven innovation across Australia's minerals, energy, agriculture, aviation, marine and education sectors, with an indicative net benefit to Australia $2.3 – $6.2B as at 2015 – 2016 (Lateral Economics, 2016).

AuScope strives to create universal access to earth and geospatial research infrastructure (equipment, data, analytics) to drive innovative Australian scientific research and to support scientific investigations in government and industry.

With the release of the Decadal Plan for Earth Sciences, and the announcement in the May 2018 budget of 12 years of funding for the National Collaborative Research Infrastructure Strategy (NCRIS, AuScope's funder), AuScope is building a five-year investment plan to deliver strategic investment in earth and geospatial science research infrastructure over the next decade. We welcome you, as the Australian research community to be involved in this process. Here we will present the current vision for future AuScope investment and invite participation both during the session and at the AuScope planning workshop that will follow the AGCC meeting.

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Micro-CT investigations of two well-preserved Middle Cambrian radiolarians from the Georgina Basin, Australia

Sheng J[1], Kachovich S[1], Aitchison J[1]
[1]School of Earth and Environmental Sciences, The University Of Queensland

TS2 - 2.4 Ancient and Historical Record of Life in Australia, Room R1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Jiani Sheng is PhD student from the School of Earth and Environmental Sciences of the University of Queensland. Her research focuses on the application of micro-CT in 3D visualisation and analysis of problematic microfossils. She applies micro-CT to investigate both extracted and in-situ Early Paleozoic radiolarians in order to better understand the skeletal structures and the evolutionary stages amongst the oldest radiolarians.

A radiolarian assemblage was extracted using acetic acid from limestone concretions of the Inca Formation, Georgina Basin, Australia. This unit is of Middle Cambrian (Epoch 3) age and contains one of the best-known occurrences of the earliest well-preserved radiolarians. Observation and analysis of Early Paleozoic radiolarians with complex three-dimensional structures can be challenging but have been successfully achieved with the X-ray micro-computed tomography (μ-CT). Improvement in our understanding of radiolarian skeletal structures will advance knowledge of the taxonomy of Early Paleozoic radiolarians. Lower Paleozoic radiolarian biostratigraphy is underdeveloped due to the difficulty in studying in-filled spherical radiolarians, which are dominated by complex spicular and multi-spherical forms. Exceptional preservation of the Middle Cambrian (Epoch 3) Inca Formation fauna from the Georgina Basin presented us with a rare opportunity to perform detailed investigations with the μ-CT of two radiolarians belonging to the genus Archeoentactinia. The individual spicules that make up the skeletons were able to be digitally segmented. The results reveal that the fundamental building units of the Archeoentactinia incaensis Won and Below and A. tetractinia Won and Below of the family Archeoentactiniidae are exclusively tetractine (four-rayed) spicules. Their structures indicate a close relationship to the Echidninidae, thus reassessment of taxonomic classification of the earliest radiolarians is required. By digitally inserting a sphere into the cavities of the specimens, the spicule distributions were analysed. Our results suggest that in Archeoentactinia there is a stepwise skeletogenesis of the spicules constructing the basic framework.

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Giving a good grounding, earlier - exploring methods for geoscience engagement in early childhood.

Harvey M[1]
[1]*Charles Darwin University*

Biography:
A geologist who has worked in mining and exploration for over 20 years, Marianne participated in the inaugural voyage to Antarctica of the Homeward Bound Project, a strategic leadership programme for women in science. Aboard this journey Marianne discovered she aspires to educate and entertain by communicating geoscience to a wide variety of audiences. She hopes to increase awareness of human impacts on the Earth's physical processes so humans can learn to interfere less with the natural environment.

The ability to learn about our physical environment begins before birth. The warmth, the tastes – a myriad of sensations fuel experiential learning. The fact that the fastest rate of brain development in children is between the ages of 0 to 3 years, is undisputed. And it is the nurturing of a child's innate curiosity that ensures they become life-long and open-minded learners.
We also know that allowing kids to get dirty is good for their immunity, and that they need to get enough exercise to avoid digital dementia from device-usage. But outside sensory time, climbing rocks or playing with dirt and water with family or community enables a deeper environmental awareness, and more likely an interest upon which to scaffold some geoscientific understanding.
The aim is not to turn all kids into avid rock-lickers, simply to reduce an implicit bias that 'rocks are boring.' The Australian school curriculum only introduces concepts dealing with the Earth's mineral resources in Year 2 science, when children are around the age of 7. This may be too late to inspire new geoscientists, as children at 5 years old know their own likes and dislikes, have formed personal preferences and have already developed the majority of their life-long interests.

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The infrastructure that lets us ask where? The impact of AuScope on Australian geoscience research.

Rawling T[1], Dawson J[2], Brown N[2]
[1]AuScope, [2]Geoscience Australia

TS1 - 4.4.1 The Geoscience of Where, Room R7, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Tim Rawling is the CEO of AuScope Limited which is the NCRIS capability supporting Australian research infrastructure investment in earth and geospatial science. Tim is a structural geologist and geophysicist with a background in 3D modelling. He has experience working in research positions across the academic, government and industry sectors.

In May 2018, the Australian Treasurer announced $64million of new funding, plus ongoing operational funds, for Geoscience Australia's National Positioning Infrastructure. This will provide critical new technology that will transform Australia's positioning network to allow national coverage with sub-10cm accuracy.

What does this mean? With this technology, a whole new generation of possibilities can be realised, from virtual fencing in agriculture to disease control at the grape bunch level in viticulture.

And how is this possible? Solid long-term planning and investment in GNSS infrastructure through AuScope and Geoscience Australia.

This talk will outline the impact of strategic investment in research infrastructure, including VLBI and GNSS, and discuss opportunities for future strategic investment opportunities in the earth and geospatial science fields.

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Groundwater geochemical evolution and residence time distribution in two headwater catchments of the Murray-Darling Basin, Southeast Queensland

Martinez J[1,2], Raiber M[1], Mckay A[3], Cendón D[4,5], Suckow A[6]
[1]CSIRO Land and Water, [2]School of Earth, Environmental and Biological Sciences, Queensland University of Technology (QUT), [3]Department of Natural Resources, Mines and Energy (DNRME), [4]Australian Nuclear Science and Technology Organisation (ANSTO), [5]Connected Waters Initiative, School of Biological, Earth and Environmental Sciences, University of New South Wales (UNSW), [6]CSIRO Land and Water

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Jorge is a hydrogeologist with over 15 years of professional experience in the field of water resources management and groundwater remediation. With a background in geology and a PhD in hydrogeochemistry, he is interested in water-rock interaction processes and the fate and transport of chemicals in groundwater.
Jorge has recently joined CSIRO as a research scientist to explore the use of hydrochemistry and environmental tracers in combination with various modelling techniques to investigate regional hydrogeological processes.

This study assessed diffuse recharge, inter-aquifer mixing and surface water-groundwater interactions in two headwater subcatchments (Dalrymple and Oakey creeks) within the Condamine River catchment, part of the Murray-Darling Basin in southeast Queensland.
The integrated assessment combined hydrochemical datasets and environmental tracers (stable isotopes, ^{3}H and ^{14}C), providing insights into the factors controlling hydrochemical evolution and residence time distribution of alluvial groundwaters along flow paths intersecting different geological settings.
Using multivariate statistics, six water groups were identified, showing correlations between water types and hydrostratigraphic units, sample depth, spatial position within the catchment and likely interactions between groundwater and creek waters. The two most distinct water types had median electrical conductivity of 200 µS/cm (Mg-Ca-HCO_3 type) and 3250 µS/cm (Na-Cl type).
Groundwater residence time was estimated via lumped parameter models (^{3}H -^{14}C) and the apparent age was based on ^{14}C. Modern groundwater samples were sourced mainly from the upper alluvial aquifers and from a large volcanic aquifer underlying the alluvium in more than 60% of the study area. Pre-modern groundwaters are associated with Jurassic sandstones and with lowland alluvial aquifers. In this part of the system, the alluvium is likely connected to the sedimentary bedrock, resulting in mixing of groundwater of different ages.
The comparative assessment of the two catchments demonstrated direct correlations between residence time and distance from the catchment headwaters and highlighted the influence of the geological framework on mixing ratio distribution, evaporation ratio and water-rock interaction rate in different sections of these tributaries.

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New ways to engage with Australian stratigraphy

Brown C[1], Marais-van Vuuren C[1]
[1]*Geoscience Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Cathy graduated from ANU with a BSc in geology in 1980. She worked at ANU, UNE and the Geological Survey of NSW, before returning to Canberra to do a Grad Dip in Information Management in 1989. Cathy then joined BMR to manage stratigraphic units data and, apart from an excursion into managing laboratory and rock store data for a few years, has mostly remained in stratigraphy-related roles, adding Chair of the Australian Stratigraphy Commission to Australian Stratigraphic Units Database manager since 2008.

Access to the Australian Stratigraphic Units Database (ASUD) and information on stratigraphic nomenclature has been updated recently. While it is still available through the Geoscience Australia Home page http://www.ga.gov.au/, the look and feel of the contact forms and the three search pages, the 'Stratigraphic Units Search', the 'Stratigraphic Units by State/Territory', and the 'References Search', have changed.

Perusing the stratigraphy web pages and direct searching of the database is one way to get information on Australian stratigraphy, and includes our infographic and a practical exercise on establishing, naming and defining a new unit.

Information is also available through links with other data and websites. The ASUD provides the basic stratigraphic information behind all of Geoscience Australia's geological GIS products such as the '1:1 million Surface Geology' and the range of sub-surface layers that are now being produced, with the current focus being on the 'Exploring for the Future' area.

The same data is used in the geological maps part of the AUSGIN Geoscience Portal http://www.geoscience.gov.au/, and the Data Standards section provides links back to our stratigraphic nomenclature pages.

State and Territory Geological Survey products and various Geoscience Australia products such as the new Boreholes data packages, and existing products such as the biostratigraphy charts, and various groundwater publications also include stratigraphic data.

Further enhancements are being planned, both to delivery of stratigraphic nomenclature information and the contents of geoscience data packages, so we welcome input on what our information and data delivery should look like in the future.

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Nucleation of rift basins and initiation of the East African Rift System in NW Kenya: The 'Turkana First' model

Boone S[1], **Gleadow A[1]**, Seiler C[2], Morley C[3], Foster D[4]
[1]School of Earth Sciences, University of Melbourne, [2]Geoscience Australia , [3]Department of Geological Science, Chiang Mai University, [4]Department of Geological Sciences, University of Florida

TS2 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Andy Gleadow is a Professorial Fellow in Earth Sciences at the University of Melbourne. He has worked extensively on the development of fission track thermochronology for understanding the thermal and tectonic evolution of the continental crust in many parts of the world. He has published widely on these methods and especially their application to continental rifting, basin analysis and landscape evolution. He has been Head of Earth Sciences at both Melbourne and La Trobe Universities, and previously served as President of the GSA, amongst many other roles. His work has been recognised by numerous Fellowships, awards and medals.

The Turkana Depression (TD) in northern Kenya and southern Ethiopia is a key segment of the East African Rift System (EARS) for studying the onset of intracontinental rifting and the influence of rift superposition on the lithospheric response to later extension. A regional low-temperature thermochronology study of TD basement rocks presented here, in conjunction with structural observations, provides new insights into the Cretaceous-Recent tectono-thermal evolution of the upper Turkana crust and the localisation and propagation of extensional deformation.

During the Late Cretaceous-early Paleogene, isolated depocentres of limited thicknesses (<500 m) developed in western Turkana, as the surrounding NW-SE trending Anza and South Sudan rift systems experienced significant subsidence (up to 9 km) during Cretaceous-Paleogene time. This challenges the often invoked assumption that the Anza and South Sudan systems once linked within the TD, instead suggesting that extension in Turkana was restricted during that time. Nonetheless, the moderate degree of Turkana lithospheric attenuation appears to have been sufficient to have facilitated subsequent localisation of Eocene plume-related volcanism, that marked the initiation of the EARS.

Around 45-40 Ma, pronounced denudational cooling affected southern Turkana in response to the development of the ~N-S Lokichar Basin and associated uplift of surrounding margins, making it the earliest known manifestation of ~E-W extensional deformation in the EARS. The broadly concurrent nucleation of plume-magmatism and strain in Turkana, predating rifting elsewhere in East Africa by ~15-10 Myr, suggests that inception of the EARS was facilitated by the dynamic interplay of pre-existing lithospheric heterogeneities and mantle processes.

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Cover thickness uncertainty mapping by assimilating diverse estimates

Visser G[1], Markov J[1]
[1]CSIRO, [2]CSIRO

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Gerhard Visser currently develops customised inversion/inference/statistical methods for CSIRO's deep earth imaging free science platform. His current research focus is on cover thickness and full waveform inversion. He received his PhD in 2017 from Monash university in Computer Science (mathematical statistics) for research on the theoretical foundations of Bayesian methods. He has also worked in industry developing algorithms for sports prediction.

Around 80% of Australia's continental crystalline basement is under cover. Thickness of cover over crystalline basement is one of the main economic risks for 21st century mineral exploration in Australia. Cover thickness estimates can be derived from various types of geophysical data using various estimation/inversion methods. More direct observations like those derived from drillholes and outcrops are also useful.

We introduce a Bayesian method for assimilating cover thickness estimated and measurements obtained by various methods with an emphasis on the use of expert knowledge. Our assimilation method has the flexibility to incorporate a range of options for characterising uncertainty of individual input estimates and structural geological information. Cover thickness volume uncertainty estimates are produced.

Performance of our method was first evaluated using synthetic data derived from the Bishop model. Various statistical considerations were explored, including: irregular data distribution, depth dependence of noise, outlier detection and handling, inequality constraints, multi-pixel estimates, inter-estimate noise relations and fault inclusion. We demonstrate the value of taking these into account and how our method enables it. A real case study was used to validate method performance and demonstrate its application.

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Finding Fractures in the Cooper Basin Deep Coal Play: An Integrated Approach to Predictive Modelling

Hissey E[1], Telenko B[1], Camac B[1]
[1]*Santos*

TS1 - 3.2.3 Petroleum and its co-products, Room R2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
After a brief career as a mine geologist, and 6 months exploring the Gobi Desert for copper and gold, Emma decided that FIFO life was not for her. She completed her Bachelor of Science (Petroleum Geology & Geophysics) with First Class Honours at the Australian School of Petroleum, University of Adelaide in 2008. In 2009, she commenced work at Santos Ltd and is currently in the Cooper Basin Unconventional Growth team working on the Permian Source Rock (Deep Coal) Play.

Typical Coal Seam Gas (CSG) reservoirs store hydrocarbons upon or within the coal molecular structure. When the cleat system in a coal seam gas reservoir is de-watered, the system pressure is reduced and gas molecules desorb from the coal and are produced through the permeable cleat system to surface. However, the Cooper Basin Deep Coals have a poorly-developed, often annealed, cleat system. This is predominately due to the rank, depth and high inertinite content of these coals. Without a water-filled cleat system, reducing the reservoir pressure significantly enough to allow desorption to occur requires an alternate mechanism. Lab-analysis of the Permian deep coal seams demonstrates a network of free gas storage capacity which includes phyteral porosity, and fracture and joint systems. It is the presence of the natural fracture systems that is proposed to replace the traditional role of the cleat system in a CSG well, with the added benefit of being gas-filled, not water-filled.
This study has focussed on integrating a combination of structural framework modelling, geomechanical analysis, stress modelling and petrophysical interpretation over several prospective regions for Deep Coal activity. This has resulted in a workflow that takes the concept and generates a predictive model with two primary functions; to map areas of sufficient coal thickness for completion, and to assess where the probability of natural fracture occurrence is greater. The validity of the model can be verified using flow results from the extensive activity that has occurred in the Cooper Basin Deep Coals to date.

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Spectral analyses of drill core from Tunkillia, South Australia

Gordon G[1]

[1]Geological Survey of South Australia, [2]University of South Australia

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:

Georgina Gordon graduated from the University of Adelaide (BSc Hons) with a major in structural geology. She has since worked for the Asutralian Mineral Foundation on the Data Metallogenica project, and has spent several years with the Geological Survey of South Australia as a spectral geologist working with hyperspectral drill core analyses and mapping the industrial mineral resource potential of the greater Adelaide region.

ABSTRACT:

The Tunkillia gold prospect is located within the Yarlbrinda Shear Zone in the Central Gawler Gold Province in South Australia. Gold and silver enrichment is hosted by steeply dipping quartz veins within the Tunkillia Suite. Previous spectral studies have used short wave infrared (SWIR) analyses (ASD; HyChips), with a focus on the upper weathered zone from Area 191 and Tomahawk. These SWIR studies agree kaolinite and smectite can be used to distinguish different horizons in the upper pallid and leached zones. Sericite and chlorite have identified downhole as the major minerals in the alteration assemblage, and changes within these groups form an alteration halo surrounding gold mineralisation.

Potassic feldspar and quartz play an important role in the alteration mineralogy for gold deposits of the Central Gawler Gold Province, and have been the focus of testing using the HyLogger-3™ based at the Tonsley Core Library in Adelaide. The latest advent of the scanning technology includes thermal infrared wavelengths (6000-11500nm) and revealed a decrease in potassic feldspar towards high gold mineralisation.

The data from the Gold Sniffer and the HyLogger-3 has been coordinated in an attempt to identify the sulphide minerals associated with gold in the visual wavelengths and plotted down hole for comparison with the alteration mineral assemblage. This method produced a broad distribution of spectral features in red, blue and green wavelengths that could be correlated with gold mineralisation.

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The role of a Geological Survey in providing a platform for geotourism and geoheritage and its delivery to the world

Krapf C[1], Cowley W[1], Gerrard C[2]
[1]Geological Survey of South Australia, [2]Department for Energy and Mining

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Carmen is a Senior Geologist at the Geological Survey of South Australia working on characterisig the cover in SA. She is an expert in regolith mapping, as well as sedimentology and geomorphology, and worked in many modern and ancient desert areas around the world.
Carmen is also the current president of the Australian Regolith
Geoscientists Association (ARGA).

The Geological Survey of South Australia has been the custodian of geological information and data for South Australia for more than 150 years and continues to provide it to a wide variety of stakeholders. This includes information about geoheritage sites as well as information on many sites across the State that are of geological interest not only to geologists and explorers but also to the wider public.
Today's challenge is to provide information via easy to access and navigate data portals, websites and Apps and to be at the same time visual appealing and interactive. With the recent update of the South Australian Resources Information Gateway (SARIG), which delivers state-wide geoscientific and geospatial data, new opportunities arose for delivering innovative geotourism and geoheritage information. One example is 'Discovery Trails', which provide the ability to view virtual tours of South Australia's geology from the desktop computer or mobile device. Discovery Trails highlight real locations across the state and combine multimedia elements such as images, text and videos to showcase South Australia's diverse geological history.
There is a wide variety of geoscience information for geotourism sites available throughout South Australia, however, this information has been compiled by a wide variety of organisations, groups and individuals. State-geology data portals like SARIG could provide an overarching platform to combine and access the available information by collectively providing links from a central site to the available information.

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Imaging Moho variations across Australia from Bayesian inversion of autocorrelograms

Tork Qashqai M[1], Saygin E[1], Kennett B[2]

[1]CSIRO Deep Earth Imaging Future Science Platform, [2]Research School of Earth Sciences, The Australian National University

TS1 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:

Mehdi received his Ph.D. in geophysics at Macquarie university in August 2016. His PhD work mainly focused on the internally consistent joint inversion of multiple geophysical datasets using a Bayesian framework for mapping the thermochemical and seismic structure of the lithosphere. He then joined the Deep Earth Imaging Future Science Platform group at CSIRO as a postdoctoral fellow in July 2017. His research within Deep Earth Imaging group is mainly focused on passive seismic imaging methods. This includes, but not limited to, the developing and implementing probabilistic (joint) inversion of passive seismic data for imaging crust and upper mantle structure.

It has been shown that for plane acoustic waves arriving with normal incidence to a horizontally stratified acoustic medium, one side of autocorrelation of the seismic transmission response corresponds to the reflection response beneath the receiver (reflectivity) as if there was a virtual source at the location of the receiver. In recent years, the autocorrelation of the diffusive wave field (e.g., ambient noise energy) or teleseismic coda waves has been widely used for imaging local seismic structures beneath seismic stations, including depth to the major discontinuities in the crust and upper mantle (e.g., Moho). Although there have been many studies on the retrieval and forward modelling of stacked autocorrelograms, studies on the inverse modelling of these kind of seismic observations have been limited. In this study, we not only extract the stacked autocorrelograms from P-wave teleseismic coda recorded at ~1200 permanent and temporary seismic stations across Australia, but also utilise a Bayesian framework to invert these data for imaging the Moho depth (and crustal structure) beneath individual stations. The results for all stations are then combined to construct a Moho map for the Australian continent. Subsequently, we use the most comprehensive Moho model for Australia (AusMoho) as a benchmark to verify our inversion results. The long-wavelength pattern of the Moho variations is found to be highly consistent with the AusMoho model, which has been derived from other seismological methods.

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Unearthing GSSA history – legacy documents and equipment

Cowley W[1]

[1]*Geological Survey Of South Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:

After graduating from Adelaide University (South Australia) in 1979, Wayne worked in base metal and uranium exploration, in four Australian states. In 1985, Wayne joined the Geological Survey of South Australia, where regional 1:250 000 scale geological mapping was Wayne's main activity until 2003. Recent years have seen Wayne take on state-wide projects such as compiling a variety of state geology maps, and stratigraphic nomenclature, geological heritage, and database custodian roles.

The Resources and Energy Group (including the Geological Survey of South Australia (GSSA)) of the former Department for Premier and Cabinet have moved to 11 Waymouth Street after 20 years at 101 Grenfell Street, and known from 1st July as the Department for Energy and Mines.

The process to reduce the volume of business files, documents, maps and equipment was guided by a past employee with extensive knowledge of Departmental document series and administrative procedures, supported by an archivist. With the assistance of long-standing employees, many collections of vital source documents were augmented, catalogued, and submitted to State Records, for example:

- Geologist's, geophysicists' and other field notebooks
- Aerial photographs with geological and geophysical annotations, in many cases original field observations
- Compilation plans produced by the former Drafting Section for pre-digital published geological maps

Many documents generated in the pre- or early-digital era were retained for restarting unfinished projects or to preserve information obtained from areas difficult to access, such as the APY Lands.

Petrological and geochemical reports and field photographs require further digitising and cataloguing. The process has also identified pre-digital era posters, excursion guides, and drillcore display guides, previously unlocatable plans and reports, and has unearthed many items of historic value.

Biostratigraphy samples and petrological thin sections will now reside in the South Australian Drill Core Reference Library at Tonsley. University theses relevant to SA geology were also rationalised. Historic field and drafting equipment has also come to light.

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Environmental tracers in coal and unconventional gas development proposals: How can we do better?

Lamontagne S[1], Mallants D[1]
[1]*CSIRO Land and Water*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr. Lamontagne is an environmental scientist specialising in water resources impact assessments using environmental tracers. Current research interests include evaluating the impacts of post-mining landscapes on water quality, groundwater - surface water interactions, and regional hydrogeology.

The perception of a limited use of environmental tracers for hydrogeological characterisation in new coal seam gas and coal mining development proposals in Australia was tested by convening a workshop in May 2018 in Adelaide. The event included a broad cross-section of the sector, including industry, science and regulatory agencies, universities, and consultants. A review of the recent literature clearly showed a widespread usage of tracer techniques in recent years even though this is not always reflected in development proposals per se. Tracers were most commonly used for the conceptualisation of hydrogeological systems and also in some cases to quantify specific processes (like recharge rates, etc.). In line with the hydrogeological literature in general, tracers have seen very limited applications for directly constraining the numerical models used to evaluate the impact of development on water resources. However, by improving the conceptualisation of hydrogeological systems, tracers have materially enhanced the robustness of some development proposals. Industry is supporting the use of tracer techniques where appropriate and expressed the need for further training (for the sector in general, including for the regulator). Cost, delays to get results back, and lack of expertise for data interpretation are among the reasons cited limiting a greater uptake of the tracer approach. Further evaluations of the 'data worth' of tracer measurements for different problems should be compiled and showcased to help industry and the regulator plan cost-efficient applications.

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The diverse origins of breccias within the Gawler Range Volcanics: lithological characteristics, formation processes and implications for mineral prospectivity

Werner M[1]
[1]*Geological Survey Of South Australia*

TS6 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
PhD awarded from University of Würzburg/Germany in 2007.
Worked from 2005-2008 in various roles at Australian School of Petroleum of University of Adelaide.
Employed from 2008-2011 by Geological Survey of Western Australia (Musgrave Mapping Team).
Since 2011 at Geological Survey of South Australia.

The c. 1.6 Ga Gawler Range Volcanics (GRV) are dominated by felsic coherent volcanic facies interpreted as thick silicic lava flows. Clastic rocks are present in minor proportions within this succession, but are an essential key to unravelling its volcanic evolution. Past research and recent studies in the Gawler Ranges have shown that coarse-grained rocks, mostly in the form of breccias, represent a significant proportion of this clastic facies. Some of these breccias represent potential pathways for hydrothermal fluids and thus may host economic mineral deposits. Understanding the various formation processes of these breccias and the resulting potential for hydrothermal fluid flow is therefore critical in developing effective exploration strategies in this geological setting. Despite numerous breccia occurrences within the GRV, their origin is in many cases not well understood or controversial.
This presentation will provide an overview of the diverse range of breccias occurring in the GRV by describing their lithological characteristics and observed styles of hydrothermal alteration. Examples include autoclastic, pyroclastic, sedimentary, intrusive and cataclastic breccias. Understanding fragmentation, particle transport, emplacement and deposition processes provides a guide for distinguishing individual breccia types and will help to assess their mineral prospectivity. Recently discovered low-grade mineralisation in regionally extensive coarse GRV volcaniclastics showed that these rocks facilitated hydrothermal fluid flow near fault zones within a volcanic succession largely considered as impermeable and demonstrated their prospectivity for epithermal mineral deposits.

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Flood hazard evaluation in Mzi valley (Ghardaia- Algeria).

Mimouni O[1]
[1]*University Of Sciences & Technology Houari Boumediene*

Biography:
I graduated from Georgia Institute of Technology, Atlanta (GA Tech.), with a Master degree in Engineering Geology, in June 1981. In may 2010, I presented my Doctorate thesis entitled :" Algiers region waters-Pollution and flood risks).
I am actually Professor in charge of courses, in Engineering geology department, responsible for the License-Master-Doctorate program (LMD) and head of a National Research Program (PNR) on Geological and Environmental risks in Northern Algeria Neogene basins. "risques géologiques et environnementaux dans les bassins néogènes dans l'Algérie du Nord.

Ghardaïa city is located about 600 Km south of Algiers, in the northern Sahara, at an average altitude of 600 meters. It is part of the desertic Saharian plateau called Hamada, constitued by hard, brown to black limestones of Cretaceous age.
The city extension is oriented toward the wad Mzab which makes it vulnerable to flooding. In this work, we will present a hydroclimatic area overview, a flooding risk study in this kind of arid zone, precise the vulnerability of the city from flooding and propose solutions to avoid such phenomenon. In the meantime a prevention work was already realized and a dam was proposed and built and we will give all the characteristics as well as the reasons for the location choice.

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The 1595Ma Gawler Range Volcanics: A template for petrogenesis of a Silicic Large Igneous Province (SLIP).

Foden J[1], Stewart K[1], Cox G[1], Tregagle J[1], Ross A[1]
[1]*University Of Adelaide*

TS8 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Igneous petrologist and geochemist

The Mesoproterozoic (1595± 3Ma) Gawler Range Volcanics (GRV) is an anorogenic, silicic large igneous province (SLIP). While continental LIPs are typically dominated by mafic magmas, felsic magmas are nevertheless important either as the dominant lavas (e.g. the GRV and the Indian Malani), or as components of mixed mafic and felsic provinces (Yellowstone, Etendeka, Karoo).

The GRV provides a template for global SLIP generation. Modelling shows that felsic melts evolved from mafic parent magmas generated by productive melting of a pyroxenite-rich mantle plume at between 1.4 and 1.8 GPa (~40-50km) and ~1380oC. Felsic melts result from a combination of fractional crystallisation and crustal assimilation (AFC) and represent ~30% of the mass of the mafic parent. The felsic GRV lavas left a gabbroic intrusion equivalent in size to the Bushveld complex in the lower continental crust, creating a >+30milligal GRV centered gravity anomaly. The parental dacite (~63% SiO2) melts escaped to upper crustal magma chambers (~0.15GPa, <~4-5km) where further fractionation and cooling generates rhyolite with > 73% SiO2. Dacites (Yardea) have T ~ 990-940oC, rhyolites T = ~ 890-820oC. These shallow bodies controlled the eruptive style.

SLIPs are surface reflections of large mafic intrusions stalled in the lower crust. Factors that dictate mafic stagnation in the deeper crust as opposed to direct surface eruption are complex. They include lithospheric stress state, crustal thickness, lower crustal temperature, lithospheric plate motion stagnation and rate and volume of mafic melt production and input.

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GeoVis3D - Interactive Analysis of Virtual Geological Models

Roach M[1], Scott R[1], Donaghy J[1]
[1]*University of Tasmania*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Michael Roach is a Senior Lecturer at the University of Tasmania who teaches both undergraduate and postgraduate geophysics and geology units. Michael has a special interest in the application of virtual content for Earth science education

GeoVis3D is new free software for interpretation of 3D virtual geological models that provides functioality for structural analysis, stratigraphic measurements and qualitative interpretation.
GeoVis3D allows measurement of the orientation of linear and planar features on the external surface of the model and also the orientation of structures that intersect the model based on the trace of the plane on the surface of the model. All structural measurements are tabulated and automatically plotted on an equal area stereonet as either poles or great circles. Features in the model, stereonet and tabular views are automatically linked so that selection of a feature in one view will highlight the corresponding feature in the other views.
True thickness stratigraphic logs are easily generated by first defining the orientation of a reference plane and then digitising points on the interfaces between units. Lithology and grainsize variations for each unit are selected from pup-up menus. GeoVis3D also allows annotation and labelling of features directly on the 3D surface of the model. Hotspots placed on the surface of the model can link to web addresses, and to a variety of digital media. Interpretations can be saved as 3D DXF files for export to external software. All measured data and model annotation is stored in XML format for easy exchange of geological interpretations.
GeoVis3D is free, has an intuitive workflow and is a highly effective platform for virtual data analysis that provides an open access solution for sharing detailed three dimensional geological interpretations.

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Characterising the mineralogy of the Gold Creek Volcanics, Tawallah Group, McArthur Basin, with reference to Stanton cobalt prospect, Northern Territory.

Smith B[1]
[1]*Northern Territory Geological Survey*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Belinda Smith graduated with Honours in Geology from the University of Western Australia. Since 1995, Belinda has been working through her company Rocksearch Australia for various exploration companies and the Northern Territory Geological Survey. Belinda entered the colourful world of spectral lines and HyLogger imagery in 2010 at NTGS but also still works as a consultant geologist.

An increased economic demand for cobalt has stimulated exploration at Stanton prospect, in the eastern McArthur Basin. The Total Mineral Resource of 1200t contained cobalt (Northern Cobalt, 2018) is hosted in the Gold Creek Volcanics of the Tawallah Group, which is a mixed basalt-sedimentary succession with an average thickness of 170 m (Rawlings, 2006). The basalt-sedimentary formation has been informally subdivided into sequentially named units of 'basalt 1', 'basalt 2' separated by thinner sedimentary horizons of 'arenite 1', 'arenite 2' etc (Rawlings, 2002). Mineralisation is mainly constrained in the 'target unit' that is between 'basalt 4' and 'basalt 5' near the top of the Gold Creek Volcanics. The 'target unit' comprises heterolithic beds of mildly dolomitic micaceous mudstone and interbedded fine sandstone. The mineralisation is most intense within interpreted 'breccia pipe' zones.
Apart from 'basalt 4' being described as 'feldspar-phyric', the basalt sequences are indistinguishably described as fine-grained, aphyric, with vesicles near the upper and lower contacts. The arenite units comprise a mixed quartz-dolomite lithic composition, interbedded with lesser mudstone. Quartzarenite and doloarenite exhibit identical colour, textures and sedimentary structures, which has meant that doloarenite has not been distinguished from siliclastic sandstone in drill logs (Rawlings, 2002). However, after HyLogger scanning, the mineralogy of individual basalt and arenite units can be distinguished from each other at Stanton prospect, as well as in drillholes distal to the Stanton mineralised zone.

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Science in Australia Gender Equality (SAGE) at Geoscience Australia (GA)

Lem A[1]
[1]*Geoscience Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Andrew is one of Geoscience Australia's 2018 Graduates. He has completed Bachelors (Hons) in Renewable Energy and Sustainability Engineering and a Masters in Information Technology at UNSW, and a Masters of Teaching Secondary Education at UTS. He is excited at the opportunity to pursue all three fields of applied sciences, IT and education at Geoscience Australia.

Research[1] indicates that inclusive organisations that value diversity, including having gender diverse leadership teams, outperform those that don't. Australian university science graduates reached gender parity over 20 years ago. Geoscience Australia (GA), however, continues to face the challenge of attaining greater gender equity across the organisation, and especially within its senior leadership. GA is committed to improving its performance in gender equity by creating a more inclusive workplace.
GA has joined the pilot Athena SWAN program in Australia, run by SAGE (Science in Australia and Gender Equity). This framework of accreditation, based on the UK Athena SWAN Charter, is recognised as a comprehensive and practical scheme to improve scientists' careers by addressing gender inequity. The Charter of 10 principles encourages institutions and public research organisations to commit to a progressive approach to policies, practices and actions to improve their culture thus creating and supporting a more diverse workplace.
GA will submit an application in July 2019 for Bronze accreditation that will identify a set of actions to be implemented to address the gender equity challenges. We will continue to measure and analyse our data to determine if the actions are having a positive effect, thereby allowing us to build on improvements in creating a gender inclusive workplace and potentially enabling us to apply for Silver accreditation.

[1]for example: Desvaux, Devillard, de Zelicourt, Kossoff, Labaye and Sancier-Sultan, Wood, McKinsey, Women Matter: Ten years of insights on gender diversity, 2017; University of Melbourne, Building a Business Case for Gender Diversity, 2013;

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Sustainable Geotechnical and Geological Data Management for Infrastructure in New South Wales

Och D[1]

[1]*WSP*, [2]*University of New South Wales*

TS6 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 9:30 AM - 11:00 AM

Biography:

David's role within WSP is primarily to provide high level technical advice on a wide range of projects and issues in Australia and overseas. He is often called upon to assess particular difficult issues encountered and come up with practical solutions to help the design, analysis or construction and which do not lend themselves to normal solutions. David also often involved in high level review and assessment of projects, particularly with respect to design and concept design.

David's expertise in tunnelling and engineering geology is demonstrated by performing key lead and advisory roles on projects including Coopernook to Herons Creek Alliance, Hunter Expressway Alliance, Kempsey Bypass (piling), Sydney Metro City & Southwest, Sydney Metro – West, VicDesal, Ramu II Hydro PNG, and local building and transportation projects.

David carries out research faults and dyke systems within the Sydney Region and regional NSW involving structural and geochemical analysis and age dating.

David still maintains an active research capacity with collaboration with University of Adelaide, University of Technology, Sydney, University of NSW, University of Newcastle, ANU, Kyoto University, Geological Survey of NSW, RMIT and CSIRO.

David also maintains an expansive geological/geotechnical GIS based database, which has been used in all the projects for which he has been involved.

Sydney Metro is Australia's largest public transport project. As the network is rolled out across Sydney, there will be a complex interaction between new tunnels competing for space with an existing network of transport and service tunnels and building basements. The topography of Sydney is an additional constraint. These factors require geological and geotechnical considerations to be at the forefront of any decisions made during the planning of future Metro corridors.

The geological setting of the Sydney Basin is well understood and documented. However, the complexity of these existing infrastructure networks and associated impacts on locating new sub-surface transport corridors requires the planners and designers to understand ground conditions. There is no central database capturing new and historical geotechnical investigations by the public sectors in NSW, with all data mainly archived by the private sector. Therefore, if no existing data is identified during desktop studies new ground investigations will often be required.

Sydney Metro and its partner WSP developed CREATE, a system to collect all data from the initial scoping phase up to construction in a GIS based framework. This database provides an invaluable resource overlaying all geotechnical, geological, geophysical, environmental and stakeholder data.

For this system to deliver its full potential, government departments would need to integrate their internal data or develop a centralised state-wide data collection centre. The collection of geotechnical data will require the government to legislate a registry system. This can complement planning consents, which allows the capture of this valuable resource for future use.

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Is scientific evidence enough to build social consent for nuclear fuel storage in South Australia?

van Camp L[1]
[1]*Golder Associates*

Biography:
Lissa van Camp is the leader for Environmental Services in South Australia and Australian lead in Renewable Energy Services for Golder Associates. She has worked on pumped storage hydro, marine energy and large scale wind and solar facilities, and currently working with Hydrostor Inc. on compressed air storage solutions.

In 2016, the Nuclear Fuel Cycle Royal Commission released its final report detailing how storage of spent fuel could be relevant to South Australia. The report found the State generally has the attributes and capabilities to build and operate a world-class facility using a combination of geological and engineered barriers. Through Golder's support of the Committee for Adelaide's Nuclear Fuel Tour, Lissa visited regulators, safety authorities and two purpose-built spent nuclear fuel storage and disposal repositories in Finland (Onkalo) and France (Cigeo), and met with regulators from the UK. In addition, Golder has been instrumental in building legislative frameworks, social consent and facilities for low level and intermediate radioactive waste overseas. With these experiences, Lissa was then an Expert Witness to the Citizens Jury, first of 50 people, then 350 people, which was established to ensure that members of the public were able to make an informed decision. Although no site was nominated, evidence was presented demonstrating that spent fuel can be safely stored in South Australia, which could in turn provide significant economic benefit. The Jury determined that South Australia should not pursue the opportunity to store and dispose of high level spent fuel. For significant projects such as a spent nuclear fuel repository in Australia, sufficient time to build a mature understanding of the issues and subsequent social consent is integral to moving forward.

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What is your confidence in your simulated confidence interval?

Kentwell D[1]

[1]*SRK Consulting*

TS8 - 4.2 Mining geology and geometallurgy, Room R6, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Danny Kentwell is a geostatistician with a background in geological modelling, mine planning and surveying. He has 25 years' international experience with multiple and varied commodities. . Danny is Fellow of the AusIMM and a Competent Person for JORC Code and a Qualified Person for NI 43-101 reporting of resources for numerous commodities and deposit types. Danny has experience with many change of support and selective mining unit scale estimation and simulation methods.

Assessment of uncertainty in Resource estimation is often quantified by deriving a confidence interval for a particular volume from a set of block simulations. The underlying assumption is that the set of parameters used for input to the simulation is fixed and that they are all correct. Just as kriging results and kriging quality are sensitive to the number of samples in the local search neighbourhood, so too are simulations that rely on local search neighbourhoods for their implementation. For example, fewer samples in the neighbourhood means a different kriging result and more importantly a larger kriging variance, this leads to a wider set of possible simulated values at each point/block and thus to a different set of confidence intervals for any given volume.

Just as with the kriging paradox of local accuracy vs global accuracy at cut offs above zero, we have to examine the sensitivity of the confidence intervals to search neighbourhood parameters and decide what set of search neighbourhood parameters are most appropriate.

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AusGeol.org - The Virtual Library of Australia's Geology

Roach M[1]
[1]*Uni of Tasmania*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Michael Roach is a Senior Lecturer at the University of Tasmania who teaches both undergraduate and postgraduate geophysics and geology units. Michael has a special interest in the application of virtual content for Earth science education

AusGeol.org is the Virtual Library of Australia's geology. The AusGeol library provides free access to interactive visualisations from over 3800 'sites' around Australia and delivers a range of products including: photo-realistic 3D models derived from both terrestrial and UAV photography, full-spherical panoramas and 'deep zoom' imagery. Visualisations of significant localities are also integrated to generate interactive virtual tours. All visualisations are accompanied by comprehensive metadata that facilitate display and retrieval of features based on keyword, stratigraphic or lithological queries.
Visualisations are delivered by the AusGeol web portal (www.AusGeol.org) via either an interactive map interface (Atlas tab) or by tabular selection and display (Sites tab). Map and GIS data from external web map services can be displayed in the Atlas tab to provide spatial and geological context for the visualisations. 3D photo-realistic models and full spherical panoramas can be visualised interactively within the AusGeol site and all data are available for free download for local viewing or incorporation into other applications. The AusGeol project has also produced free software called GeoVis3D for quantitative geometric analyses of 3d virtual models
The AusGeol library was initially developed to deliver educational resources for undergraduate Earth Science education but the ultimate aim of this initiative is to provide a comprehensive digital record of the important elements of the geology of Australia. The library has a wide range of applications in secondary and tertiary Earth science education, for research and for public outreach.

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Impact of hydrocarbon contamination on compound-specific carbon and hydrogen isotopic signatures of n-alkanes

Schinteie R[1]
[1]*Csiro*

TS5 - 2.6 Geobiology & 2.8 Earth, life and ores, Room R1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Richard Schinteie is a research scientist with the CSIRO Energy business unit. His principal research areas are organic and petroleum geochemistry, geobiology, and sedimentology. Richard obtained a BSc (Biological Sciences), GradDipSci (Geology), and MSc (Geology) from the University of Auckland in New Zealand, and a PhD (Earth Chemistry) from the Australian National University in Canberra. Prior to joining CSIRO, he was a postdoctoral research fellow at the California Institute of Technology in Pasadena, USA.

Compound-specific isotope ratios are routinely measured on extractable organic matter to decipher biogeochemical processes and events in Earth history. To deliver accurate interpretations, it is paramount that isotopic values are derived from indigenous compounds and are not the result of contamination. However, distinguishing between these sources can be difficult, especially if a degree of mixing occurred. We assess the impact of hydrocarbon contamination on the carbon and hydrogen isotopic composition of n-alkanes from evaporates. These samples originated from a drill core previously shown as severely overprinted by hydrocarbons from a range of different sources. We applied for the first time exterior/interior (E/I) rock extraction experiments to assess the impact of hydrocarbon contamination on isotope values. In these experiments, exterior and interior portions of the same rock samples were separately crushed to powder, extracted and prepared. Compound-specific isotope values of n-alkanes from the different rock portions were subsequently measured and compared. In most cases, we observed n-alkanes from exterior portions to have consistently lighter δ13C and δ2H values than their interior counterparts with an E/I isotopic offset averaging from 0.2 to 3.9‰ for δ13C and approximately 10‰ for δ2H. These diverging isotope patterns tend to correspond to E/I concentration differences of n-alkanes that are the result of contaminants overprinting indigenous isotopic signals. Through the application of E/I ratio plots, contaminants can be recognized, and mixed indigenous/contaminant signals identified. These experiments provide a useful tool for investigating the degree of isotopic overprinting and for getting a better indication of indigenous isotopic signatures.

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The Amadeus Basin fold-and-thrust belt, central Australia: stages of intraplate deformation

Weisheit A[1], Donnellan N[1], Normington V[1], Edgoose C[1]
[1]*Northern Territory Geological Survey*

TS2 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Anett studied geosciences at the University of Tuebingen (Germany). Her PhD focussed on the structural and hydrothermal evolution of a basement inlier in the northern Flinders Ranges in South Australia. Since 2014 Anett has been employed with the Northern Territory Geological Survey in Alice Springs (Australia). Currently Anett is part of a geological mapping team working in several basement provinces in central Australia. Anett is also working on interpreted geology maps of the Amadeus Basin in the Northern Territory (presented at AGCC).

The Tonian–Carboniferous Amadeus Basin in central Australia preserves several sedimentary successions deposited in an intraplate setting. The basin covers an area larger than England, it is locally up to 14 km deep, with less than 15% exposed rock. Two major periods of syn- and post-depositional regional tectonism, and reactivation of basement structures led to the formation of a complex fold-and-thrust belt, several 1000 km away from plate margins. This structural evolution is preserved in outcrop as local and regional unconformities, changes of lithology / facies, bedding-parallel and oblique slickensides, tectonic breccias and shear zones. Integration of new mapping with detailed geophysical interpretation has now led to a revised understanding of the deformational history of the basin.
The Ediacaran-aged Petermann Orogeny, cored in Musgrave Province basement, resulted in the formation of a tectonic southern margin and thick-skinned, north- to northeast-directed fault-propagation folds in the south of the basin. During the Ordovician–Carboniferous Alice Springs Orogeny these structures were partly reactivated and overprinted by sets of several-100 km long, south-directed fault-bend folds and fault-propagation folds. The Alice Springs Orogeny is cored in Arunta Region basement, causing a tectonic northern margin and significant deformation in the northern Amadeus Basin. Sets of thick-skinned, oblique-slip to strike-slip faults developed late and caused the disruption of pre-existing structures. The degree of faulting, and the recognition that much of the folding in the Amadeus Basin is fault-related, has not previously been recognised and has fundamental implications for the understanding of the regional tectonics through time.

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Groundwater hydrogeochemistry of the Capricorn Orogen and mineral exploration through cover

Thorne R[1], Reid N[1], Gray D[1]
[1]*CSIRO*

TS7 - 3.1.1 Effective exploration and discovery under cover, Room R2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Robert Thorne is a research scientist working at CSIRO, he specialises in near surface mineral exploration with a particular focus in hydrogeochemistry and regolith.

This study uses groundwater hydrogeochemistry and the newly established regolith-landform evolution models from across the Capricorn Orogen, Western Australia, to aid in understanding how geochemical anomalies are developed through, and in cover this region. The Capricorn Orogen is a ~1000 by 500 km, variably deformed region of Western Australia located between the Pilbara and Yilgarn Cratons. Groundwater samples have been taken from ~1000 stock bores across the orogen. The results are used to develop indices for mineral exploration as well as providing new pathfinder element suites to improve exploration. For example, the buried (400 m deep) Abra base metal deposit is identified through elevated Pb concentrations close (< 3km) to the deposit. Whilst surface soil and regolith sampling methods have proven to be ineffective at this deposit. Stable isotopes within groundwater are also able to assist in identifying prospective regions. Oxygen and hydrogen isotopes highlight groundwater samples that have a composition suggestive of a water source other than meteoric water. This water source has mixed with meteoric water and may be linked to faults, mineralisation or hydrothermal alteration. Light $\delta^{34}S$ values and associated light $\delta^{18}O$ from sulphate highlight the Paulsens Au deposit and have the potential to target new areas of mineralisation. A model for the evolution of the surface environment allows links to be made between regolith and groundwater sampling leading to an increased potential for finding mineral systems halos in and under cover.

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Interpretation of zircon U-Pb ages on volcaniclastic rocks:A case study on the Fairbridge Volcanics of the Macquarie Arc, southeastern Australia

Zhang Q[1], Nutman A[1], Buckman S[1]
[1]*School of Earth and Environmental Sciences, University of Wollongong*

TS7 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
QING ZHANG is a PhD candidate from the University of Wollongong (2015.9-). Qing did her Master's degree at the China University of Geosciences, Beijing (2012-2015), and used to work on structural geology and geochronology, to understand how the regional structural controls the multiple intrusions and polymetallic ore deposits. Currently, she is focusing on understanding the tectonic setting of southeastern Australia, with methods of geochronology, stable isotopes and geochemistry. Generally, she has broad interests in arc-continent collision and intracontinental deformation.

Detrital zircon geochronology has become an essential technique to determine the final deposition age of volcaniclastic and sedimentary rocks. However, when the youngest components are not dominant within the sample, they are often omitted, using Pb loss as the explanation. This case study is on the Fairbridge Volcanics of the Macquarie Arc, southeastern Australia, which has been described as an Ordovician Formation based on the dominant component. In this study, Gaussian deconvolution of 104 zircon analyses reveals 4 main age components at approximately 436 Ma, 445 Ma, 459 Ma and 470 Ma (the Precambrian zircons were not included in this calculation). The youngest Silurian component (436 Ma) is stratigraphically younger than previous studies, which dated the rocks to the late Ordovician. This young component is not an individual phenomenon in this area. The coeval volcaniclastic rocks from other Formations of the Macquarie Arc, such as the Cargo Volcanics and Basal Ranch Member, displayed similar components, especially for the youngest ages. Therefore, these young components in the volcaniclastic rocks should be valued and the stratigraphy might need to be adjusted.

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Individual and regional risk assessments of landslides

Huang J[1]
[1]The University Of Newcastle

TS5 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Jinsong Huang is an associate professor at the University of Newcastle. His research interests include risk assessment in geotechnical engineering and computational geomechanics. He served as the editor-in-chief of the special issue "Modelling spatial variability in geotechnical engineering" in Georisk, and he is an editorial board member for this journal as well as Canadian Geotechnical Journal and Computers and Geotechnics. He is a committee member on the ASCE Geo-Institute's Technical Committee on Risk Assessment and Management (RAM) and the ISSMGE Technical Committee (TC304) on Engineering Practice of Risk Assessment & Management.

Slope failures or landslides triggered by rainfall and seepage are reported every year in different countries. Although not as high profile as other natural hazards such as cyclones, storms, floods and earthquakes in Australia, landslides cause more life loss and injury, along with economical losses due to damages to infrastructure, and agricultural and mining facilities (Geosciences Australia: www.ga.gov.au). In spite of improvements in landslide hazard recognition, prediction, mitigation measures, and warning systems, worldwide landslide activity is increasing. Uncertainty is a dominant feature of all landslides. Various uncertainties arise during the resolution of the problem, from climate data of rainfall, to infiltration rate, to site characterization, to material properties, to analysis, design and consequence assessment. These variabilities are rarely taken into account directly in traditional geotechnical analysis, rather some "average" or suitably "pessimistic" property is assumed to act across the whole region of interest. This keynote will focus on the modelling of spatial variability of soil/rock properties in the risk assessment of individual landslides. The issues of using Machine Learning algorithms in the risk assessment of regional landslides will also be briefly discussed.

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Geochronology of Proterozoic metallogenic events in the Mount Isa Province

Dhnaram C[1], Lisitsin V[1]
[1]*Geological Survey Of Queensland*

TS2 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Courteney Dhnaram has worked within Minerals group at the Geological Survey of Queensland for over 10 years, focusing on regional to camp scale studies on copper and gold mineralisation within North and North West Queensland.

Analysis of the available geochronology across the Mount Isa Province confirms a traditional broad sub-division of the major Proterozoic mineral systems in the Mount Isa Province into 'early' sediment-hosted Pb-Zn-Ag and 'late' structurally controlled Cu (±Au±Mo±Co±U) families.

Pb-Zn-Ag deposits within both Western and Eastern Successions are isotopically constrained to 1660-1570Ma by U-Pb dating of host rocks and Pb-Pb dating of mineralisation. However, Ar-Ar geochronology of associated alteration minerals commonly provided younger ages between 1530-1480Ma, deemed to reflect resetting by a younger thermal event.

Extensive Re-Os, Ar-Ar, K-Ar and U-Pb geochronology on selected Cu (±Au±Mo±Co±U) deposits within the Eastern Succession bracket the IOCG mineral systems in the region to 1595-1480Ma. Data suggests a number of discrete metallogenic events during this extended period. The main event occurred at ~1530-1500Ma, synchronous with extensive magmatism of the Williams Supersuite. Relatively minor events occurred at ~1595Ma (probably related to peak regional metamorphism with associated partial melting) and ~1480Ma.

Significant uncertainties remain on the geochronology of Cu (±Co, U) deposits in the Western Succession and their chronological and genetic relationships with sediment-hosted Pb-Zn-Ag (±Cu±Co) deposits in the Western Succession and Cu-Au (±Co, U) deposits in the Eastern Succession. Resolving these uncertainties will require a systematic geochronological data acquisition program across the Province, which is currently under way.

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Palynology of a Late Permian Marker Mudstone in the Bowen and Galilee basins: Implications for inter-basinal correlation

Wheeler A[1], Van de Wetering N[1], Esterle J[1], Götz A[2]
[1]The University of Queensland, [2]University of Portsmouth

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Alexander Wheeler is a South African palynologist who completed his undergraduate degree in Zoology and Geology at Rhodes University and continued to obtain his honours degree in Geology. He completed his MSc at the University of Pretoria looking at palynofacies changes in the Witbank and Highveld Coalfields. Currently he is pursuing his PhD under the supervision of Prof. Joan Esterle at the University of Queensland. His research focuses on palaeoenvironmental reconstruction of the Late Permian Galilee Basin and interbasinal correlation.

The coal deposits of the intracratonic Galilee Basin are understudied compared to the Bowen Basin to the East. Even with the well constrained biostratigraphy developed in eastern Australia, intra- and interbasinal correlation remain challenging due to a lack of detailed palynological studies in the Late Permian sections of the Galilee basin. A carbonaceous mudstone, dubbed the “Marker Mudstone”, deposited above the uppermost Permian coal seams represents a potentially useful tool for regional correlation of the end-Permian deposits in both basins. The aims of this study were to place the Marker Mudstone in a biostratigraphic context using samples from the borehole Tambo 1-1A and to reconstruct the end-Permian palaeoenvironment of the Springsure Shelf in the Galilee Basin.
When compared to biostratigraphic data from a section containing the Marker Mudstone in the Bowen Basin, the samples from the Galilee Basin show a degree of diachroneity. In the Galilee Basin, the Marker Mudstone represents the uppermost expression of the APP5 biozone (based on the scheme of Price 1997) while in the northern Bowen Basin it represents the base of the APP6 biozone. Palaeoenvironmental data suggests the Marker Mudstone represents a lacustrine deposit, which formed as base level rose and the alluvial-deltaic system that deposited the Bandanna Formation sediments subsided. Whether the diachroneity reflects changing palaoenvironment or a separate unit is still under study.

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Groundwater science contributions to water policy development and decision making in the 21st century

Coram J[1]
[1]CSIRO

TS7 - 3.3.5 Groundwater science for policy development and decision making, Room R5, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Jane Coram is Director of CSIRO's Land and Water Business Unit. She has almost 30 years experience in natural resources science delivery, and a broad multidisciplinary understanding of land and water sciences. She has held leadership positions including CEO of the National Measurement Institute, Acting Chief Scientist at Geoscience Australia, and Groundwater Branch Head at Geoscience Australia.

Australia's natural challenge of being a land "of droughts and flooding rains" (Dorothea Mackellar), overlaid with changes in climate, land–water use and resource development, drives the imperative for innovative science to inform Australia's water management decision-making.
For more than a decade, federal and state governments have sought science insights into water futures. By combining Australia's capability in characterising and modelling groundwater in innovative ways, we have had significant success in unlocking groundwater information for seemingly data-poor areas, achieving a step change in groundwater assessment information for water managers and industry. In the process, Australia is now leading international developments in probabilistic groundwater resource assessment, deploying big data analytics and uncertainty analysis to support quantitative risk assessment and adaptive management.
The potential for new science to continue to inform and transform water policy and decision making in an uncertain climate is thus profound. When we get it right, truly innovative solutions to water management challenges can be reached. Yet science sometimes struggles to realise its potential to make a sufficiently relevant, timely or accessible contribution to addressing those challenges.
In this presentation I will consider several recent examples where science and policy have connected effectively in developing innovative solutions to water management challenges. I will also reflect on the characteristics of less effective interactions between science and policy, the challenges and opportunities of incorporating scientific "expert opinion" into decision making processes, and how we might optimise the contribution of groundwater science to groundwater policy and decision making in the 21st century.

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Petrographic and Geochemical Identification of Paragenetically Complex Carbonate Veins, Mount Isa, Northwest Queensland

Andrew B[1], Barker S[2], Lilly R[3], Rea P[4]

[1]School of Science, University of Waikato, [2]Centre for Ore Deposit and Earth Sciences, University of Tasmania, [3]Academics With Exploration; Studies Of Mount Isa and the Eastern Succession (A.W.E.S.O.M.E.S), Department of Earth Sciences, The University of Adelaide, [4]Mount Isa Mines Resource Development

Biography:

Upon completion of my MSc in 2010, I worked in green-fields and brown-fields exploration across a range of commodities including titanium-vanadium, gold, copper, fluorite, iron and coal in both Western Australia and New Zealand. In 2015, I returned to the University of Waikato to undertake research towards a PhD. My project involves identification of cryptic alteration halos associated with copper mineralisation at Mount Isa, Northwest Queensland. My research interests include development of practical geochemical tools for mineral exploration, utilising geochemistry to identify and map critical processes in hydrothermal mineral systems and transfer of heat and mass in the crust.

Carbonate minerals are ubiquitous vein-infilling materials associated with many styles of hydrothermal mineralisation, including skarn, Carlin-type gold, mesothermal gold, porphyry, low-sulfidation epithermal gold and Mount Isa-type sediment hosted Cu deposits. Commonly considered gangue minerals of little or no significance, understanding how the composition of carbonate minerals can vary as a function of fluid chemistry, temperature and pressure means that carbonate minerals could be an important tool in mineral exploration in situations where paragentic sequences are clearly defined.

However, the identification of overprinting carbonate generations in hydrothermal veins can be difficult when using standard petrographic techniques, especially in veins with complex paragenetic histories. This is the case at Mount Isa, where ore stage veins contain multiple stages of carbonate formation that are very difficult differentiate during visual logging.

In this study, we utilised cathodoluminescence to differentiate a previously poorly identified phase of calcite from high iron dolomite within ore stage veins. Observations were coupled with portable X-Ray Fluorescence analysis of carbonate veins to develop a field deployable tool for identification of these paragenetically complex veins.

Sampling of a range of exploration drill holes from Mount Isa shows this phase of carbonate is more widely distributed than previously recognized. While the exact significance of this fluid flow event is yet to be determined, it is posited here that this stage of calcite veining may represent a distil halo to processes related to mineralisation at Mount Isa.

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Up and Down: vertical land motion of the Australian continent

Riddell A[1,2], King M[1], Watson C[1]
[1]Geography and Spatial Sciences, University Of Tasmania, [2]Geoscience Australia

Biography:
Matt King studied Surveying at University of Tasmania and during his PhD there he branched out into measuring the kinematics of a large floating ice shelf. From 2001, he had 11 fantastic years in Newcastle-upon-Tyne, UK, where he developed an interest in observing how Earth's shape is changing, and understanding the drivers for that change. He specialises in ice-sheet and sea-level change and solid Earth deformation associated with these. He returned to University of Tasmania in 2012 to take up an ARC Future Fellowship where is he Professor of Polar Geodesy and Head of Discipline of Geography and Spatial Sciences.

Current rates of Australian vertical land motion appear to not be spatially coherent with the predicted geophysical models with a discrepancy at the level of a few millimetres per year. Recent Global Positioning System (GPS) measurements at permanent geodetic sites suggest that the vertical motion of the crustal plate across Australia is between 0 and -1 mm/yr. Large-scale geophysical models and tectonic theory suggest that the vertical motion of the crust should be much closer to zero or slightly positive as a result of glacial isostatic adjustment, the solid Earth's response to ice-ocean loading changes. The observations and models therefore appear in conflict. We compare observations of vertical motion to geophysical models of crustal displacement to better understand the geophysical origin of changes to the Australian plate. Correction of GPS site velocities with geophysical models results in an average reduction of ~0.2 mm/yr, but still demonstrate spatial variability and correlation. Spatiotemporal filtering provides a methodology for reducing common mode errors between stations within a regional network allowing for the suppression of noise and the reduction of uncertainty on velocity estimations. We then compare the noise characteristics of the original time series with the multivariate regressed time series and note a significant reduction of PLW noise amplitude, spectral index and trend uncertainty can be achieved. Improving the signal to noise ratio of geodetic coordinate time series by separating the constituent source signals is an effective way of identifying small or weak deformation signals, thus improve our geophysical interpretation across our region.

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Catchment salt balance and historical salinity flushing quantified in a high rainfall stream (Mount Lofty Ranges, South Australia)

Anderson T[1]

[1]*Flinders University*

TS5 - 3.3.2 New groundwater technologies and approaches & 3.3.5 Groundwater science for policy development and decision making, Room R5, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Tom Anderson is completing his PhD in Earth Sciences with skills in hydro-geochemistry and quantitative hydrogeology. His research interests lie in groundwater/ surface water interactions, quantifications of catchment scale salt balances; chronology of groundwater using carbon14 analyses; compartmentalization of groundwater; and spatio-temporal analysis of surface water.

In addition to academic success Tom has 2 years of consulting experience and in environmental sciences and environmental monitoring.

Human-induced landscape salinization, including dryland salinity, has had devastating consequences on many catchments in southern Australia. Salinization occurs due to increased recharge and a rise in groundwater tables following land clearing of deep rooted native vegetation. In low lying areas with poor drainage groundwater table rise can lead to evapotranspiration and salt scalding. However, these same processes of increase recharge and groundwater table rise can lead to decreases in salinization as the historic salts are flushed into surface waters. This study in the Mount Lofty Ranges of South Australia documents a case of catchment desalinization. In the Scott Creek catchment, a 28 year record (1989-2016) of flow and salinity data were analysed on a monthly basis. Analysis of catchment-scale chloride deposition and export determined that approximately three times more chloride is being exported than is being received by catchment from atmospheric sources. Salt load exported to surface waters over the time period analysed was calculated to decrease on average by 6.4 tonnes per year, due to freshening of the catchment. Furthermore, analysis of an intermittent sub-catchment demonstrates accumulation of chloride rather than export during dry years whereas in the permanent stream catchment chloride accumulation is rarely greater than export. Findings from this study show that a continuous, high resolution monitoring history is required to thoroughly evaluate salt input and export.

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Advancing the Particle-In-Cell Scheme to an Adaptive, Unstructured Computational Framework

Mathews C[1], Davies R[1], Wilson C[2], Kramer S[3]
[1]Australian National University, [2]Carnegie Institution for Science, [3]Imperial College London

TS5 - 1.1.2 Optimisation and uncertainties in Earth models, Hall C, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
PhD Student from Australian National University

A growing number of geochemical observations point towards the existence of distinct geochemical “reservoirs” within the mantle, some of which have survived for over 4 Byr of planetary evolution. Depending on their volume and material properties (e.g. density, viscosity), these reservoirs could play a significant role in governing mantle dynamics. To test whether or not this is the case, it is desirable to simulate thermochemical mantle convection rather than convection driven purely by temperature variations.

Fluidity, a multi-purpose, finite-element, control-volume, adaptive, unstructured mesh computational modelling framework, has the ability to simulate thermochemical convection, through the use of a multi-material control volume scheme. This mass-conserving scheme successfully passes several common thermochemical benchmarks, but it is limited in its general applicability. As an alternative method, a particle-in-cell scheme has been implemented into the Fluidity framework. The implementation of such a scheme into an unstructured, adaptive framework has not yet been achieved within the geodynamics community and, thus, has some inherent challenges. Examples include the transfer of particle properties to an unstructured mesh, and the redistribution of particles in accordance with the dynamically load-balanced mesh in parallel. This presentation will summarise these challenges and how they have been overcome, demonstrate the validation of the newly implemented particle-in-cell scheme, and include comparisons of this scheme with the previous multi-material, control-volume framework.

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How to ensure your groundwater science is used in policy development and decision making

Stewart S[1]

[1]Department For Environment And Water

TS8 - 3.3.5 Groundwater science for policy development and decision making, Room R5, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Simone is a Senior Hydrogeologist/Principal Policy Officer who has worked with the South Australian Government in water resource management for the past 13 years, with an interest in the science policy interface, Simone currently works a joint position within the groundwater team and the stat policy team.

Policy developers and decision makers, especially in the field of hydrogeology, rely heavily on science as a basis of evidence for their decisions. It is therefore our role as hydrogeologists to ensure that the science investigations we undertake and the outcomes of our projects are utilised by policy makers. After all, what is the point of gaining a new understanding of aquifer systems, or devising better practices for water management if they are never implemented? You don't want to waste your time. So how do we ensure our work is relevant and utilised?

I will use my experience as a hydrogeologist and policy officer to provide insight into how best to promote your science to a policy developer. Using the science development for the Eyre Peninsula Water Allocation Plan as an example, I will demonstrate how my role as a scientist didn't end when the resource condition limits for the aquifer were defined, but rather extended into the realm of what would usually be considered policy development – that being deciding water allocation volumes in response to changes in resource condition.

A key factor in being able to translate science to policy is understanding the relevant legislative framework within which the policy is developed. This, I believe, is a key aspect which most hydrogeologists overlook. I will therefore also provide some tips on how best to interpret your relevant legislation.

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Retrieval of Interstation Local Body Waves from the Teleseismic Coda Correlations - Australia

Saygin E[1], Kennett B[2]
[1]CSIRO Deep Earth Imaging FSP, [2]The Australian National University

TS1 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Erdinc Saygin is currently seismic imaging research theme leader at Deep Earth Imaging-Future Science Platform, CSIRO. He is leading early career research scientists working predominantly on the development and application of seismic monitoring and imaging methods across scales.

He graduated with a PhD in Earth Physics from the Australian National University in 2007. Later on, he worked at Geoscience Australia, the Australian National University and University of Western Australia before joining to CSIRO in September 2017.

We retrieve the local P wave Green's functions between the elements of Warramunga seismic array, Australia (WRA) by cross-correlating and bin-stacking the teleseismic earthquake coda waves recorded at the array. The stack is made for the coda of P and S wave phases from over 5000 events occurred between 2000 and 2017 in the distance range from 40°-50° from the centre of the array. A sequence of time windows along the coda allows the tracking of the various body-wave arrivals, using record sections constructed by binning the 276 inter-station correlograms in 0.5 km distance increments with stacking. The correlation of the coda part of each seismic phase produces highly coherent interstation arrivals for different analysis windows. Such arrivals can be reproduced by just stacking 100 arrivals from the pool of over 5000 events, showing the stability of the observed Green's functions. Modeling demonstrates that these arrivals correspond to multiple reflected arrivals from layers at different depths beneath the array. The recovery of high-frequency interstation body waves from the teleseismic earthquake coda opens the prospect of conducting local high-resolution seismic imaging with teleseismic energy.

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Predicting soil geochemistry from open-source geochemical and geophysical data; a case study from the Mount Isa Inlier, Queensland

Metelka V[1], Cole D[2], McCalman L[3], Steinberg D[3], Otto A[1], Greenwood M[4], Lisitsin V[4], Rodger A[1]
[1]CSIRO/Mineral Resources, [2]CSIRO/Data61, [3]CSIRO/Data61, [4]Department of Natural Resources, Mines and Energy

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Vaclav is a multi-disciplinary geoscientist, now working at CSIRO Mineral Resources constantly looking for innovative methods that can be directly applied to mineral exploration. Before CSIRO, he was with the Czech Geological Survey and later on the Centre for Exploration Targeting focusing his efforts on projects dealing with regional targeting of mineral resources and geoscience education around the globe and in Australia.
Vaclav's main research interests lie in integrating remote sensing, geochemical, and geophysical data with geological field observations to improve our mineral targeting approaches and more broadly the generation and understanding of the 2-4D geological models that we create.

Soil geochemistry is routinely used in most exploration programs across the globe. The acquisition, processing and interpretation of geochemical data in covered terrains however remains complex and the identification of anomalies related to underlying rocks becomes almost impossible. Under such circumstances, explorers will rather turn to geophysical methods especially in structurally controlled mineral systems. Ideally, the geophysical and geochemical observations should be accessed together to understand any possible correlations, though this is not a common practice.
We use publicly available geochemical and geophysical data from the Eastern part of the Northwest Mineral Province acquired over outcropping or sub-cropping areas in a trial to predict Cu, Au, Pb, and Zn concentrations, as if no cover existed. The final model relies on the quantile random forest method supported by magnetic and gravity data covariates. We demonstrate the sampling bias towards the outcropping regions and estimate where this bias renders our predictions unreliable. Apart from the element concentrations, we assess the uncertainty of the predicted values to provide an additional measure of the model internal consistency.
In cross validation, the r^2 of the predictive models lies above 0.5, with best models attaining r^2 values over 0.7. The study shows that our models can identify major deposit locations by spatial association with high element concentrations even in areas of significant cover where training data is scarce. The possibility of detecting geochemically anomalous regions based on remotely sensed geophysical data highlights the utility of data science and machine learning in exploration for mineral resources.

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Salt Interception Schemes in South Australia

Bushaway K[1], Woods J[1]
[1]*Department For Environment And Water*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Kittiya Bushaway is a groundwater modeller with over five years of experience in salinity register groundwater models across the South Australian Murray-Darling Basin (SA MDB) and Adelaide Plains groundwater models to support groundwater salinity management, groundwater resource assessments and planning.

Salinity is a well-known problem within the Murray-Darling Basin. More than one trillion tonnes of salt are stored in groundwater systems close to the River Murray. Therefore, the River is susceptible to high salinity due to inflows of naturally saline groundwater. High salinity levels affect the suitability of water for drinking, irrigation, industry and recreation.
Clearance of native vegetation and irrigation development has increased groundwater recharge and raised the watertable, and consequently the flow of saline groundwater to the river. To manage the increased salt, the Murray-Darling Basin Authority (MDBA) and partner governments invest in programs and infrastructure under the Basin Salinity Management Strategy (BSMS2030).
Salt Interception Schemes (SIS) are a key component of managing salinity within the River Murray. By pumping groundwater, these well fields reduce the hydraulic gradient that drives saline groundwater towards the floodplain and river. The intercepted groundwater is diverted to disposal basins where salt poses minimal risk to rivers, productive land and natural environments.
The history of eight SIS schemes in South Australia will be presented to reflect on the key achievements of the BSMS and how groundwater models are utilised for SIS design and construction. The schemes have proven to be a successful tool in managing River Murray salinity. They reduce salinity-related costs and ensure water quality is suitable for the end users. They are also proving to have long-term ecological benefits for the River Murray floodplain ecological health.

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Hacking the National Mineral, Gemstone & Fossil Collection

Schroeder N[1], Petkovski S[1]
[1]*Geoscience Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
I got hooked on palaeontology at Dinosaur Cove in the mid-1980s and have worked in the field ever since, working at universities and museums in Victoria and South Australia, and in Canada. I'm currently the Collection Manager at Geoscience Australia, looking after the fossil and mineral collections, and am studying for my PhD through the University of New England, on strange early Cambrian critters from Kangaroo Island and the Flinders Ranges.

This presentation focuses on the new ways Geoscience Australia (GA) is engaging with the public, via physical and virtual interaction with its world-class mineral and fossil collections. A selection of these specimens has long been available for public viewing in GA's foyer, but access to the majority was limited to professional researchers.

The National Mineral & Fossil Collection Experience is a controlled, 'behind-the-scenes' look at our collections. Narrated by expert guides, using insider stories, humour, props and enjoyable, hands-on activities, we provide a unique, informative and fun experience, for children and adults alike.

Developed in collaboration with Google Arts & Culture, our online exhibitions show specimens that cannot normally be exhibited; for safety reasons – e.g. radioactive minerals, or those that require special display conditions – e.g. fluorescent minerals and microfossils, and those that are too rare, valuable or fragile.

Our online exhibits have recently been augmented with Google's 'walk-through' feature, where Streetview technology to allow users to view the foyer display, so that audiences can discover these treasures from anywhere in the world.

Ultimately, we aim to make information on all our specimens accessible online, as is increasingly the practice with research collections. Our new volunteer program is essential in achieving this. Our volunteers photograph specimens, digitise associated documentation, and update database information. Volunteers can work on-site at GA, or from home, through the crowdsourcing platform Digivol.

This presentation touches on the stewardship of our national heritage, the impact of digital transformation, and the encouragement of public interest in geoscience.

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Towards a continental-scale 40Ar/39Ar map for Australia

Fraser G[1], Forster M[2], Vasegh D[2], Lister G[2]
[1]Geoscience Australia, [2]Australian National University

Biography:
Geoff Fraser is the Section Leader for Geochronology & Stratigraphy at Geoscience Australia. His work at GA over 18 years has involved applying both Ar-Ar and U-Pb geochronology to regional and national scale geological and mineral systems understanding.

Towards a continental-scale 40Ar/39Ar map for Australia
G. Fraser, M. Forster, D. Vasegh & G. Lister
As a basic “currency” of geology, maps provide an ideal format for conveying first-order meaning to a wide audience of specialists and non-specialists alike. With some exceptions, however, isotope geochronology data are generally not widely available in map view. Making such data available in map view allows convenient comparison and integration with other geological, geophysical and geochemical datasets and images, unlocking the collective value of the isotopic data and facilitating wide applications in earth evolution studies and mineral exploration. In this context, we present a progress report on ongoing work to compile and visualise 40Ar-39Ar geochronology and thermochronology results in map view at the continental-scale.
A pre-requisite for this work, and a significant hurdle, is to find and compile 40Ar-39Ar data from a large number of studies published over several decades in disparate formats, and to organise and categorise the data to allow meaningful intercomparison and visualisation. A payoff for this work is improved discoverability and utility of the data. The emerging spatial coverage provides insight into the thermal and structural history of the Australian continent, as well as guiding future 40Ar/39Ar data acquisition by drawing attention to major gaps in coverage.

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Tasman Frontier Subduction Initiation and Paleogene Climate: Preliminary Results from IODP Expedition 371

Saito S[1], Sutherland R[2], Dickens G[3], Blum P[4], IODP Expedition 371 Scientists
[1]Japan Agency for Marine-Earth Science and Technology, [2]Victoria University of Wellington, [3]Rice University, [4]Texas A&M University

TS6 - 1.3 Marine Geoscience - The evolving oceans/IODP, Room R1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Sanny Saito is a principal research scientist in R&D Center for Ocean Drilling Science at Japan Agency for Marine-Earth Science and Technology (JAMSTEC). Previously, he worked for 4 years as a research associate at the University of Tokyo and moved to JAMSTEC in 2001. Saito has been involved in scientific ocean drilling programs for 25 years as a sedimentologist, petrophysics, and downhole logging specialist. He holds a PhD degree in geology from Tohoku University, Japan.

International Ocean Discovery Program (IODP) Expedition 371 drilled six sites in the Tasman Sea from 27 July to 26 September 2017. The primary goal was to understand Tonga-Kermadec subduction initiation through recovery of Paleogene sediment records. Secondary goals involved understanding regional oceanography and climate since the Paleogene. Shipboard observations made using cores and logs represent a substantial gain in fundamental knowledge about northern Zealandia, because only Deep Sea Drilling Project Sites 206, 207, and 208 had penetrated beneath upper Eocene strata within the region. The cored intervals at five sites (U1506–U1510) sampled calcareous ooze or chalk that contained volcanic or volcaniclastic intervals with variable clay content. Paleocene and Cretaceous sections range from more clay rich to predominantly claystone. At the final site (U1511), a sequence of abyssal clay and diatomite was recovered. The ages of strata at the base of each site were middle Eocene to Late Cretaceous, and our new results provide the first firm basis for defining formal lithostratigraphic units that can be mapped across a substantial part of northern Zealandia and related to onshore regions of New Caledonia and New Zealand. All six sites provided new stratigraphic and paleogeographic information that can be put into context through regional seismic-stratigraphic interpretation in northern Zealandia and hence provide strong constraints on geodynamic models of subduction zone initiation. Our new observations can be directly related to the timing of plate deformation, the magnitude and timing of vertical motions, and the timing and type of volcanism.

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Newly discovered intraplate volcanoes on the Fairway Ridge, northern Zealandia

O'Toole L[1], Williams S[1], Dadd K[1], Crundwell M[2], Seton M[1], Mortimer N[3], Etienne S[4], Collot J[5]
[1]EarthByte Group, School of Geosciences, [2]GNS Science, [3]GNS Science, [4]ADECAL Technopole, ZoNéCo Research Program, [5]Service Géologique de Nouvelle-Calédonie (SGNC, New Caledonia Geological Survey)

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Maria Seton is an ARC Future Fellow in the EarthByte Group, School of Geosciences, University of Sydney. Maria was awarded her PhD from the University of Sydney in 2005, was awarded an Australian Postdoctoral Fellowship in 2009 and a Future fellowship in 2013. In 2014, Maria was awarded the Dorothy Hill Award from the Australian Academy of Sciences.

A widely recognised characteristic of the predominantly submerged continent of Zealandia is its long-lived and areally extensive intraplate magmatic province and numerous sedimentary basins. While samples are readily available from onshore regions, the offshore extent of the province, especially in northernmost Zealandia, remains poorly known. In July 2016, the ECOSAT2 research voyage onboard the RV Investigator (IN2016_T01) recovered c. 900 kg of sedimentary and igneous rocks from six dredge sites on the Fairway Ridge, a NW-SE trending bathymetric high near New Caledonia. Petrographic, geochemical, biostratigraphic and geophysical work on volcanic breccias from two dredge sites DR1 and DR2 was undertaken. The breccias contain clasts of basaltic and nephelinitic composition. The analysed lavas are not subduction-related, but erupted in an intraplate setting as shown by their LREE enrichment relative to HREEs, high Zr and Zr/Y abundances and Nb/Yb vs Th/Yb ratios. Foraminifera from limestone clasts in volcanic breccias date the volcanism as Early Miocene, 23-21 Ma. This seems to have been a time of increased intraplate magmatism across all of Zealandia. In the case of the Fairway Ridge, the volcanic rocks do not appear to be part of an age-progressive chain, but they do occur above a major change in lithospheric thickness. This observation, and high Australian plate velocities in the Miocene, support petrogenetic models of edge-driven convection and shear-driven upwelling, although other mechanisms (such as lithospheric drip and delamination) may still be plausible.

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Determining the Geochemistry of Organic Matter in Shales by Infrared Spectroscopy

Pejcic B[1], Heath C[1], Woltering M[1], Pages A[2], Laukamp C[2]
[1]CSIRO - Energy, [2]CSIRO - Mineral Resources

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Bobby Pejcic is a Senior Research Scientist and Team Leader (Hydrocarbon Detection) in the Oil, Gas and Fuels research program (Energy Business Unit) at the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Dr Pejcic currently works at the interface of chemistry, materials science, and geology and leads a multi-disciplinary team focused on developing analytical techniques and providing technological solutions for the hydrocarbon resource, geosequestration, water resource sectors.

Information on the amount, type and maturity of organic matter present in source rocks is essential for energy exploration and the general understanding of petroleum/geological systems. The characterisation of organic matter is traditionally performed using a range of techniques (i.e., carbon analyser, Rock-Eval, vitrinite reflectance, chromatography/mass spectrometry) that provide important geochemical and petrographic information on the source rock. Although these methods deliver invaluable data, they can be time consuming, expensive, and unrepresentative. An alternative method that provides more detailed, direct and rapid information on the organic geochemistry in cores and drill-hole samples is preferred. Infrared (IR) spectroscopy is a relatively non-destructive technique that can directly and rapidly investigate the chemical properties and composition of many different types of materials. Furthermore, it has been widely used to assess the dispersed organic matter and carbonaceous materials that are present in a range of sedimentary rocks. However, very few studies have reported the application of IR to determine the organic geochemistry of shales from the Canning and Perth Basins.
The objective of this paper is to review the current state of art and to evaluate the suitability of IR spectroscopy for investigating the total organic carbon, hydrocarbon index, hydrocarbon generating potential and thermal maturity of source rocks. In this paper, we discuss the infrared spectroscopy results acquired on various shale samples from the Perth and Canning Basins and compare it to the information obtained by conventional geochemical and petrographic methods.

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Airborne EM for Integrated 3D Mapping of Groundwater, Seawater Intrusion and Relationship with Sustainable Yield in Exmouth, WA

Gilgallon K[1], McGivern M
[1]Southern Geoscince Consultants

TS5 - 3.3.2 New groundwater technologies and approaches & 3.3.5 Groundwater science for policy development and decision making, Room R5, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Karen graduated from Curtin University of Technology in 2002 with a BSc (1st class Hons) in Geophysics. She has been interested in groundwater since completing her honours thesis on the Geophysical Signature of the Lake Bryde Paleochannel, shortly after which she started her career in the hydrogeology department of the Water and Rivers Commission.
As a Principal Geophysicist at SGC, she is responsible for the design, management and interpretation of all types of geophysical surveys. She has extensive experience supervising surveys in Australia and abroad. Karen has particular interest in the QC, interpretation and modelling of electrical and electromagnetic methods.

Exmouth is a regional center located 1260km north of Perth, Western Australia that relies entirely on groundwater for its water supply. Its borefield extracts groundwater from an unconfined carbonate limestone aquifer within the Cape Range Group. Groundwater flows easterly from Cape Range to Exmouth Gulf where it discharges above a saline wedge at the base of the aquifer. The current borefield extraction has insufficient capacity to meet increased water demand due to population growth and the influx of tourists in holiday periods.

In 2016-2017, the Water Corporation decided to investigate optimizing borefield performance through improved production from existing infrastructure. An Airborne Electromagnetic (AEM) survey, desktop review, 3D modelling, and pumping tests, helped define the extent/geometry of the saltwater interface and karstic features within the aquifer.

The AEM survey effectively mapped saline water. It identified existing bores in areas with lower salinity and away from the saline wedge. Twenty four hour pumping tests of these bores was undertaken at rates much higher than their current extraction rate. The survey also identified existing bores in areas of higher conductivity where increased extraction is not recommended.

The AEM survey and new hydrogeological modelling have established a clear relationship between the extent of the saltwater interface, and the location of karstic features. Importantly, bores have been identified which could accommodate additional sustainable extraction. Other bores have been identified where extraction rates should not be increased, or should be reduced.

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Sensitivity analysis and value of information in groundwater exploration: a case study from the APY lands, South Australia

Peeters L[1]

[1]*Csiro Minerals*

TS7 - 3.3.5 Groundwater science for policy development and decision making, Room R5, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Luk has over eight years research experience in modelling groundwater dynamics at regional to continental scales for water resource management, His research features a strong emphasis on maximally exploiting the information from data to reduce predictive uncertainty. In this work he brings together geology, geophysics, geochemistry, statistics, hydrology, ecology and risk assessment to address the nation's grand challenges in finding and managing groundwater.

Ensuring water supply is a crucial aspect of social and economic development in remote, arid regions in Australia, which is the focus of the G-FLOWS 3 project.

We developed a probabilistic groundwater mapping methodology to quantify the probability of sustaining a given pumping rate for a specified period, with a maximum allowable salinity. This probability can be used in a risk averse drilling budget estimation by calculating the number of wells required to drill to ensure with 95% confidence that a location meeting the water supply criteria will be found.

Based on a desktop study, the probability of finding a location that can supply 1 m3/d of water for 10 years with a salinity of at most 1000 mg/L is estimated to be 14.6%. To ensure with 95% confidence that such location is found, would require at least 19 bores to be drilled.

Finding a suitable water supply depends on aquifer thickness, hydraulic conductivity, porosity and salinity, and on the thresholds of required pumping rate, duration and salinity. A global sensitivity analysis highlights that in the APY lands, aquifer salinity is the most important variable, followed by K. The salinity threshold is shown to be more important than pumping rate or duration.

The value of information (VOI) can be expressed as the expected reduction in number of wells to drill due to gathering new information. VOI is calculated for different data acquisition strategies, including drilling and airborne electromagnetic surveys.

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Trends for gas demand and supply in Australia and Asia

White N[1]

[1]*Santos*

TS4 - 3.2.1 Future energy mix & 3.2.6 Using geoscience to address social licence concerns for energy projects, Room R5, October 17, 2018, 11:30 AM - 1:00 PM

Biography:

Nick joined Santos as a Graduate Mechanical Engineer in 2012. Since then he has held various field and office based roles across Production Engineering and Drilling & Completions. In 2017, Nick transferred to Santos' Strategy and Planning team as a Markets Analyst. Today he is responsible for providing insights on the impact of the changing external oil and gas/LNG markets on Santos' business.

Population growth and rapid urbanisation in developing Asia has seen global energy demand grow at a significant pace. To meet demand growth while reducing emissions and improving air quality, higher emission fuels such as coal and oil need to be displaced with lower emission options such as natural gas and renewables.

The IEA energy mix scenarios are some of the most globally recognised and credible outlooks available for the energy industry. Gas demand is projected to grow in all IEA scenarios through to 2030, including those that aim to limit the average temperature change to below 2ºC by 2100.

In developing Asia, governments are aiming to increase the share of gas in their energy mix as they look to combat air pollution. Last year China took a large step towards reaching its target with LNG imports growing by a huge 46% as the government ordered households and heavy manufacturers in 2 provinces and 26 cities to switch from coal to gas.

Gas fired generation also supports the integration of renewables into electricity networks. It provides clean and synchronous electricity generation that can ramp up and down quickly when system disturbances occur or when demand peaks.

Australia has the benefit of abundant natural gas and close proximity to Asia, making it perfectly positioned to help rapidly growing economies meet their energy demand while helping to improve air quality. The scale and economics gained through LNG export will allow industry to continue to develop sufficient resources to meet our domestic needs.

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Geo-spot – a new idea in Geo science

Das T[1]
[1]*Calcutta University*

Biography:

Dr. T.K.Das is a retired Professor and has been working in the field of research in Solar Physics and Geophysics since the last three decades. He has published 60 research papers in refereed national and international journals and presented 59 conference papers in different symposium. He is Fellow and Life member of different societies. He introduced the new terminology GEO-SPOT in Geo-science by which internal dynamics of earth along with earthquake phenomenon can be explained.

Geospots are assumed to be zones of strong magnetic field developed in the D'' region which exits in between earth's outer core and mantle. A horizontal magnetic flux tube which might be a part of an interior toroidal field, can be lifted to the surface by magnetic buoyancy. An ordered, large-scale convective flow that may pick up magnetic flux in its updraft and lift it to higher layers, where the Geospots are developed gradually. A pair of bipolar regions of a Geospot approach one another and merge together to form a neutral current sheet. Due to gradual release of heat by the process of magnetic reconnection taking place in the current sheet, thermal stress is accumulated in the plate below which a Geospot is likely to be present. A Fault is developed in the plate due to thermal stress and when the breaking of crustal rocks constituting the plate is reached, the rupture occurs. The mechanical shock produced in this way gives rise to elastic waves which propagate back and forth, thus causing earthquake. As a result of this rupture there is a violent displacement on the fault plane which produces the compression in one part and dilation in the other. This sort of contraction and dilation helps to generate charges appearing on the rocks due to Piezoelectric effect. The oscillation of these charges through a conducting path gives rise to Electromagnetic emission.

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The Warnie Volcanic Province: A Jurassic Volcanic Province in the Cooper and Eromanga Basins of Central Australia

Holford S[1], Hardman J[2], Schofield N[2], Bunch M[1]
[1]University Of Adelaide, [2]University of Aberdeen

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Simon Holford is an Associate Professor of Petroleum Geoscience at the Australian School of Petroleum. His main research interests are: magmatic systems in sedimentary basins, structural permeability and the evolution of Australia's 'Passive' southern rifted margin.

The Cooper and Eromanga Basins of South Australia and Queensland are the largest onshore hydrocarbon producing region in Australia. Despite over 50 years of conventional exploration in these basins, volcanic rocks have been documented infrequently. The integration of 2D and 3D seismic, well and geophysical data has unearthed a province of mafic monogenetic volcanoes and igneous intrusions that covers ~7500 km2 of southwest Queensland and are proposed to have been active between ~180 and 160 Ma. We propose these igneous rocks be termed the Warnie Volcanic Province, after the 1985 Warnie East-1 well which encountered 65 m of basalt in the Nappamerri Trough of the Cooper Basin. The distribution of extrusive and intrusive volcanics is primarily controlled by basement structure, with volcanics elongated in a NW-SE direction, closely matching dextral strike-slip faults that developed during successive periods of flexural relaxation or sag. The presence of the Warnie Volcanic Province within the Cooper and Eromanga Basins poses numerous challenges for exploration, including potential for drilling mud losses and underestimation of the presence and thickness of volcanics. Finally, we discuss the regional significance of the WVP within Australia and the implications for the basin evolution of the Cooper and Eromanga Basin.

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Development of acidizing technology for Poland's biggest oil field in the Zeschstein Main Dolomite based on reservoir rock sample studies

Czupski M[1], Kociński P[2], Kasza P[3], Wilk K[4]
[1]Oil And Gas Institute - National Research Institute, [2]Brenntag Polska Spółka z o.o., [3]Oil and Gas Institute - National Research Institute, [4]Oil and Gas Institute - National Research Institute

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
In 1997 he graduated from Rzeszów University of Technology, The Faculty of Chemistry. In 2008 he gained his PhD at the AGH University of Science and Technology in Kraków (Faculty of Drilling, Oil and Gas) for his thesis on acid - rock reaction kinetics. He has been working for Oil and Gas Institute - National Research Institute for 21 years, currently in the position of assistant professor.

The paper presents laboratory studies on the basis of which stimulation technology for oil field located in the Zechstein Main Dolomite was elaborated. Zechstein Main Dolomite in the Polish Lowland are characterized by significant facies differentiation. The aim of this work was to implement technology that would intensify oil production without a simultaneous increase in water production.
Laboratory tests started with core plug preparation and after that permeability and porosity measurements and analysis of pore space using x-ray computed tomography were performed. Next, a series of ,,core flow'' tests were conducted using several acidizing fluids. For each ,,core flow'' experiment, the pressure drop across the core was recorded and the initial and regained permeability to crude oil was measured. Core plugs were then re-studied to determine permeability coefficient and image of the pore space using x-ray computed tomography were carried out. Thanks to this, wormhole structures formed during acid injection into a dolomite core were studied and defined. The most promising results were obtained for acidizing fluid based on viscoelastic surfactant sensitive to crude oil. This finding was so important due to the fact of increasing reservoir water production. By utilizing this sensitivity, the fluid may more effectively stimulate oil-saturated zones and temporarily block water saturated sublayers. Based on these tests results recommendations required for design of matrix acidizing treatments were prepared. The first pilot treatments confirmed the effectiveness of developed technology. Oil production increase without increasing water cut and at the same time production differential pressure drop were noticed.

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Core analysis after foam hydraulic fracturing stimulation to understand formation damage in the Rotliegend Sandstone Formation in Poland

Wilk K[1], Kasza P[1], Czupski M[1], Labus K[2], Dydo P[2]
[1]The Oil And Gas Institute – National Research Institute, [2]Silesian University of Technology

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Research assistant at Oil and Gas Institute from July 2011. Graduate from the Rzeszow University of Technology, Faculty of Chemical Technology, specialization: Biotechnology in Chemistry. She obtained her master degree in technical sciences. Currently working on her PhD on formation damage after foam fracturing treatment.

The main goal of hydraulic fracturing is to increase production rate and recovery factor of oil and/or gas. When used fracking fluids are based on water, the so-called permeability damage is likely to occur caused by, among others, swelling of clay minerals, or by other physical and chemical mechanisms taking place in a formation being fractured. Damage to permeability is an undesirable phenomenon because it clearly limits the inflow of reservoir media to the exploitation well. Minimizing these unfavourable phenomena of limiting the permeability is possible, by reducing the amount of water in fracturing fluids and replacing its parts with gas. Fracturing fluids prepared in this way are called foams or energized fluids. It turns out, that in many Polish sandstone formations, swelling clay minerals occur, preventing the use of traditional water-based fracturing fluids due to the permeability damage hazard. Therefore, this article presents a laboratory study that illustrates the potential using of nitrogen as an less damaging the formation energized fracturing fluids. Identification, analysis and assessment of formation damage was performed based on mineralogic-petrographical tests and compared to the damage caused by conventional fluids. This type of tests makes it possible to describe the porous space, and the level and character of filling with binding minerals. The level of damage to rock pores after the flow tests has been defined using: permeability and porosity tests, scanning electron microscopy SEM analysis, fluorescence tests in UV light and other possible tools to map damage to the rock formation.

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Anatomy of the Kuunga Orogen in East Antarctica

Halpin J[1], Daczko N[2], Fitzsimons I[3], Whittaker J[1], Mulder J[4]
[1]Institute for Marine and Antarctic Studies, University of Tasmania, [2]ARC Centre of Excellence for Core to Crust Fluid Systems and GEMOC, Department of Earth and Planetary Sciences, Macquarie University, [3]School of Earth and Planetary Sciences, Curtin University, [4]School of Earth, Atmosphere and Environment, Monash University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Jacqueline Halpin is a geologist with the ARC Antarctic Gateway Partnership at the University of Tasmania. Her research involves both field exploration and laboratory-based analytical methods to explore the evolution of Earth's continents, and test and improve tectonic plate reconstructions. Her current focus in Antarctic geoscience explores the interactions between the solid Earth and the overlying ice sheet.

The Kuunga Orogen in East Antarctica essentially lies buried below the ice sheet, and therefore remains the most poorly exposed and enigmatic Gondwana-forming orogen. Paleomagnetic constraints from India and Australia imply that a Neoproterozoic plate boundary bisecting East Antarctica accommodated some 3000-5000 km of relative plate motion. However, evidence for typical plate boundary processes in the Antarctic geological record (e.g., arc/subduction-related magmatism, high-P metamorphism) during this time remains equivocal.

Here we explore the spatial extent and timing of Neoproterozoic-Cambrian tectonics associated with the amalgamation of eastern Gondwana using new and published geological datasets. We suggest the boundary between crust originally of 'Indian' and 'Australian' affinity can be resolved into two plate-boundary segments in East Antarctica, representing two contrasting tectonic regimes: (1) a strike-slip/transpressional margin delineated by a series of NNW-trending lineaments in Queen Mary-Wilhelm II-Wilkes lands, and (2) a near-orthogonal convergent margin that consumed the "Mawson Ocean" basin, now recorded by significantly thickened (60 km) crust and lithosphere (200 km) through the Antarctic interior, incorporating the Gamburtsev Subglacial Mountains region.

We suggest that, based on key changes in Hf-isotopic character of detrital zircon, cryptic Neoproterozoic arc magmatism in the interior of Antarctica commenced from c. 720 Ma, continent-continent collision was underway by c. 620-600 Ma, and that the plethora of c. 550-500 Ma U-Pb ages mostly mark the final stages of collision, slab break-off failure and orogenic collapse. These new constraints provide an opportunity for improved plate models for the Neoproterozoic and the transition from the supercontinent Rodinia to Gondwana.

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The NVCL in 2030: Development and benefits of building and using the world's largest public national geological material properties knowledgebase

Huntington J[1]
[1]*CSIRO Mineral Resources*

TS1 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Jon Huntington has a career's worth of experience in the hyperspectral characterisation of rocks from laboratory, field, airborne and spaceborne sensors. He has worked as an exploration and mine geologist, in applied research for Australia's CSIRO, consulted to national and international companies, and led numerous applied industry-funded remote sensing research projects through AMIRA International and MERIWA. Jon was instrumental in the co-development of the HyLogging concept, The Spectral Geologist (TSG) software package and was founding Director of AuScope National Virtual Core Library (NVCL). He is currently a CSIRO Honorary Fellow still exploring the spectroscopy of minerals, providing training and mentoring.

For ten years geoscientists have had free on-line access to a unique cm-scale mineralogical and image database of over a million metres and five terabytes of historical Australian drill holes, acquired for resource exploration, mine development and stratigraphy over the past 80 years.
Debate is currently underway whether a future NVCL maintains the status quo or envisions requirements by the earth science education sector, resources industries and geological surveys that support them, a decade from now. Geotechnical applications should also be considered plus METS-related hardware and software service providers and exporters.
The paper thus addresses user-needs and benefits, data acquisition and delivery, as well as technological infrastructure and economic benefits, by means of interviews with industry users, geological survey directors, technology developers and visionaries and educators. Disruptive technologies and delivery business models suggest we should be considering all options because we may currently be falling short in answering some of our community's future needs, especially with respect to timeliness and location.
While the current National Virtual Core Library has been largely hyperspectrally-motivated the paper argues for a future with a broader perspective. This could comprise multiple earth science sensors, tools, data and products (e.g. mineralogical, geochemical, geophysical, textural and spatial) brought together in a much more tightly-knit environment. Such an environment, coupled with rapid delivery alternatives, could allow industry, researchers and students to learn much more from shared, nationally-distributed, multiscale infrastructure delivering a national drill core NVCL Material Properties and Paragenesis (MPP) 2030 Knowledgebase.

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The Australian Newer Volcanics Province as an Example of the Interaction of a Mantle Plume and a Lithospheric Step

Duvernay T[1], Davies R[1]
[1]*Australian National University*

TS5 - 1.1.2 Optimisation and uncertainties in Earth models, Hall C, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
I am keen on mantle convection and basically everything that relates to it. Currently at ANU, my work focuses on the development of numerical models (based on the Fluidity framework, https://github.com/FluidityProject/fluidity) that can account for the recent east-australian volcanism.

BSc: Earth, Environment and Planets Sciences; Universite Paris 7; Paris; France
MSc: Geophysics; Institut de Physique du Globe de Paris; Paris; France
Five Months Internship: Geophysical Fluid Dynamics; Eidgenossische Technische Hochschule; Zurich; Switzerland
PhD Student: Mathematical Geophysics; Australian National University; Canberra; Australia

The theory of plate tectonics successfully explains the large-scale motions of the Earth's lithosphere, the rigid outermost shell of our planet. It also accounts for the fact that most volcanoes occur at plate boundaries. However, a significant class of volcanism takes place within plates or across plate boundaries. This so called intra-plate, or hotspot volcanism, is usually associated with mantle plumes, but several intra-plate volcanic provinces display characteristics that are inconsistent with the mantle plume hypothesis. As a result, alternative mechanisms have been proposed, including edge-driven convection and shear-driven upwelling, which are controlled by regional lithospheric structure. Interestingly, in some regions, such as Eastern Australia and Africa, volcanism displays certain characteristics that are consistent with both deep-rooted (plume) and shallow (lithosphere driven) processes, hinting at an interaction between both phenomena. To quantify the nature and surface expression of these interactions, we have performed both two- and three-dimensional numerical models of the convective uppermost mantle, using the Fluidity computational modeling framework, which account for both a plume and the shallow flow regimes induced by the lithospheric structure. Under certain conditions, the models predict complex and transient volcanic trends at the surface. Preliminary results will be presented, with particular relevance to volcanism in Eastern Australia.

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The peaks and patterns of Antarctic crustal heat production

Halpin J[1], Burton-Johnson A[2], Watson S[1], Whittaker J[1], Maritati A[1], Staal T[1], Reading A[3], Hand M[4], Hasterok D[4], McLaren S[5]

[1]Institute for Marine and Antarctic Studies, University of Tasmania, [2]British Antarctic Survey, [3]School of Natural Sciences, University of Tasmania, [4]School of Physical Sciences, University of Adelaide, [5]School of Earth Sciences, University of Melbourne

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Jacqueline Halpin is a geologist with the ARC Antarctic Gateway Partnership at the University of Tasmania. Her research involves both field exploration and laboratory-based analytical methods to explore the evolution of Earth's continents, and test and improve tectonic plate reconstructions. Her current focus in Antarctic geoscience explores the interactions between the solid Earth and the overlying ice sheet.

The geothermal heat flux to the base of the Antarctic ice sheet is inherently difficult to measure, yet accurate estimates are necessary to better understand cryosphere dynamics. Radiogenic heating within the crust from decay of naturally occurring radioactive heat producing elements (HPEs) is a significant component of the total surface heat flux budget. The distribution of HPEs is heterogeneous at a range of scales, and fundamentally tied to the geological evolution of the lithosphere in space and time. Despite this, current Antarctic geothermal heat flux models use laterally homogeneous heat production. Furthermore, regional ice sheet models have shown that localised regions of high HPE-enriched crust can impact the organisation of ice flow in slow-flowing regions, underscoring the need for improved knowledge of both the magnitude and spatial variability of heat production in the Antarctic crust.

We have assembled the first database of Antarctic-wide geochemical data, with over 14,000 entries, >8,000 of which can be utilised for heat production calculations. Preliminary analysis suggests that the mean heat production rates for Antarctic Archean, Proterozoic and Phanerozoic rocks exceed global averages and are higher and more variable than those currently used in Antarctic geothermal heat flux models. Felsic igneous rocks that intruded during/after the Ediacaran-Cambrian assembly of Gondwana are particularly HPE-enriched (mean >3.5 $\mu W/m^3$ compared to global upper crust ~1.6 $\mu W/m^3$), and require further identification/mapping across East Antarctica. Our ultimate aim is to work towards more accurate predictions of Antarctic geothermal heat flux for use by (for example) the ice sheet modelling community.

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Improving the rockfall failure hazard assessment and consequences

Jaboyedoff M[1]

[1]*Institute of Earth Sciences - University of Lausanne*

PS4 - Plenary Session: Applied Geoscience - Geohazards, risks and Society (Hall C), Hall C, October 17, 2018, 2:00 PM - 3:00 PM

Biography:

Michel Jaboyedoff is a geologist with a degree in physics and a PhD in clay mineralogy. He started doing research on natural hazards in 1994. Since 2005, he is a full professor at the University of Lausanne, focusing his research on natural hazards and related risks and integrated risk analysis. He worked in several risk management projects around the world (Argentina, Bolivia, Canada, Nepal, Norway, Switzerland …). His main research topics are related to the development of tools based on remote sensing techniques applied to rockfall hazard and risk analysis.

The rockfall hazard (H) has two components, the frequency of failure (λ) and the probability of propagation (Pp), i.e. $H = \lambda \times Pp$. Frequency of failure is controlled by external solicitations or/and by the effect of rock mass fatigue. First step of λ estimation is to assess the slope failure kinematic potential taking into account a 3D topography based on the existing structures or density of potential structures. These potentialities can be assessed based on discontinuity mean trace length and spacing, including geomechanical properties or not. But such an approach does not integrate the time dependence of stability.
Recent observations based on detailed monitoring permit to investigate the time dependence of λ looking at statistics of rockfall and processes of fatigue: (1) The rock slope fatigue by thermal effect has been demonstrated is several cases; (2) Thermal imaging allows to analyse in some cases rock bridges extent; (3) Freezing and thaw and rainfall is recognised as triggers; (4) The groundwater fluctuation are producing differential movements in rock masses; (5) Rockfall volumes inventories can be used to improve the estimation of λ; (6) In addition, recent works have demonstrated that the effect of fragmentation may change the rockfall hazard (H); (7) Pre-failure displacements provide information about rock degradation; Etc.
Integrating highly accurate monitoring techniques allow to quantify more precisely fatigue coupled with probabilistic stability analysis in 3D may lead to a better assessment of λ. Coupled with high-resolution real 3D rockfall modelling, the estimation of H will be greatly improved.

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Estimating Palaeo-Mesoproterozoic Ocean-Atmosphere Redox Conditions with Chromium Isotopes and Cerium Anomalies

Bruce D[1], Cox G[1], Farkas J[1], Klaebe R[1], Samanta M[1], Toledo G[1]
[1]*The University of Adelaide*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
I have recently graduated from the University of Adelaide in 2018 with my undergraduate in Bachelor of Science (Mineral Geoscience) and am currently undertaking an honours degree majoring in Geology. My current project is under the discipline of biogeochemistry, focusing on determining Mesoproterozoic ocean-atmosphere redox conditions. Although it seems I have already chosen a specific discipline in geology, my experience with NExUS (National Exploration Undercover School) in 2017 has assured me that I'm yet to decide which discipline of geology I'm passionate the most.

Estimating Palaeo-Mesoproterozoic Ocean-Atmosphere Redox Conditions with Chromium Isotopes and Cerium Anomalies
This study uses a combination of paleo-redox proxies, such as Cr isotopes (δ53Cr) and REEs (Ce/Ce* anomalies), measured in black shales from the McArthur Basin (~ 1.64 and ~ 1.40 Gyr Fraynes and Velkerri Formations, respectively) to constrain the redox state of the Palaeoproterozoic and Mesoproterozoic ocean-atmosphere system. The main aims of this project is to provide more quantitative constraints of the palaeo-redox state, and to better understand the role of oxygen availability in Eukarya evolution.
This importance stems from the potential for a strong link between rising pO2 and eukaryotic diversification. Previous studies have suggested very low Mesoproterozoic pO2 where pO2 varied between 0.1 to 0.001% PAL (Present Atmospheric Levels), such low levels are thought to inhibit the eukaryotic diversification. Conversely, other studies contradict this and argue for higher estimates on pO2 ranged (>>1% PAL); such levels would be sufficient to support respiration of large organisms. However, eukaryotic diversification was not observed until ca. 0.76 Ga. Overall, the goal of this study is to test which one of these two scenarios is more plausible via novel redox proxies.

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Engaging Students and Teachers with Earth Sciences Education - The Earth Science Western Australia Story

Watkins J[1]
[1]*Earth Science Western Australia*

TS8 - 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Jo Watkins is the CEO of Earth Science Western Australia, an educational not-for-profit working to engage students and teachers with Earth Sciences education. Prior to this role she was a teacher, primarily in high school sciences and senior school Earth and Environmental Science. She has qualifications in Teaching, Geology and Environmental Science and is passionate about sharing her love for these subjects.

How do you engage teachers and students with Earth Sciences education? This was the problem that Earth Science Western Australia (ESWA) set out to solve back in 2005.
Over many years, working with education, the geoscience community and the resources industry, ESWA has produced a large suite of resources and directly engaged with thousands of teachers and students, across Western Australia. Along the way many lessons have been learnt and we look forward to sharing these with you.

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Managing Risk with Quantitative Integrated 3D Mineral System Characterisation

Potma W[1]
[1]CSA Global

TS6 - 3.1.2 Making better exploration decisions through an integrated geoscience approach, Hall E2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Warren is a Principal Geologist with CSA Global Mining Industry Consultants, where he specialises in integrated mineral systems analysis with a focus on structural geology and geometallurgy. His background includes: An MSc in structural Geology from Monash Uni; gold exploration and mining with Anglogold; mineral systems and exploration technology R&D with CSIRO, where he went on to successfully develop the CSIRO-Chile Mining and Mineral Processing International Centre of Excellence in Chile for CSIRO; and stints as exploration manager for Hot Chili, Silver Swan Group and Caravel Resources (Base metals & Au). At CSA Global, Warren is leading the paradigm shift to early stage implementation of integrated 3D GEOmet (holistic mineral system) characterisation and modelling strategies, to maximise value throughout the exploration and mining value chain.

We are all familiar with the issues facing our mineral exploration sector: diminishing success rates, increasing cost of discovery, issues of cover, paucity of low-hanging fruit, low Resource grades.
The critical risk/reward tipping points occur early in the mining lifecycle. Generative (ground acquisition) is a game-changing decision point often poorly supported by quantitative/integrated data interrogation. While early stage reconnaissance exploration (prospect definition) presents the highest cost phase with the lowest likelihood of success (project progression to drill testing).
The most robust exploration & development decisions are possible when: all existing data is systematically integrated and interrogated; data and interpretations are placed in a 4D mineral system framework, and considered in a mineral system process context; data gaps are identified and rectified before expensive decisions are made; and value is placed on acquiring the appropriate quantitative data early in the project lifecycle.
The “apparent” expense of collecting and integrating the “right” datasets early, has a value multiplying effect throughout the project lifecycle providing volumetrically representative quantitative data and a 3D mineral system model that reduces costs and risk, while dramatically improving outcomes across the mining value chain from ground selection, through all stages of exploration, 3D modelling, geometallurgy, metallurgical test work design, process design, mine design, scheduling, environmental and closure.
Two case studies are presented demonstrating the value of early collection, 3D integration and modelling of critical quantitative datasets in magmatic hydrothermal mineral systems, providing a cradle to grave unifying link across the mining value chain.

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Developing Geotrails for a Large Continent

Lewis I
[1]*GSA (SA Division)*

TS5 - 5.1 Geology in Society: geotourism and geoheritage & 5.6 Diversity in the Geosciences, Room R8, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Ian D works as a hydrogeologist for the South Australia Department for Environment and Water and is completing his PhD on the Geology of the World Heritage Naracoorte Fossil Caves. Ian is Honorary Director of the Kanawinka Volcanic Geotrail which links visitation of the volcanoes across Western Victoria. Through the Geological Society of Australia, Ian is developing a broader concept of 'Geotrails' to link separate special features of the landscape across large distances of the Australian continent where extended travelling is required and to promote Geotourism for the benefit of rural regions in Australia.

Worldwide trends in Nature Tourism have greatly enhanced a public interest to visit natural sites such as World Heritage areas, UNESCO Geoparks, National Parks and Ecoparks. While these are readily accessible in closely-populated lands such as Europe, the USA and China, those of large area with more sparsely-distributed populations - Canada, South America, Africa and Australia - have the challenge of distance between important natural sites for the visitor.
One emerging trend is the linking theme of Geotrails. For example, a series of many local and province-scale Geotrails link across Canada to cover the full width of the North American continent.
Geotrails can be short. However, across large distances of the Australian continent where extended travelling is required, large Geotrails can relate themes such as geology, landscapes, coastlines, local history, culture and wildlife. 'Geo' means 'world', not just 'rocks'! One outstanding South Australian example could incorporate the attractions of the Heysen and Bonython Trails extending 1,000 kilometres from Kangaroo Island to Arkaroola and Witchelina exploring the Adelaide Geosyncline, utilising a 'Songline' theme and the important association with Sir Douglas Mawson and his Australian-Antarctic geological discoveries.
Rather than promoting them only as trails for walkers and hikers, or individual small geotrails, these great Geotrails can be greatly enhanced by emphasising driver access to multiple points along them, utilising apps and promoting packaged flights to and over these marvellous locations in a travel style which will appeal to many and be very marketable for Nature Tourism.

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Heterogeneous mantle source of mid-ocean ridge basalts from the Macquarie Ridge Complex

Jiang Q[1], Jourdan F[1], Olierook H[1], Merle R[1,2,3], Evans K[1], Conway C[4], Bostock H[5], Wysoczanski R[5]
[1]School of Earth and Planetary Sciences, Curtin University, [2]Research School of Earth Sciences, The Australian National University, [3]Department of Geosciences, Swedish Museum of Natural History, [4]National Museum of Nature and Science, [5]National Institute of Water and Atmospheric Research

TS8 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Qiang Jiang is a PhD student working on igneous geochemistry and 40Ar/39Ar geochronology.

Chemical heterogeneity of the depleted upper mantle is a significant problem for understanding the genesis of mid-ocean ridge basalts (MORB). An isotopically unusual series of ridges and seamounts are found along the Australia–Pacific plate boundary south of New Zealand, known as the Macquarie Ridge Complex (MRC). Major and trace elements of the MRC basalts range from N-MORB to E-MORB but are otherwise relatively homogenous along the ridge, indicative of source extraction from the uppermost mantle. However, limited Sr-Nd-Pb isotopic data, predominantly from only emerged portion of the MRC (Macquarie Island), reveal a highly correlated Pb isotopic trend between Pacific MORB and a HIMU-like source. Currently, no isotopic data are available from other parts of the MRC so it is uncertain whether this HIMU-like component is restricted to Macquarie Island or is systemic to the whole MRC. Moreover, a lack of robust geochronological constraints means that it is uncertain whether the contribution of the HIMU component varies with time. With the current paucity of data, three possible models exist: (i) the HIMU component is well-mixed with the depleted asthenosphere, (ii) fine-scale HIMU blobs are evenly distributed throughout the upper mantle, or (iii) a single HIMU anomaly is present underneath Macquarie Island. Here, we will test these models via 40Ar/39Ar dating and detailed elemental and Sr-Nd-Pb isotopic analyses across 1200 km of the MRC. The results resolve the nature of the upper mantle at the Australia–Pacific plate boundary and have important implications for the HIMU reservoir in this region.

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Crustal evolution: how repeated igneous activity and scale of magmatism govern the composition and isotopic character of the continental crust

Siegel C[1], Bryan S[1], Allen C[1], Gust D[1], Purdy D[2]
[1]Queensland University of Technology, [2]Geological Survey of Queensland

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
My research interests lie in geothermal energy exploration, U- Pb geochronology of accessory minerals, igneous petrology, geochemistry, and crustal evolution. I have previously worked on several projects aiming to unravel the nature of the crustal basement beneath thick sedimentary cover. I utilise multidisciplinary techniques including the merging and interrogation of existing datasets, stochastic 1D thermal modelling, field work, GIS techniques, U-Pb geochronology, Hf and O isotopes in zircons, petrography, and whole-rock chemistry. I am currently undertaking reactive transport modelling on the Century Pb-Zn deposit in Mount Isa to establish the feasibility to reconcile geochemistry and geophysics.

Studies on crustal evolution rarely consider the long-term integrated effect of repeated magmatic events on crustal growth and differentiation. Here, we examine long-term (~350 Myr) temporal compositional trends of granitic magmatism within a relatively small (~100 x 200 km) area avoiding lateral crustal variations to understand how temporal-compositional variations of silicic igneous rocks record crustal evolution. Long-term temporal compositional variations are tracked using whole-rock chemistry, zircon chronochemistry and Hf isotopic compositions. We particularly focus on U, Th and K and calculated heat production values as proxies for crustal evolution, and tracking crustal sources involved in granitic magmatism. We identified two major compositional groupings that were repeatedly developed over time: Group 1 comprises voluminous Permo-Carboniferous and Early Cretaceous I-type igneous rocks; and Group 2 represents lower volume Triassic, Middle Cretaceous and Tertiary A-type igneous rocks. These compositional groupings switch and repeat over the 350 Myr history of granitic magmatism. Heat production values over time exhibit a zig-zag pattern and mirror Hf isotopic signatures where rocks with elevated heat production values exhibit less radiogenic Hf isotopic signatures. Group 1 igneous rocks are interpreted to record large-scale magmatic systems that trigger extensive crustal melting of multiple crustal sources but melt homogenisation leads to whole-rock compositions that trend towards bulk crustal compositions. In contrast, Group 2 igneous rocks reflect smaller-scale systems producing more compositionally diverse A-type magmas from less extensive crustal partial melting. Over the long-term, the large-scale magmatic events make the Hf composition of the crust more radiogenic through basaltic underplating.

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Detrital rutile geochronology from metasedimentary rocks of the Thomson Orogen, Australia

Siegel C[1], Bryan S[1], Allen C[1]
[1]*Queensland University of Technology*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
My research interests lie in geothermal energy exploration, U- Pb geochronology of accessory minerals, igneous petrology, geochemistry, and crustal evolution. I have previously worked on several projects aiming to unravel the nature of the crustal basement beneath thick sedimentary cover. I utilise multidisciplinary techniques including the merging and interrogation of existing datasets, stochastic 1D thermal modelling, field work, GIS techniques, U-Pb geochronology, Hf and O isotopes in zircons, petrography, and whole-rock chemistry. I am currently undertaking reactive transport modelling on the Century Pb-Zn deposit in Mount Isa to establish the feasibility to reconcile geochemistry and geophysics.

Sedimentary provenance changes in the detrital record can provide important information on regional tectonic evolution. In Eastern Gondwana, a fundamental provenance switch occurs in the Neoproterozoic to Early Paleozoic detrital record where two distinctive zircon detrital signatures are observed: 1) a ‘Petermann’ signature dominated by Grenvillian age (~1200-1000 Ma) zircons and a minor Pan-African (~650–500 Ma) age population interpreted to derive from the Musgrave Province, and 2) a ‘Pacific-Gondwana’ signature dominated by Pan-African and minor Grenvillian-aged zircons believed to originate from the distal Transgondwanan Supermountains. Detrital zircons, however, only provide part of the story. This study re-evaluates this provenance change by complementing detrital zircon with rutile ages. Rutile is essentially a medium- to high-grade metamorphic mineral, whose U-Pb ages give the timing when metamorphic temperatures cooled below 600oC, and help unravel the regional unroofing history. We analysed rutiles from seven low-grade greenschist facies metasedimentary rocks of the Thomson Orogen. Six samples characterised by a Pacific-Gondwana zircon signature have rutile ages ranging from 510 to 550 Ma and Zr-in-rutile temperatures of 650-850°C. The other sample with a Syn-Petermann zircon signature has rutile ages around 480 Ma and lower Zr-in-rutile temperatures (450-650°C). For the lone sample, the rutile maximum depositional age is younger than that for zircon. Key findings are: 1) detrital rutiles record less age variability than zircons collected from the same sample; and 2) rutile trace element composition, specifically Cr and Nb, indicate that most Thomson Orogen detrital rutile grains derive from metapelitic and/or felsic granulitic rocks.

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Formation of cratonic lithosphere during the initiation of plate tectonics

Moresi L[1], Beall A[2], Cooper K[3]
[1]University Of Melbourne, [2]Cardiff University, [3]Washington State University

TS4 - 1.1.4 Crustal evolution of Archean Cratons, Hall A, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Computational geodynamicist with two decades of experience

The Earth's oldest near-surface material, the cratonic crust, is typically underlain by unusually thick Archean lithosphere (<300 km). This cratonic lithosphere likely thickened in a high compressional stress environment. Mantle convection in the hotter Archean Earth would have imparted relatively low stresses on the lithosphere, whether or not tectonics was operating, so a high stress signal from the early Earth is paradoxical. We propose that a rapid transition, from a stagnant lid Earth to the onset of plate tectonics, generated the high stresses required to thicken the cratonic lithosphere. Numerical calculations are used to demonstrate that an existing buoyant and strong layer, representing harzburgite and felsic crust, can thicken and stabilize during the lid-breaking event. The peak compressional stress experienced by lithosphere is 3-4 higher than for the stagnant lid or mobile lid regimes immediately before and after. It is plausible that the cratonic lithosphere has still not returned to this high stress-state, explaining its stability. The lid-breaking thickening event reproduces craton features previously attributed to subduction: thrust structures, assembled crustal fragments and transport of basaltic upper crust to depths required to generate felsic melt. Palaeoarchean 'pre-tectonic' structures can also survive the lid-breaking event, acting as strong crustal rafts. Together, the results indicate that the signature of a catastrophic switch, from a stagnant lid Earth to the initiation of plate tectonics, has been captured and preserved in the unusual characteristics of cratonic crust and lithosphere.

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Underworld in the cloud: Using research codes for teaching and training

Moresi L[1], Mansour J[2], Farrington R[1], Giordani J[1], Woodcock R[3], Squire G[3]
[1]University Of Melbourne, [2]Monash University, [3]CSIRO

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Computational Geodynamicist with 2 decades of experience.

Computers have become so familiar that students are often unaware that formal and careful design of algorithms and their implementations remains a valuable and important skill that has to be learned and practiced to achieve expertise and genuine understanding.

How can we grow a love of algorithmic, critical thinking and problem solving skills ? We can certainly start by writing a bottom-up training program to develop the expertise that is required ... but we can also reach back down from the cutting edge of research into a classroom or workshop to encourage and inspire a new generation of students and practitioners.

Our code was developed for modelling plate-scale fluid mechanics and studying problems in lithosphere dynamics. Though specialised for this task, it has a straightforward python user interface that allows it to run within the environment of jupyter notebooks on a laptop (at modest resolution, of course). The python interface was developed for adaptability in addressing new research problems, but also lends itself to integration into a python-driven learning environment.

To manage the heavy demands of installing and running our code in a teaching laboratory, we have developed a workflow in which we install docker containers in the cloud which support a number of students to run their own environment independently. We share our experience blending notebooks and static webpages into a single web environment, and we explain how we designed our graphics and analysis tools to allow notebook "scripts" to be queued and run on a supercomputer.

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Using remote sensing to detect the geomorphologic change around Barrow, USA and its effect of the geological potential of development

Li Z[1]

[1]*Research Institute Of Petroleum Exploration And Development, CNPC*

Biography:

Zhiyu Li was born in Beijing, China. He received the B. Eng degree in Geological Engineering from University of Alaska Fairbanks, USA, in 2014, the M.S. degree in Petroleum Engineering in University of Pittsburgh, USA, in 2016.

He is now a engineer in Research Institute of Petroelum Exploration and Development, China. His main areas of research interest are petroleum reserves and resources estimation and evaluation.

The land erosion issue caused by the water in the coastal area, due to the global warming and carbon dioxide accumulation caused by human activity, has become a significant problem in the world and has become a serious threat to the cities in coastal area. This paper take Barrow, which is the largest city of the north coastal area in Alaska, USA, as an example to analysis the erosion issue causing by the water body around. Landsat image of the study area has been downloaded to analysis this issue. Several methods, such as thermal infrared radiation, are used in ERDAS to process the image, and the subtraction method in remote sensing are used to analysis the erosion issue in this project. Erosion in the study area is obvious along the river and around the lake, it is inconspicuous in the urban area. The geomorphology of study area is temporarily steady due to the man-made prevent erosion construction. It is still a serious threat for the city of Barrow. More attention should be paid to the erosion between the coast and lake, once it connects the sea and the lake by erosion, the water body around the city could be destroyed.

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The Holocene initiation of the Great Barrier Reef: Where, when and how did the reef start to grow?

Sanborn K[1], Patterson M[1], Webster J[1], Warner S[1], Webb G[2], Braga J[3], Nothdurft L[4], Murphy R[5], Humblet M[6], Dechnik B[1,7], Zhao J[2]

[1]Geocoastal Research Group, School of Geosciences, University of Sydney, [2]School of Earth and Environmental Sciences, The University of Queensland, [3]Department of Stratigraphy and Paleontology, University of Granada, [4]School of Earth, Environmental and Biological Sciences, Science and Engineering Faculty, Queensland University of Technology, [5]Australian Centre for Field Robotics, School of Aerospace, Mechanical and Mechatronic Engineering, University of Sydney, [6]Department of Earth and Planetary Sciences, Graduate School of Environmental Studies, Nagoya University, [7]Departamento de Ecologia e Recursos Naturais, Universidade Federal do Espírito Santo

TS6 - 1.3 Marine geoscience - The evolving oceans, Hall E1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:

Kelsey Sanborn is a PhD candidate in the Geocoastal Research Group at the University of Sydney, supervised by A/Prof Jody Webster and co-supervised by A/Prof Andrea Dutton (University of Florida). Her research specifically investigates coral reef response to past episodes of geologically rapid sea-level change, and how sea level can be reconstructed using the reef record. Kelsey came to Sydney in 2014 after finishing a Bachelor of Science in Geology and Environmental Sciences from Tufts University in Boston, USA. Kelsey has significant research interests in carbonate sedimentary facies analysis, coral taxonomy, carbonate platform geomorphology and evolution, and coralgal assemblage analysis.

Despite the importance for understanding reef response to environmental change, the early Holocene initiation of the Great Barrier Reef (GBR) remains poorly understood over high-resolution temporal and spatial scales. This is due largely to the lack of well-dated and closely-spaced core transects. A recent campaign at One Tree Reef, southern GBR has produced twelve cores forming three transects across different geomorphic and hydrodynamic environments (i.e. windward margin, leeward margin, and lagoonal patch reefs) that provide unprecedented details of Holocene reef growth. From the nine cores that reach the base of the Holocene reef, the timing and nature of initial reef growth was investigated. The combination of coral and algal palaeoecological assemblages combined with sedimentary facies and mineralogical data from petrologic and hyperspectral analysis allowed a multi-proxy approach for palaeoenvironmental interpretation. Detailed geochronology using 90 new Uranium-Thorium coral ages constrains shallow-water reef initiation to 8.795 ± 0.037 ka in the patch reef, implying coral growth occurred soon after flooding of the antecedent substrate despite high sediment flux and poor water quality at this time. The height and morphology of the Pleistocene reef surface, as determined from core and seismic data, was an important control on the spatial distribution of early Holocene reef communities. These results are compared to the limited reef core data from the northern and central GBR to examine the environmental and geomorphic factors that promoted or limited coral growth across the entire reef system during this pivotal time.

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Molecules and Cells: A Remarkable Preservation of Life and an Evolutionary Adaptation

Grice K[1], Plet C[1,2], Schwark L[1,3], Melendez I[1,4]
[1]Curtin University, [2]CSIRO, [3]Christian-Albrechts-Universität zu Kiel, [4]Woodside

TS4 - 2.6 Geobiology, Room R1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Professor Grice was awarded a PhD in Organic Geochemistry at the University of Bristol. At Curtin University she has held two ARC QEII fellowships and a DORA. She is the Director of the WA-OIGC. She has received a number of research awards- The Premier's Inaugural Science Award for Early Career Achievement in Science, WA, International Pieter Schenck Award and the Gibbs Maitland Medal. She is a Fellow of, Geochemical Society and European Association of Geochemistry, Royal Australian Chemical Institute and a Fellow of the Australian Academy of Science. She has advised > 25 PhD students and published >160 papers.

Novel biomarker and stable isotopes approaches have been applied to reconstruct the paleoenvironmental setting of a Devonian aged fossiliferous deposit in the Canning Basin, WA. Highly unusual carbonate concretions, referred to as 'Gogo nodules', form around the decaying soft tissue of e.g. fish and invertebrates. Biomarkers and stable isotopes derived from green sulfur bacteria and sulfate reducing bacteria play a significant microbial role in the preservation of the biolipids via hydrogen sulfide vulcanisation. The abundance of steroids derived from cholesterol, with an original biological stereochemistry, links to the exceptional preservation of lipids derived from e.g. crustaceans. This discovery of steroids including sterols derived from an individual Devonian fossil, bridges the disciplines of molecular fossil and isotope geochemistry to the field of paleontology. Microbially-induced carbonate encapsulation, thereby preventing complete transformation and decomposition, has significantly expanded our understanding of steroid occurrence and diagenesis in the geosphere. Very recently it has been demonstrated that an ichthyosaur vertebra of 183 million years old was found to contain cholesterol but also contains red and white blood cell-like structures and collagen. The small size of the red blood cells was attributed to an evolutionary adaptation to low oxygen levels in the atmosphere when the ichthyosaur lived.

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Linking regolith-landform mapping with surface geochemistry in a regolith dominated terrain to inform mineral exploration

Caruso A[1], Clarke K[1], Tiddy C[2], Delean S[1], Lewis M[1]
[1]School of Biological Sciences, The University of Adelaide, [2]Future Industries Institute, The University of South Australia

TS6 - 3.1.2 Making better exploration decisions through an integrated geoscience approach, Hall E2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Alicia Caruso is a final year PhD candidate at The University of Adelaide. Her research focuses on examining the use of advanced remote sensing techniques to benefit mineral exploration under cover. She is specifically looking at the interactions at the surface and subsurface between mineralogical and geochemical expressions of alteration using remote sensing and traditional mineral exploration methods. Her work endeavours to integrate remote sensing into the standard mineral exploration toolkit.

Interpreting landscapes and regolith has become a large part of early mineral exploration methods in recent years. Remotely sensed data to assist production of regolith-landform maps has been used for some time but largely for broad interpretation and subjective mapping. The aim of this study was to create an objective mapping method that mapped the broad characteristics of regolith. This study was done in a location where traditional regolith mapping had been completed using a standardised subjective methodology. An unsupervised classification was performed using a Digital Elevation Model, Topographic Position Index and gamma-ray radiometrics as data inputs resulting in 30 classes that were clustered to 8 classes representing regolith types. To test the association between objective and traditional mapping methods, Mapcurves was used to determine the 'Goodness-of-Fit', resulting in a mean score of 27% between methods. Integration of soil geochemical data with the mapped regolith types is examined to interpret if and how geochemical signals may be dispersed through the landscape. Such mapping and geochemical interpretation may be applicable in first pass exploration targeting within regolith dominated terrains.

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New Insights into the Subglacial Geology of the Remote Interior of Western Wilkes Land, East Antarctica

Maritati A[1], Halpin J[1], Whittaker J[1], Daczko N[2]
[1]Institute for Marine and Antarctic Studies, University of Tasmania, [2]ARC Centre of Excellence for Core to Crust Fluid Systems and GEMOC, Department of Earth and Planetary Sciences, Macquarie University

TS6 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
I am a PhD candidate at the Institute for Marine and Antarctic Studies, University of Tasmania. After working in the West Australian mining industry, I completed a Master of Geoscience at the University of Western Australia where I investigated the crustal architecture of the Knox Rift, East Antarctica using potential field modelling. My current research activity focuses on combining multiple geoscientific datasets at different scales to gain insights into the crustal architecture of the Antarctic plate and the significant forcings the Antarctic bedrock imparts on the overlying ice sheet.

Western Wilkes Land, together with conjugate parts of southern Australia, records poorly-understood tectonic events that led to the amalgamation of the Proterozoic supercontinents Columbia and Rodinia. However, due to the lack of geological data in Antarctica, the tectonic architecture of western Wilkes Land remains largely unknown and only inferred from plate reconstructions.

In recent years, onshore aerogeophysical data over Wilkes Land revealed the presence of large-scale basement provinces and extensive sedimentary basins and permits better resolution of Australo-Antarctic links. Here we present a novel application of new and recently published Australian and Antarctic geological data to identify the age and character of the inaccessible crystalline basement and sedimentary cover of western Wilkes Land. We reinterpret aeromagnetic data from the conjugate Australo-Antarctic margin in the light of recent isotopic studies in southern Australia. We suggest that granitic basement similar in age and composition to the three magmatic supersuites that characterise the Coompana Province in southern Australia (c. 1600-1500 and 1200 Ma) is present in western Wilkes Land. In addition, zircon and monazite isotopic data from the first sandstone erratic rocks inferred to sample the Sabrina Subglacial Basin that covers a large part of western Wilkes Land suggest that parts of this basin may be comparable to the Neoproterozoic Officer Basin of Australia, sourcing Coompana-type crust.

Our improved knowledge of subglacial geology in western Wilkes Land will greatly inform future studies seeking to better resolve the tectonic processes that controlled the Proterozoic evolution of Columbia and Rodinia.

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The environmental conditions behind a sudden rise in biological complexity at 2.4 Ga

Nomchong B[1], Van Kranendonk M[1]
[1]University Of New South Wales

Biography:
I am a PhD student from the University of New South Wales, Sydney.
My research involves studying the physical and geochemical properties of stromatolitic carbonates of the Paleoproterozoic Turee Creek Group, WA, to piece together a picture of what the environment was like during their deposition, and what effects factors in the environment (particularly the presence of oxygen) may have had on the fossil organisms.

The 2.4 Ga Turee Creek Group (TCG), Western Australia, offers a rare record of marine carbonates deposited immediately following the Great Oxidation Event (GOE). The appearance of dissolved oxygen, a hitherto toxic gas, in the atmosphere and shallow oceans throughout the GOE posed new challenges to early microbial life, but also offered a new source of energy, a prerequisite for increased biotic complexity and higher energy metabolic functions.

Recent studies of a marine stromatolitic carbonate reef in the TCG have revealed evidence for a sudden increase in biotic complexity, including: great diversity in microbialite form; phosphorites; clotted microbialites in the shallow part of the reef; and a diverse deep-water microbial community. To determine the role a potentially oxygenated environment may have played, the paleoenvironmental conditions during deposition of this reef are investigated.

In this study, geochemical analyses have been undertaken on multiple co-occurring carbonate fabrics in the TCG (e.g. stromatolites, sediment and seawater precipitates) to constrain paleoenvironmental and post-depositional processes. Here, we present new carbonate isotope and bulk XRF data, and discuss their implications on the paleoenvironment. We also discuss the implications for planned future analyses and how they contribute to our end goal: to eventually constrain the amount of oxygen present in the system, temperature of the seawater, the architecture of the carbonate reef, and the digenetic history of these carbonates. Characterisation of these conditions will provide insight into the adaptation of life to the GOE and the coevolution of biology and Earth’s atmosphere.

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Unusual or unfamiliar minerals revealed by the NVCL, their significance and procedures for their recognition and validation.

Huntington J[1], Green A[2], Botrrill R[3], Green D[3], Gopalakrishnan S[4], Gordon G[5], Hancock L[6], Killen D[4], Lau I[9], Laukamp C[9], Le Gras M[9], Mauger A[5], Moltzen J[3], Smith B[8], Tilley D[7], Wawryk M[6], Woolley R[3]
[1]Hhgeoscience, [2]OTBC, [3]MRT, [4]GSQ, [5]GS South Australia, [6]GSWA, [7]GS NSW, [8]NTGS, [9]CSIRO Mineral Resources

TS2 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Jon Huntington has a career's worth of experience in the hyperspectral characterisation of rocks from laboratory, field, airborne and spaceborne sensors. He has worked as an exploration and mine geologist, in applied research for Australia's CSIRO, consulted to national and international companies, and led numerous applied industry-funded remote sensing research projects through AMIRA International and MERIWA. Jon was instrumental in the co-development of the HyLogging concept, The Spectral Geologist (TSG) software package and was founding Director of AuScope National Virtual Core Library (NVCL). He is currently a CSIRO Honorary Fellow still exploring the spectroscopy of minerals, providing training and mentoring.

Opportunities for finding unfamiliar or unusual minerals in a national database of over a million metres of hyperspectral drill core data, sampled every 10 mm, are very considerable. This paper presents some of these findings from all Australian jurisdictions and explores their significance and possible origins. Depending on the environment being analysed hyperspectral data are so often dominated by common minerals, such as white micas, chlorites, quartz, feldspar, etc. however there are a growing number of less familiar minerals, some described as rare, but which in reality are not when researchers have access to tools to sense them. We describe not only the unfamiliar spectra but also how to find them in a huge database and processes to validate what they are. Some of our findings reflect hydrothermal alteration, some surface oxidation and weathering, and some just different geological settings than many people have to deal with day-to-day. All however require recognition and inclusion as failure to do so generates errors, residuals or outliers in automated interpretation algorithms and hampers recognition of other components, but may also deflect from an understanding of the real reason they are there. Hyperspectrally-derived mineralogy is so much more than the observation of mineral presence or abundance and must encourage exploration of processes and their broader significance.

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Sediment Provenance and Tectonic Evolution of the Eastern Mentelle Basin: Insights into the Early Rifting History of East Gondwana

Maritati A[1], Whittaker J[1], Halpin J[1], Wainman C[2], Danisik M[3], IODP Expedition 369 Scientific Party[4]
[1]Institute for Marine and Antarctic Studies, University of Tasmania, [2]Australian School of Petroleum, University of Adelaide, [3]John de Laeter Centre for Isotope Research, Curtin University, [4]Texas A&M University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
I am a PhD candidate at the Institute for Marine and Antarctic Studies, University of Tasmania. After working in the West Australian mining industry, I completed a Master of Geoscience at the University of Western Australia where I investigated the crustal architecture of the Knox Rift, East Antarctica using potential field modelling. My current research activity focuses on combining multiple geoscientific datasets at different scales to gain insights into the crustal architecture of the Antarctic plate and the significant forcings the Antarctic bedrock imparts on the overlying ice sheet.

Palaeogeographic and tectonic reconstructions of the early rifting (Late Jurassic to Early Cretaceous) of East Gondwana often overlook East Antarctica due to the lack of geological data both onshore and offshore. Nevertheless, Antarctica was likely a significant contributor of clastic material that formed the syn-rift successions of sedimentary basins along the west Australian margin (i.e. Perth, Mentelle basins). Furthermore, the Knox Rift, located onshore Antarctica, may represent a continuation of early rifting in the Mentelle and Perth basins, later abandoned as rifting progressed.

International Ocean Discovery Program (IODP) Expedition 369 recovered for the first time sandstones from the syn-rift sequences of the eastern Mentelle Basin. Located in proximity of the relict triple junction of the Antarctic, Indian and Australian plates, these sandstones present a unique opportunity to provide new insight on the palaeogeographic and tectonic evolution of the Antarctic and Australian plates during the early rifting stages of East Gondwana.

We present initial results from the post-expedition analytical work on the syn-rift sandstones of the eastern Mentelle Basin that aims to improve our understanding of the depositional and tectonic history of the Mentelle Basin in the broader East Gondwana framework. Using our new data and recent isotopic data from previously unaccessed outcrops in East Antarctica, we seek to test the hypothesis of an East Antarctic provenance of sediments in the Mentelle Basin and investigate tectonic links of the Mentelle Basin with the inferred conjugate Knox Rift in East Antarctica.

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Old friends reunite: a new proposal for an Ordovician Lachlan Supergroup in the Tasmanides

Deyssing L[1], Trigg S[1], Gilmore P[2], Colquhoun G[2], Cayley R[3], Fitzherbert J[2]
[1]Geological Survey of New South Wales, [2]Geological Survey of New South Wales, [3]Geological Survey of Victoria

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Since 2007, Liann Deyssing has been a geologist in the Regional Mapping section of the Geological Survey of New South Wales. During this time, she has been involved in the Braidwood and Captains Flat mapping projects, working across a range of geological specialties. Her work over the last few years has been as part of the team working on the NSW Seamless Geology Project; compiling, joining and upgrading the best available geology and datasets across the state.

As a result of being studied in geographic isolation, without input from recent biostratigraphic advances, Ordovician turbidite and black shale sequences of the Lachlan Orogen (LO) have previously been assigned to several different stratigraphic units. This has resulted in uncertainty in definitive correlations between units, with implications for tectonic models of the LO and the Tasmanides.
Recent work has demonstrated that some units are indistinguishable across large geographic areas with respect to age, lithology, composition, provenance and depositional environment. Further, as part of the Seamless Geology Project of the Geological Survey of NSW, boundaries between some units could not be determined, both within NSW and across the border into Victoria (e.g. the Abercrombie Formation, Clements Formation and Pinnak Sandstone). It is therefore proposed that the Clements Formation and Pinnak Sandstone are incorporated into, and superseded by, the Abercrombie Formation, and as a consequence the Wagga Group is superseded by the Adaminaby Group.
It is also proposed to combine the Girilambone, Castlemaine and Adaminaby groups into a Lachlan Supergroup, comprising the early to early-late Ordovician terrigenous turbiditic sequences. This new supergroup would be consistent with the recent division of the late Ordovician sequence into the Bendoc and Margules groups, defined by the cessation (Bendoc Group) and then resumption (Margules Group) of terrigenous turbiditic sedimentation. This division has been applied across the LO as part of the Seamless Geology Project, which results in the Gungoandra Siltstone, New Country Sandstone and Willandra Sandstone being reassigned from the Bendoc Group to the Margules Group.

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Slope stabilisation for regional roads in NSW - a case example

Aryal S[1]
[1]*WSP*

TS3 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Dr Sudarshan (Sudar) Aryal is a geotechnical practitioner with more than 27 years of local and international experience. Sudar is a technical specialist in the design, delivery and assurance of many infrastructure projects. He has experience across a broad range of geotechnical engineering projects, employing engineering methodologies and techniques to ensure the successful implementation of investigation, design through to construction

This presentation intends to highlight the need for a different thinking and approach in asset management for the road infrastructure which traverse through the areas with hilly terrains and thus are at high risks of impact from natural/man-made geohazards. Slope instability is a common issue along these roads and a major cause for increased maintenance investment for Roads and Maritime Services (RMS) of NSW – the asset owner. Slope stabilisation works completed in a section of Waterfall Way at Myers Bluff is a case example where a non-traditional approach was adopted.
The sites at Myer Bluff comprised a number of slip-affected road sections. Being a busy road connecting inland NSW to the coast, these sites created significant operational challenges to RMS including safety to road users and need to keep road open and several constraints that the design of stabilisation works had to consider including: construction traffic, construction work space restrictions; construction access issues and selection of plants for construction.
WSP provided the detailed design for stabilisation works for RMS. The construction was completed in 2015. Efficient delivery of this project relied upon a thorough understanding of the project issues, risks and constraints, application of relevant real-work practical experience and the ability to draw on a strong track record of design expertise from similar past projects to serve the interests of all the stakeholders including the end user – the public.
This talk presents our approach, the development of the design that addresses all the constraints and associated project outcomes.

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An Investigation of Deepwater Sedimentation in Submarine Canyon and Fan on a Typical Passive Margin Using Stratigraphic Forward Modelling

Wan L[1], Bianchi V[1], Hurter S[1], Salles T[2], Tyson S[3]
[1]The University Of Queensland, [2]The University of Sydney, [3]Universiti Teknologi Brunei

TS8 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
2015-present, PhD candidate at the University of Queensland
2012-2015, MSE at China University of Geosciences
2008-2012, BSE at China University of Geosciences

The present work simulates an integrated depositional system over a geological time scale of 150 ka extending from the river mouth to the deep basin connected via a sinuous canyon on a typical passive margin, with the Perth Canyon region, Western Australia as an example. The final three-dimensional model involves the delta on the shelf, the channel-levee complex in the canyon and the submarine fan in the abyssal plain. And the results are compared with analogs respectively.
The numerical model (LECODE) achieves a good balance between computational efficiency and dynamic control of relevant processes. The study adopts both qualitative analyses of depositional/erosional thickness and grain size, and quantitative analyses of measurements and dynamic parameters.
On the delta, the model reproduces the normal and the forced regression as well as the transgression with respect to forcing sea level conditions. Within the canyon and on the submarine fan, the impact of sea level changes is reflected mainly via the evolution of erosional and depositional area/volume, channel stacking patterns and their distribution, flow velocity and concentration. Inner bank erosion occurs at the canyon head due to the flow direction on the delta. In the middle canyon bend, the flow reaches a peak velocity and the bends of flow trajectories migrate downstream, which is accompanied by the strong erosion of the outer bank and increasing channel sinuosity. This study assesses the linkages and transitions between different marine depositional environments and provides new insights on the formation and evolution of deep-water sedimentation.

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U/Pb Geochronology of Apatite within the Marshall Shear Zone of the Ernest Henry Deposit, NW Queensland

Griffin A[1], Lilly R[1], Glorie S[2]

[1]Academics With Exploration; Studies of Mount Isa and the Eastern Successions, [2]Centre for Tectonics, Resources and Exploration

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:

I am currently an honours student at the University of Adelaide with experience at a mine site as part of a vacation work program at Glencore.

The Ernest Henry Mine is situated 35km NW of Cloncurry, within the Eastern Fold Belt of the Proterozoic Mount Isa Inlier. The ore body is hosted within the heavily altered and brecciated Mount Fort Constantine volcanics. The deposit is structurally bound by two subparallel shear zones trending NE and dipping 45° SSE termed the Hanging Wall Shear Zone (HWSZ) and the Footwall Shear Zone (FWSZ). The Marshall Shear Zone (MSZ) is located approximately 1km to the South of the HWSZ and FWSZ and its role in relation to mineralisation has not been assessed.

Compositionally the MSZ is visually analogous to the HWSZ and FWSZ with early coarse grained euhedral apatite and rare garnet which may be linked to peak D 2 deformation of the highly foliated metasediment and metavolcanic protolith. Overprinting alteration and infill minerals include magnetite, biotite, amphibole and K-feldspar with minor, relatively late, cross-cutting calcite, quartz, chalcopyrite and pyrite of the ore-stage assemblage.

This study aims to date MSZ apatite using the U/Pb method to constrain the timing of peak metamorphic conditions, formation of the primary shear fabric and provide trace element constraints on hydrothermal fluid compositions. This will establish geological constraints on the structural setting prior to the introduction of the later ore-bearing fluid(s).

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Diversity in Deep Earth Imaging: A perspective from establishing a new collaborative geoscience hub

Chopping R[1], McWilliams M[1]
[1]CSIRO: Deep Earth Imaging FSP

TS5 - 5.1 Geology in Society: geotourism and geoheritage & 5.6 Diversity in the Geosciences, Room R8, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Richard Chopping is a geophysicist with over a decade of experience in applying geophysics to Australian exploration challenges. His work has focussed on the use of potential field, EM and MT methods and the physical property expressions of mineral systems. Richard is presently a Research Theme Leader within the newly formed Deep Earth Imaging Future Science Platform at CSIRO.

In 2017, the CSIRO established the Deep Earth Imaging Future Science Platform (DEI-FSP) as one of six new Future Science Platforms. The DEI-FSP is a new collaborative multidisciplinary geoscience hub, hosted in Perth, and brings together early career researchers to tackle challenges in exploration and management of minerals, energy and groundwater resources. In establishing the DEI-FSP, an international recruitment campaign for 18 early career researchers, four theme leaders and the platform leader was undertaken. In addition, a further nine PhD student places have been funded by the DEI-FSP in five Australian universities. This unprecedented recruitment campaign represents a snapshot of the diversity pool of geophysicists, geochemists, geologists, data analysts, physicists and computer scientists. Through it, we have a greater understanding of some of the oncoming challenges for early career scientists and areas that can be improved upon for greater diversity in recruitment, from a gender, nationality, and scientific discipline perspective.

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The significance of Photic Zone Euxinia at the Chicxulub Impact Crater

Schaefer B[1], Summons R[2], Cui X[2], Coolen M[1], Grice K[1], IODP 364 Science Party
[1]WA-Organic and Isotope Geochemistry Centre, School of Earth and Planetary Sciences, Curtin University, [2]Massachusetts Institute of Technology

TS1 - 2.3 Mass Extinctions, Room R1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Bettina Schaefer is a PhD student with Kliti Grice and Marco Coolen at Curtin University working on the end-Cretaceous mass extinction.

The meteorite impact event 66 Ma ago has been widely accepted as the main cause of the End-Cretaceous mass extinction event. The event led to an extinction of 75% of all species on Earth. For this study samples (impact melt, breccia, suevite and sediments) from Integrated Ocean Drilling Program (IODP) 364 drilling expedition “Chicxulub: Drilling the K-T Impact Crater” were extracted for biomarkers and analysed to investigate the molecular and isotopic organic record of biotic and environmental change before and after the K/Pg boundary event.
Biomarkers of dinoflagellates, diatoms and land plant markers were detected in the Cenozoic and their variations indicate alternating inputs of organic matter from marine and terrestrial sources. Diagnostic biomarkers of green, brown and purple sulfur bacteria were identified and their distributions support the rapid occurrence of photic zone euxinia (PZE) before and after the K/Pg boundary. The significance of PZE (episodic vs persistent) throughout the section reflects a variation in marine productivity cycles up to the top of the Eocene. Further, high amounts of organosulfur compounds in the Eocene support early diagenetic sulfurisation (inter and intramolecular) of biomolecules in the ancient column water. Further analysis of the samples and the coupling with the stable isotope data have revealed important information on the paleo environmental depositional setting at ground zero.

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The controlling variables in landscape evolution: numerical models of the erosion-deposition-subsidence patterns of the Great Artesian Basin

Braz C[1], Smith G[2], Gupta R[2], Zahirovic S[1], Müller D[1]
[1]EarthByte Group, The University of Sydney, [2]Curtin University

TS5 - 1.1.2 Optimisation and uncertainties in Earth models, Hall C, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Carmen Braz is a PhD candidate at the University of Sydney with the EarthByte group and Basin Genesis Hub. She began her PhD in 2016 following the completion of her Bachelor of Science (Honours) at Sydney University, where she was interested in the plate tectonics and geodynamics of the Caribbean region. Carmen is currently interested in linking deep Earth processes with surface processes to study basin evolution. Her current work, in collaboration with Curtin University, focuses on numerical modelling of erosion and deposition in Australian basins.

Inundation of interior eastern Australia during the Early Cretaceous produced extensive shallow marine deposits throughout the Eromanga, Surat, Carpentaria, and Clarence-Moreton basins, becoming progressively non-marine through the mid Cretaceous despite rising global sea levels. These sediments form the Great Artesian Basin (GAB) that underlies ~22% of the Australian continent. Geodynamic modelling suggests that dynamic topography, the long-wavelength low-amplitude topographic response to mantle flow, is an important factor in the flooding and emergence. Numerical models using Badlands have linked dynamic topography with surface processes and have investigated time-dependent geomorphic responses. The modelling has assessed the effect of variables including initial paleo-topography, subsidence, rainfall, erodibility, sea level, and lithosphere elastic thickness.
Many uncertain variables mean thousands of scenarios are possible. Iteratively testing each requires enormous computational time to find the controlling variables and measure their effects. Experimental Design and Analysis was used to specify the minimum number of scenarios to capture and evaluate the significant effects. This gave a probability distribution of all possible scenarios and statistical measures for the relative importance of each parameter. The observed sedimentation and burial history of the GAB has been reproduced and the results indicate the main controls are sea level and uplift whereas rainfall and equivalent elastic thickness of the lithosphere are not as important.

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CBM in Poland as unconventional source of natural gas - case study

Kasza P[1], Kroplewski Ł[2], Jureczka J[3]
[1]Oil and Gas Institute - National Research Institute, [2]Polish Oil and Gas Company, [3]Polish Geological Institute - National Research Institute

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Piotr Kasza PhD, Head of Reservoir Stimulation Department at Oil and Gas Institute – National Research Institute. Graduate and doctorate from Faculty of Drilling Department, AGH University of Science and Technology, Cracow. In recent years, particularly active in the area of developing technologies for unconventional hydrocarbons reservoir completion. Manager of Gilowice Project concerning the possibility of commercial obtaining of methane from coal. He leads and participates in national and international research projects. Since 2017, he has represented INIG-PIB in the Board of the International Centre of Excellence on Coal Mine Methane operating at the United Nations Economic Commission for Europe.

Poland has a large coal resources located in three main basins. The largest methane content in coal seams was confirmed in Upper Silesian Coal Basin. Therefore since the 90's of last century the first projects of pre-mine drainage were carried out. Unfortunately the results were rather poor and for some time CBM idea was abandoned. Few years ago, Polish Oil and Gas company decide to invest in unconventional reservoirs of oil and gas and resume pre-mine drainage project again. Wells localized in Gilowice near Brzeszcze coal mine were selected to this project. Those wells were drilled few years before set up this project and it was necessary to check wells condition and prepare horizontal well for planed fracturing treatments. After workover five fracturing treatments in the horizontal part of the Gilowice-2H well were done. Final stage of this project was testing the methane production capacity of the coal seams. Achieved results were very promising and POGC decide to extend project to another location in Upper Silesia Coal Basin. This new project, sponsored by Oil and Gas Company and coal companies under the government auspices, is very important for Poland to get another significant source of natural gas and diversification of gas sources.

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A comprehensive microscopic and geochemical study on melanosomes and keratin in a fossilised fish eye from the Fur Formation, Denmark

Wang D[1], Grice K[1], Coolen M[1], Rickard W[2], Whiteside J[3]
[1]WA-Organic and Isotope Geochemistry Centre (WA-OIGC), School of Earth and Planetary Sciences, Curtin University, [2]John de Laeter Centre (JdLC), Faculty of Science and Engineering, Curtin University, [3]National Oceanography Centre Southampton, University of Southampton

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I am a PhD student from School of Earth and Planetary Sciences, Curtin University, under the guidance of Prof. Kliti Grice and A/Prof. Marco J. L. Coolen. My reserach interest is focused on organic geochemistry which combines geological information with chemical data in order to obtain paleoenvironmental information and life evolution. My reserach topic is biomarkers and stable isotopes associated with major geological events across the Cretaceous.

Fossilised pigments are significant in yielding many aspects about the ecology of ancient life. It has been assumed that the tiny microstructures observed in exceptionally well-preserved fossils are associated with biofilms made by bacteria. However, recent studies have provided clear and convincing evidence, both morphologically and chemically, that these microstructures are melanin-bearing melanosomes, colour-bearing organelles, refuting a misinterpretation as bacterial biofilms. By applying time-of-flight secondary ion mass spectrometry (ToF-SIMS), molecular content of putative melanosome from a fish eye fossil from the early Eocene of Denmark were analysed and showed a close agreement of the mass spectra compared to a natural melanin standard (Lindgren, et al, 2012). Trace metal abundances proved that copper, as organometallic compounds, is present in eumelanin, providing a proxy for determining the density and distribution of eumelanin (Wogelius, et al, 2011). Other elements, such as Ca and Zn, also showed a strong correlation with the melanin pigment. Identification of keratinous proteins in fossil matrix which these microbodies are embedded in also supports the assignment of these microbodies as melanosomes (Pan, et al, 2016). However, the source of the organically bound trace metals is still under debate (Edwards, et al., 2016). Also, recent studies have shown that epidermal keratin can decay easily during microbial activity and diagenetic process (Saitta, et al, 2017). Little research has been done on the chemical processes during melanosome preservation and the degradation process of keratinous protein.

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Direct economic return to government of Public Geoscience Information investments in Chile: First evaluation of the National Mapping Program.

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[1]Servicio Nacional De Geología Y Minería, [2]Pontificia Universidad Católica de Chile

TS5 - 3.4 Resources sustainability – responsible investment and management & 3.5 Technology integration, Room R2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
MSc and PhD in Geology at the Universidad de Chile, Santiago-Chile
Head of the General Geology Department at the Chilean Geological Survey, responsible for the National Mapping Program for Basic Geology, Geophysics and Stream sediments Geochemistry of the chilean territory, publishing cartography at different scales

We evaluate the direct economic return of the provision of Public Geoscience Information (PGI) by the National Mapping Program (NMP) carried out by the Chilean Geological Survey. The study considers different scenarios for the NMP and uses multiplier effect ratios through the value chain of PGI and a probabilistic discounted cash flow model.
The model indicates that, in average, every dollar invested in PGI in Chile during the past three decades could have generated 11.5 dollars of government tax revenues from the mining industry (in terms of its NPV), with an IRR of around 21%. This is in accordance with comparable studies abroad, despite methodological restrictions of the study. These indicators are positive in almost all the scenarios considered in the study and similar results are obtained for the NMP when different scenarios are evaluated.

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The impact of individual flood events on sedimentology in a highly variable discharge river is determined by discharge variation pattern.

Alexander J[2], **Amos K[1]**, Herbert C[2], Fielding C[3]
[1]University Of Adelaide, [2]The University of East Anglia, [3]The University of Nebraska - Lincoln

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Kathryn is a Senior Lecturer at the Australian School of Petroleum, University of Adelaide. Her expertise is in clastic sedimentology, research focusing on understanding the controls behind processes of sediment transport and deposition in a range of environments, based on the study of modern environments and the rock record. A key driver for this research is the application of improved understanding about depositional systems to the interpretation of ancient successions. Kathryn obtained her PhD in 2004 from the University of East Anglia, UK.

In March 2017, rainfall associated with Tropical Cyclone Debbie caused a flood in the lower Burdekin River, Queensland, that peaked at 11,955 m3s-1. Research into its effect on channel-bed sediments incentivised analysis of historical rainfall-discharge responses and their resultant channel-bed changes. In the past 40 years there have been 14 discharge events with peak magnitude over 10,000 m3s-1 in the lower Burdekin. We present analysis of these, their associated rainfall and impact on the channel bed. Deposits were evaluated from field observations (1998-2017), aerial photographs (1994 – 1998) and satellite images (2006-2017). Five depositional elements are described: 1) unit bars, 2) vegetation-generated bars, 3) gravel sheets and lags, 4) antidune trains, and 5) sand sheets. Flow events with similar peak discharge magnitudes are categorised based on the rate at which the stage fell. This depends on weather and rainfall patterns and results in different deposit character. 1) Short-duration rainfall over the eastern sub-catchments produces a flashy hydrograph; these events rework bar surfaces and produce minor bar accretion. Washed-out dunes dominate bar surfaces, and antidunes are preserved. 2) Rainfall over the northern catchments, or widespread rainfall, produce hydrographs with more slowly falling limbs and greater total discharge volume. These change bar position and produce new attached bars. Bar surfaces are dominantly sand and gravel sheets. We highlight how substantial the gaps in our understanding of the sedimentology of highly variable discharge rivers are; this study helps to address this, and will help interpretation of many deposits in the ancient record.

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Porphyry exploration supported by airborne hyperspectral in the Peruvian Andes

Farrar A[1]
[1]*First Quantum Minerals*

Biography:
Alex has been leading First Quantum's generative exploration programme for porphyry copper deposits in southern Peru, Chile and Argentina for the last 5 and a half years. Alex currently resides in Santiago, Chile and previously was based for five years in Lima, Peru. Prior to this Alex lived in Zambia and worked in the DRC and Zambia, and was involved in FQM's discoveries of the Sentinel copper and Enterprise Ni mines also with First Quantum. Alex started in the industry as an underground mine geologist in Mount Isa in 2006.

Prospectivity maps applying the mineral systems approach were created using geologic, geophysical and geochemical based inputs and were combined with multispectral datasets such as ASTER and LANDSAT to create a fully integrated, ranked ‘prospectivity map’ for porphyry copper exploration in southern Peru. Geologic and geophysical datasets were used to create a favorable structural ‘architecture’ map, whilst the geochemistry and multispectral datasets were used to directly target potential hydrothermal systems and combined into one product.
‘Areas of Interest’ (AOIs), occur where multiple favorable factors come together in one location and thus are deemed a favorable geodynamic location for the formation of a porphyry copper deposit. In total there were roughly 200 AOIs deemed necessary for follow up fieldwork. After a year of intense fieldwork in challenging Andean terrain it was decided that in order to speed up field validations of the AOIs, and in an attempt to reduce the number of false positive anomalies being visited, FQM would trial an airborne hyperspectral survey. A novel survey design allowed for all priority AOIs to be overflown as well as all eight known porphyry deposits.
By being able to re-rank the existing AOIs based on their hyperspectral characteristics, FQM was able to prioritize field visits to the most prospective AOIs earlier than would have occurred if the survey was never acquired. This has resulted in the identification of four large porphyry alteration zones, three of which were able to be 100% staked by FQM and are now FQM projects.

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Biomarker distribution in a Devonian concretion (Scotland, UK)

Tripp M[1], Plet C[2], Whiteside J[3], Grice K[1]
[1]Curtin University, [2]CSIRO, [3]University of Southampton

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Madison is a current Honours student at Curtin University in Perth with Prof. Kliti Grice, undertaking research on exceptionally preserved fossils in carbonate concretions.

Although carbonate concretions are widespread in organic-rich sediments of all geological ages and are being actively investigated, there are few reported biomarker studies. In this study, thorough biomarker and compound-specific isotope analyses of a Devonian Eifelian stage carbonate concretion from Hillhead Quarry in Scotland (UK) were undertaken. The concretion was separated to remove the external weathered portion of the concretion from the internal, fossil-containing portion of the concretion, and each was analysed separately.
Analysis of the aliphatic fractions showed the presence of β-carotane, farnesane and gammacerane, as well as $\delta^{13}C$ values of biomarkers which could be used as indicators to interpret the palaeoenvironment of formation. The aromatic fraction showed an abundance of 2,3,6-aryl isoprenoids. This data indicated hypersaline, anoxic, photic zone euxinia conditions of the formation; conditions in which green sulfur bacteria perform photosynthesis using H_2S to fix CO_2 in the presence of light. Other sources include algae, macrophytes and waxes derived from higher plants. A lack of β-substituted naphthalenes in the aromatic fraction indicated that the concretion had a low thermal maturity.

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Efficient new approaches for optimal geological exploration and characterisation

Zaitouny A[1,2], Small M[1,2]
[1]CSIRO, [2]UWA

TS5 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
I am a postdoctoral fellow in Complex Engineering Systems within CSIRO-Mineral Resources and a member of the Complex System Group at UWA. During my Master, PhD and current first postdoctoral position, I gained sound knowledge and expertise in abroad applications of complex systems theory to experimental systems. I have experience in dynamical systems, complex networks, optimisation, modelling, data mining, filtering, tracking and navigation, animal ecology/movement, mineral resources and bio-genetics. Beside the collaboration with my team at UWA, I am working with a group of scientists and engineers within the Mineral Resources flagship at CSIRO to mathematically model complex engineering systems.

Although geological exploration is a very important process for the understanding and development of new resource fields, it remains very expensive and time consuming. Exploration is essentially based on two tasks: 1) drilling operation which is crucial for collecting data and 2) resource estimation and assessment of new resource structure. We propose new techniques and ideas to efficiently achieve the task of resource estimation by using minimal number of drills. Mining through some geological data sets we show that the resources underneath the earth surface is structured in domains with different vertical and horizontal distributions. Hence, assignment based on the orientation of these domains is important for proper resource estimation. We introduce a multivariable technique to be implemented on both geophysical and geochemical data to identify both layers and domains. Using the outcomes of the domains assignment process, we also demonstrate the extension of these ideas to 2+1 dimensional modelling for resource estimation and interpolation using techniques based on information theory as well as advance radial basis modelling approaches.

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Resources Sustainability and Environmental Impact in Bayan Obo Deposit

Wu Q[1], Wang X[2]
[1]Tsinghua University, [2]China Aero Geophysical Survey & Remote Sensing Center for Land and Resources

Biography:
Mr Wu Qifanan associated professor in Tsinghua University
B.Sc. and M.Sc., Nuclear Geophysics from 1981 to 1988, Chengdu College of Geology
Ph.D., Geology, from 1997 to 2001, China University of Geosciences (Wu Han).
A Chinese expert in environmental radiation monitoring and assessment
A member of the Geological Society of China
A member of the Geophysical Society of China
A member of the China Society of Radiation Protection
A member of the Environmental Modeling for Radiation Safety (EMRAS II)(2009-2012), Modeling and Data for Radiological Impact Assessments (MODARIA)(2013-now), IAEA.

1. Resources
Bayan Obo deposit locates in north China, which possesses 950 million tons of iron ores and 35 million tons of REO ores respectively. The ores consist of multi-elements in minerals such as iron(34%), rare earth elements(REO 5%), thorium(0.032%) , and some other elements. More than 280 million tons of ores have been mined since 1957. About 10 million tons annually of ores are mined to produce for iron and steel and rare earth elements.
2. Management and utilization of residues
More than 560 million tons of waste rocks have been produced. But only a small amount of waste rocks are used for road construction. About 150 million tons of tailings have been stored in tailing pond as resources for future reuse. A substantial amount of the slag has been used to make cement, concrete, bricks, etc. RE slag is stored in the Radioactive Waste Storage Facility as thorium and other element resources for future reuse.
3. Environmental impact
Mining site and Waste rock dump locate in pasture, which covered about 19 km^2. As a result, a large area of pasture was lost. About 11km^2 of farming land nearby Baotou city was used as main tailing pond. Radiological impact occurred because of mining and processing activity. Radiation levels varied from 600 to 2000nGy/h in mining sites, 400 to 800nGy/h in the dumping sites, about 600-2000nGy/h in the slag stock 650-1,200nGy/h in the tailing pond, 85-150nGy/h in the contaminated area.

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Impact of climate change on the groundwater resources of India

Nair S[1]
[1]*Centre for Earth Research and Environment Management*

Biography:
Executive Secretary, Centre for Earth Research & Environment Management (non-profit NGO), guest faculty, Department of Water Management, BKC, MG University, Senior Consultant Scientist, Nansen Environmental Research Centre (India), and member of the drought monitoring cell of the State Planning Board. PhD (Hydrometeorology) from Cochin University. Received advanced training in Water Management and Coastal Zone management from MASHAV and UNESCO. More than 28 years' research, research supervision and teaching experience in Meteorology, Hydrology and water management. Published 130 research papers and participated in 145 international meetings related to water. Current research focuses on climate change impact on megacities and natural resources.

Impact of climate change on groundwater resources that contribute to nearly 80% of the agricultural production poses a serious threat to food security in India, as the dependency on groundwater increases with rising demands and depleting surface water resources. Increasing temperatures produce more evaporation from surface water bodies and also make the soil dry, reducing the recharging of underground resources. Rainfall is becoming highly seasonal in parts of western and southern India. High seasonality allows wasteful runoff and reduces the duration of groundwater recharge. High intensity rainfall erodes topsoil, reducing the water holding and recharging capacity of the surface. Trends in rainfall in the dry zones increase dependency of groundwater for irrigation where there is no balance between extraction and recharge. Increase in the number of tube wells and deep bore-wells has been tremendous. Changing frequency and intensity of cyclones increasingly salinate the coastal aquifers. Changes in the course of rivers as a result of flooding and sedimentation may lower the water table in the heavy rainfall regions. Melting rate of Himalayan glaciers has been accelerated in recent years, gradually leading to water crisis in the northern parts of India. Falling water availability leads to social issues such as migration, conflicts over allocation and pricing. Present study analyses the trends in climate and its impact on groundwater resources and agriculture, reviews the existing policies and suggests guidelines for an appropriate water policy. India has rich and unutilized groundwater potential. Sustainable utilization of the resources can help maintain food security.

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The role of carbonate in the formation of magmatic Ni-Cu-PGE deposits along craton margins

Blanks D[1], Holwell D[1]
[1]School of Geography, Geology and the Environment, University of Leicester

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Daryl Blanks is a PhD student in applied geology at the University of Leicester, UK. Her PhD research project is focussed on determining the nature and genesis of the Munali Ni-Cu-PGE deposit in southern Zambia. As part of this research, she aims to define the emplacement mechanisms for the formation of magmatic sulfide breccia deposits, using case studies from Western Australia, and examine the role of carbonate in Ni-Cu-PGE systems on a global scale.

Magmatic Ni-Cu-PGE deposits are almost exclusively formed from mafic-ultramafic silicate magmas with such melts fundamental in acting as the source, carrier and host to Ni-Cu-PGE sulfide mineralisation. Spatially, many magmatic sulfide deposits are localised along craton margins, and the geodynamic setting and nature of the mantle source in these areas are considered to be important in producing fertile magmas. Carbonate and apatite have recently been recognised as common accessory minerals associated with sulfide in some mantle xenoliths and also within some craton margin hosted ultramafic-mafic sulfide deposits. These span the entire lithosphere, from intrusions emplaced into the lower crust, e.g. ultramafic pipes in the Ivrea Zone, Italy, to deposits in upper crustal systems, e.g. the Munali Ni sulfide deposit, Zambia. Munali exhibits multiple styles of magmatic carbonate-rich sulfide mineralisation and textures suggestive of liquid immiscibility. The mineralogical association of primary carbonate, apatite and sulfide, combined with C and O isotopes show clear mantle-like signatures for some of the carbonate in the ores. Lower crustal examples exhibit a strikingly similar mineralogical association, with carbonates texturally associated with sulfide. The presence of magmatic carbonate that is intimately associated with Ni-Cu-PGE sulfides throughout the lithosphere, suggests that carbonate melts may play a fundamental role in the genesis and transport of sulfide melts in some Ni-Cu-PGE sulfide deposits. As such, carbonatitic systems as well as mafic-ultramafic systems may be prospective targets for magmatic sulfides.

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Applications of machine learning to mineral exploration

Caté A[1]
[1]SRK Consulting

TS4 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Dr. Antoine Caté is structural geology consultant at SRK Toronto. He has both academia and industry field experience in Australia, Morocco, France, Ireland, Canada, and USA working on gold and base metal deposits. He is also an expert in the applications of data science and machine learning in geosciences, including for prospectivity analysis. Antoine is author or co-author in several peer-reviewed publications and numerous presentations in economic geology, and in applications of machine-learning in geosciences. Antoine current work at SRK includes structural geology field investigation, 3D modelling, and the development of innovative tools applied to mineral exploration.

The use of machine learning for industrial applications has seen a rapid growth in the last 20 years thanks to the increased computation capabilities of modern processors. This field of artificial intelligence is based on algorithms that identify patterns in data, and make predictions based on these patterns. Supervised, unsupervised and reinforcement learning is applied with success in finance, marketing and medicine.
An important effort from both academic and industrial fields is made to integrate geoscientific machine learning in to petroleum, and mining industries. Machine learning is implemented in mineral exploration for two main applications: mineral prospectivity, and interpretation of borehole data. In mineral prospectivity, machine learning is used to integrate multiple layers of 2D or 3D data to estimate the probability of occurrence of undiscovered resources based on information from existing deposits. The training of algorithms on borehole data allows automatic interpretation of lithologies, alteration or fractures in boreholes from complex physical or chemical data collected on drill core.
Examples from both applications illustrate machine learning applied to mineral exploration can be used to solve numerous problems involving large amounts of complex data. The nature of machine learning algorithms allows rapid production of robust predictions on complex datasets. However, its use must be integrated with existing best practices, and it is crucial that both input and output data are monitored and scrutinized by exploration geologists.

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Introducing satellite gravity applications for mineral resources study and exploration.

Motta J[1], de Souza Filho C[1], Carranza E[2]
[1]University Of Campinas, [2]University of KwaZulu-Natal

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
João Motta has a BSc degree in Geology (2011) and a Master degree (2015) by the State University of São Paulo (UNESP, Brazil).
He is currently a PhD candidate at the University of Campinas (Brazil) working on the application of long wavelength satellite-only Earth Gravity Models into the mineral systems research and exploration.
His research focus is the integrative application of geophysical methods for building robust geological models of the lithosphere, specifically the deep crust, to constrain the location of major mineral deposit districts. That was motivated by an early career in the metals exploration industry.

Geophysical prospecting evolved from interests in surveying the Earth for its composition and geometry indirectly. The observation of Earth's gravity field by satellites started in the 1970's through indirect measurements, being followed by the launching of dedicated missions (e.g., CHAMP, GRACE, GOCE). The products yielded from these missions can compose Earth gravity models which allow imaging the Earth's density structure deep into the lithosphere on a global scale.
Current applications of satellite-only gravity models in Earth Sciences are restricted to four subjects: crustal structure and physical behaviour; determining the Moho discontinuity depth; evaluating the mantle structure, stress, and seismicity; and continental water storage and crust rebound. Quantitative inverse approaches have been most applied to derive products from these data, with quantitative direct and qualitative interpretation being secondary.
These approaches can be applied to the minerals research to provide constraints on both fossil and active systems in the following ways: appraise deep, or deeply overlain crust density structure as a vector for determining possible regional scale fluid pathways; evaluate the Moho discontinuity topography as a driver of fluid flux and connections to major conduits; track ongoing mass transport in the crust and mantle; and study the mantle density as a proxy for its chemical state.
An example along the South African subcontinent showcases an application along fossil mineral systems. These data provide insights into the regional scale structure which host those them. Exploration and research programs can benefit from the enhanced understanding of deep crust settings on a global scale.

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Shear strength of materials that cannot be tested in the laboratory due to their large particles size

Linero-Molina S[1,2], Fityus S[1], Simmons J[3], Azema E[4]
[1]University of Newcastle , [2]SRK Consulting Australasia, [3]Sherwood Geotechnical and Research Services, [4]University of Montpellier

TS7 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Civil engineer specialising in soil mechanics with 30 years experience in a broad range of projects, from hydroelectric developments, highways, roads and public transportation systems. Sandra has been responsible for planning and supervision of many geotechnical site investigation programmes and design of soil cuts, dams, shallow and deep foundations for buildings and bridges, and geotechnical instrumentation. Over the last 15 years, she has been working in the mining industry in South America and Australia focused in soil mechanics, coarse material characterisation, design of waste dumps, heap leach dumps facilities, geotechnical studies for plant sites, risk assessment and design for closure.

The limited size of commercial laboratory equipment leads to difficulties in the characterisation of granular material containing large particles. To overcome equipment size limitations, the mechanical properties of coarse materials (like blasted mine waste) are evaluated in the laboratory on samples prepared with reduced maximum particle sizes suiting the size of available laboratory devices. Geometric scaling or scalping of oversized particles are some of the techniques used to build models for testing (scaled samples). The validity of the parameters so determined is questionable.

Changes have been observed in large-scale measured shear strength for coarse granular materials with particles up to 100 mm, because of modifications of its particle size distribution (PSD). Analysis of particle shape suggested a correlation between particle shape and particle size, so modification of the PSD had consequent effects on the particle shapes distribution.

3D DEM modelling suggests that the shear strength changes, occurring when the PSD of materials is altered, are related to the changes in particles shape, introduced when altering the PSD, and it can reveal the phenomena at micromechanical level. The finding can explain the changes observed in measured shear strength because of modification of the PSD, and the curvature of the shear strength envelope of coarse granular material submitted to very high loads if the particle crushing phenomena is observed as a particles shape evolution process.

The investigation highlighted the importance of particle shape quantification and the potential use of DEM to elucidate validity of shear strength evaluated on scaled samples.

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Accurate and precise 'where' determinations: the real challenge of integrating multiple scientific phenomena observed/measured at similar locations.

Wyborn L[1], Cox S[2]
[1]National Computationl Infrastructre, Australian National University, [2]CSIRO Land and Water

TS1 - 4.4.1 The Geoscience of Where, Room R7, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Lesley Wyborn is an Adjunct Fellow at the National Computational Infrastructure and RSES at ANU. She had over 40 years' experience in scientific research and geoscientific data management in GA. Her scientific interests are in Mineral Systems and granite geochemistry, whilst her informatics interests are in generating High Performance Data National scale datasets. She is currently Chair of the Academy of Science 'Data for Science Committee' and is on the American Geophysical Union Data Management Board. She was awarded the Australian Government Public Service Medal in 2014 and the Geological Society of America Career Achievement Award in Geoinformatics in 2015.

The accuracy of GPS measurements is now down to centimeters. Australia is sitting on one of the fastest moving plates on earth, and positions measured in the past are degrading. New technologies and techniques now enable more precise and accurate measurements of 'where' our scientific observations are made, whilst multidisciplinary sensors can record suites of phenomena at the same location. However, integrating these new observations with existing legacy data from similar locations can be difficult. Too many standards, vocabularies and protocols have been developed in isolation within a single discipline, whilst methods of recording 'where' can be so variable between disciplines that it is hard to collectively access, aggregate and process data to create cohesive, calibrated, national datasets that can be used in transdisciplinary analysis.

The Semantic Sensor Network (SSN) ontology - a joint W3C and OGC standard that specifies the semantics of sensors, observation, sampling and actuation allows a modular approach to the specification of scientific information. Crucially, it separates the definition of 'where' and allows delineation of an agreed set of properties that need to be recorded to enable sampling features to be defined consistently in 4D space and allow implementation of dynamic datums across multiple disciplines. The SSN ontology also separates procedures used and the properties measured. New initiatives within the International Science Unions, OGC, Research Data Alliance, etc, are providing frameworks for the development of standards that enable translation of information across discipline boundaries, including 'where'. Combined these initiatives will drive new frontiers in scientific research.

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Engineering characteristics and behaviour of tropical red soils: examples from the Republic of the Congo and Fiji

Brook M[1], Brink G[2]
[1]School of Environment, The University Of Auckland, [2]WSP-Opus

Biography:
Martin Brook is Senior Lecturer in Applied Geology at The University of Auckland, New Zealand, where he teaches and supervises from 1st year to PhD. Prior to this, he worked throughout Australia and the Middle East as a consulting engineering geologist in the civil and mining sectors. His research interests include using emerging technologies (UAV, geophysics) to investigate land instability, and characterising and understanding the engineering behaviour of soil and rock from the sub-polar regions to the tropics.

We present some engineering geological properties of tropical red soils from site investigations in Mayoko in the Republic of the Congo, and Viti Levu, Fiji, and outline implications of the soil behaviour on infrastructure and development. Tropical soils have unique characteristics due to the compositions and micro-structures of material developed under hot, humid, soil-forming conditions. Such soils, also referred to as laterites or lateritic soils, are often extensively used in tropical regions for construction purposes, being ubiquitous, exploitable, and cost-effective. However, the engineering behaviour of these materials in-situ, are often dissimilar to engineering behaviour predicted from laboratory testing regimes. Indeed, conventional engineering classification tests (e.g., to British and ASTM standards) are largely concerned with the determination of the index properties of soils based on temperate climates. However, with tropical red soils, the inherent mineralogical/chemical composition and structure (in the case of residual soils) of the material has a pronounced influence on the measured index and engineering properties. In particular, even partial air-drying at ambient laboratory temperatures may change the structure and physical properties of these soils. Some of these changes cannot be reversed when the soil is re-mixed with water. These structural changes are reflected in sometimes drastic changes in the soil index properties derived from plasticity, shrinkage, particle-size tests and specific gravity. Conventional laboratory testing procedures cannot, therefore, be considered to be necessarily applicable to tropical red soils without some change in focus to adequately account for their unique mineralogical and chemical composition, structure and behaviour.

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Fracture network topology in a fault-damage zone

Hansberry R[1], King R[1], Holford S[2]
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D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Hansberry's work focuses on a broad area of structural geology, investigating how fault and fracture networks develop in basin and orogenic settings, how fluids move through these structures, and novel analytical approaches to characterizing the nature and timing of deformation and fluid flow in the brittle crust.

Arrays of faults and fractures control many of the physical properties of rocks. Robust characterization of these discontinuities is therefore vital for understanding and predicting many aspects of geology.. Fracture networks are often characterized across a variety of scales and dimensions and subject to various terms with sometimes inconsistent definitions, describing fracture frequency, intensity, and complexity. Recently, topological analysis of fault and fracture networks has gained popularity as a method for characterizing these features with more consistency. Topology is a branch of mathematics which deals with abstraction and generalization of spatial relationships such as connectivity and continuity, properties which are unchanged by transformations of the space they exist in (i.e. straining of a rock volume will change orientation and length of fractures, but not the topology of fracture network as a whole). In structural geology topology usually involves determining the number and type of ‘nodes’ and ‘branches’ in a fracture network, and from that calculating several dimensionless parameters such as fracture intensity, branch connectivity, and nodal classification. This allows for comparison of data types of different scales and dimensions, a common area of difficulty in linking well, outcrop, and seismic datasets. We examine the topology of a fracture network in the hanging wall of the Castle Cove Fault in the Otway Basin, a Jurassic-Cretaceous normal fault which was reactivated during late Miocene to Pliocene inversion. Topological analysis allows for a more quantitative and consistent characterization of this fracture network, and also provides new ways to visualize fracture network properties spatially.

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Palaeoshorelines on the Australian continental shelf

Brooke B[1], Nichol S[1]
[1]Geoscience Australia

TS6 - 1.3 Marine geoscience - The evolving oceans, Hall E1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
I have an internationally recognised expertise in marine and coastal geomorphology and geology, which is well reflected by my 60 papers in high quality international coastal and marine science journals. My focus has been on coastal and marine sedimentary systems and the influence of long-term changes in sea-level on the distribution of ancient and modern coastal landforms, seabed morphology and biodiversity. Much of this research has been undertaken as part of large, multidisciplinary coastal and marine research projects and programs that have explicitly addressed scientific information needs of coastal and marine environmental managers and policy developers.

Drowned Holocene and Late Pleistocene reefs and coastal landforms are major seabed structures that occur along large sections of the Australian continental shelf. These features influence long-term sediment transport on the shelf, provide habitat for a range of marine biological communities, and represent potential areas of human occupation during periods of lower sea level. Similar structures occur at a range of locations globally. In Australia, examples have been mapped using high-resolution multibeam echosounder (MBES) systems and occur at a range of depths from ~20m down to ~120m. Structures include shore-parallel ridges that extend along tens to hundreds of kilometres of the inner and middle continental shelf (~20 and 60 m depth, respectively) of southern and central Western Australia; carbonate banks on the northwestern and northern shelves, along the Gulf of Carpentaria and Great Barrier Reef (~40 m depth); low-profile (a few metres) reefs on the middle and outer shelf of New South Wales; and channel structures on the northern shelf. We present elevation models of these features, based on MBES data that indicate they represent remnants of eroded and drowned beach ridges, coastal dune fields, barrier reefs, estuarine channels, shoreline erosional benches and nearshore bedrock reef.

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The forgotten Mesoproterozoic of Northern Australia: A chemostratigraphy and detrital zircon study of the Bullita Group, Birrindudu Basin, Northern Territory.

Subarkah D[1], Collins A[1]
[1]University Of Adelaide

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Darwinaji Subarkah is a 4th year international student from Indonesia. He is undertaking a Bachelor of Science Honours degree at the University of Adelaide, majoring in Geology. His thesis project will look to unravel a largely forgotten Mesoproterozoic basin system in Northern Australia using detrital zircon geochronology and isotope geochemistry analysis.

The Mesoproterozoic Bullita Group consists of eight formations comprised of mainly carbonates and siliciclastic rocks deposited on a shallow marine platform. The group is a part of the Birrindudu Basin, which alongside the Tomkinson Province and the McArthur Basin, makes up the informally-named greater McArthur Basin. This is a regionally extensive Proterozoic 'super basin' system in northern Australia where lithological equivalents and tectonic setting during-and-post deposition are still up for debate.

Here we present a new carbon isotope curve for a core through the Formation that is the first attempt to develop a chemostratigraphic baseline for this time in the McArthur Basin. In addition, we present extensive new detrital zircon U-Pb and Hf data that constrain maximum depositional ages of formations in the Bullita Group and establish intra-basin stratigraphic correlation with other lithologically similar groups throughout the greater McArthur Basin. We also investigate the tectonic setting of the Birrindudu Basin when these grains were deposited as well as determine temporal variation in provenance and their relationship to the overlying Wilton Package sedimentary rocks that host significant hydrocarbon deposits.

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Numerical modelling of multiphase rifts – applications to the Bight Margin?

Farrington R[1], Hill K[1], Cunneen J[2], Beucher R[1], Moresi L[1]
[1]The University Of Melbourne, [2]Curtin University

TS1 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Dr Rebecca Farrington is a member of The University of Melbourne's Underworld Geodynamics research group. Having completed her doctoral studies in computational mathematics, Dr Farrington's research interests are focused on numerical modelling of large-scale geodynamic systems by applying the principles of continuum mechanics to the surface and interior of our planet, attempting to understand the dynamic evolution of Earth.

Many basins, such as the Ceduna Sub-basin in the Great Australian Bight, include two or more rift phases that greatly change rift geometries and subsidence. The Ceduna area is one that has been subject to two(+) phases of rifting that are well constrained. The timing, at least of the later event, is well recorded in the very thick sediments of the Ceduna Delta. This can be tied to the recent good quality seismic data that illustrate the earlier and underlying Jurassic to Early Cretaceous rift. We present results from time dependent forward numerical models of multiple rifting phases, and geometrical restorations of Antarctica to be adjacent to Australian in the Cretaceous, including two rift phases, subsidence through time, and the evolution of the Ceduna Delta, including the outer margin high.

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Determination of Magnetization Direction through a Stable Differential Reduction to the Pole Filter

Ribeiro V[1]
[1]CSIRO

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I am a geophysicist with an interest in applied potential fields methods and geophysical modelling. My interest is in applying these skills to understanding the geology and resource potential of Australia and beyond.
Presently I work for CSIRO in the Deep Earth Imaging Future Science Platform. Previously I have worked at Federal University of Pernambuco (UFPE) in Brazil as associate professor at the geology department (DGEO).

Magnetic data interpretation usually assumes that remanent magnetization is insignificant and the resultant magnetization can be approximated by the local geomagnetic field direction. This assumption can lead to misguided results. Several techniques to estimate the top depth and lateral limits of a compact source are based on the reduction to the pole (RTP) operator, however it still presents several known problems such as numerical instability for low latitudes and provides incorrect results if the source has unknown remanent magnetization. A new formulation based on the traditional RTP frequency domain filter operator is suggested here that incorporates the magnetic inclination complement and the influence of remanent component on the total magnetization. This new operator was then implemented through a differential algorithm in Python that estimates interactively the main total direction of magnetization. The dispersion of directions population was used to calculate the Fisher's circle of 95% confidence ($p=0.05$) about the mean ($\alpha95$). The incorporation of statistical analyses and paleomagnetic techniques was essential to guarantee the results reliability. The algorithm was tested on several synthetic models with different total magnetization directions and one real case. The results obtained shows that the new RTP filter implemented through the proposed code is stable for low latitude and it is totally independent of previous information about the source susceptibility, top depth or its geometry. This code can be an important tool to identify new possible targets for exploration and guide the location of drill holes, avoiding common mistakes involved on the characterization of cover deposits.

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Addressing conceptual uncertainty through a multi-model approach using bold hypotheses

Enemark T[1,2], Peeters L[1], Mallants D[1], Batelaan O[2]
[1]Csiro, [2]Flinders University

TS6 - 3.3.2 New groundwater technologies and approaches, Room R5, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Trine Enemark is a currently a PhD student at Flinders University and CSIRO in Adelaide, Australia. She is interested in taking into account the uncertainty of the understanding of a groundwater system in groundwater model predictions through the multi-model approach to conceptual model development. More specifically, she seeks to characterize and evaluate groundwater systems conceptual uncertainty.

A literature review of 50+ studies in which alternative hydrogeological conceptualisations are considered, shows that generating a suitable range of plausible conceptual models remains challenging. A systematic conceptualisation approach is required to ensure that all aspects of conceptualisation relevant to the study objective are covered.
For the Wildman River area (Northern Territory, Australia) a conceptualisation approach based on bold, mutually exclusive hypotheses of the groundwater system dynamics is applied. Mutually exclusive hypotheses ensure system understanding is significantly improved when falsifying hypotheses with data and models, while generating bold hypotheses widens the range of conceptualisations considered and thus reduces the risk of conceptual surprise and improves the robustness of the groundwater assessments. Conceptual issues are identified and within each aspect bold end-member hypotheses represent highest impact in opposite directions, where reality will likely be somewhere in between. For the Wildman River Area the identified conceptual issues are ranked according to expected impact on prediction of the model objective, which is the regional water balance.
The systematic development of multiple plausible conceptual models for the Wildman River area increases the transparency in the modelling workflow and thereby the confidence in the final model predictions while also anticipating conceptual surprises.

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Late Permian volcanism in the Sydney Basin and New England Orogen: cumulative massive volcanism without mass extinction.

Blevin P[1], Nicoll R[2], Bocking M[3], Crowley J[4]
[1]Geological Survey of New South Wales, [2]Geoscience Australia, [3]Bocking Associates, [4]Boise State University

TS1 - 2.3 Mass Extinctions, Room R1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Bob is currently retired but a visiting palaeontologist with Geoscience Australia

A total of 131 ashfall tuff beds were deposited over a period of 2.54 My in the late Permian Newcastle Coal Measures of the Sydney Basin between 255 and 252 Ma. The ash beds total about 60 m out of a depositional interval of about 250 m. They range from 0.01 m to over 20 to 25 m in compressed depositional thickness, with 10 ash beds being over 10 m thick. The number of ash layers in the Sydney Basin suggests a local or basin-wide volcanic eruption every 17,000 years, and possibly more frequently, as evidence of all eruptions may not have been preserved. The eruptive centres may have been located in the New England Orogen, as the extensive late Permian Wandsworth Volcanics are geochronological correlates of the Sydney Basin tuffs.

Despite the high volcanic eruptive frequency and ash volume, there appears to have been no associated extinction event, unlike the Siberian Traps volcanism, which is thought to have contributed to the extinction of some 90% of marine and 75% of terrestrial fauna and flora globally. No extinction events are evident until 252 Ma, when the Permian–Triassic boundary is marked by the end of coal deposition in the Sydney Basin and the global extinction of the Glossopteris flora. Comparison of the size and nature of the Siberian and New England magmatic outbursts serves to constrain the response and survivability of biological systems exposed to catastrophic environmental events.

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Petrology and geochemistry of primitive lavas from Kibblewhite volcano, southern Kermadec arc

Hirai Y[1,2], Tamura Y[2], Hoernle K[3], Werner R[3], Hauff F[3], Timm C[4], Hanyu T[2], Vaglarov B[2], Miyazaki T[2], Chang Q[2], Kimura J[2]

[1]Kanazawa University, [2]Japan Agency for Marine-Earth Science and Technology (JAMSTEC), [3]GEOMAR Helmholtz Centre for Ocean Research, [4]GNS Science

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Yasuhiro Hirai is currently in Graduate School of Natural Science and Technology, Kanazawa University. Yasuhiro belongs to a laboratory in collaboration with Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokosuka, Japan.

Kibblewhite volcano is a composite submarine volcano erupted on the volcanic front in the southern Kermadec arc. RV SONNE dredged lava samples from the volcano during Vitiaz (SO255) expedition in March–April 2017. The lavas range from basalt to rhyolite (SiO_2 = 49.9–70.9 wt.%) including three types of primitive lavas (here defined as Mg# >55); these are ankaramite, olivine basalt, and clinopyroxene-olivine andesite. Olivine phenocrysts in the primitive lavas are highly forsteritic (Fo = 84–93) each showing distinct fractionation trends in Fo-NiO space. This suggests that these magmas were derived from different source mantle and/or through different melting processes [1]. Trace element composition of the olivine basalt is characterized by high-Nb/Yb and low-Ba/Nb indicating back-arc origin [2]. Conversely, the ankaramite and the clinopyroxene-olivine andesite have Nb/Yb and Ba/Nb similar to other lavas from the southern Kermadec arc front [3]. Their rare earth element patterns, however, differ from each other showing La_N/Yb_N = 2.1 for the former and La_N/Yb_N = 0.9 for the latter (N shows normalization to C1 chondrite [4]). This suggests a different origin for the two magma types. Here, we will discuss the petrogenetic relationships of the three discrete magma types from the single composite cone using newly obtained Sr-Nd-Pb-Hf isotope compositions.

[1] Hirai et al. (2018), EGU general assembly. [2] Todd et al. (2010), G-cubed, 11(4). [3] e.g., Timm et al. (2016), J. Petrol., 57(7). [4] McDonough and Sun (1995), Chem. Geol., 120(3-4).

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Shallow crustal structure of southeast Australia constrained by Rayleigh wave phase velocity and Z/H ratio

Li G[1,2], Wu H[1], Yang Y[1]
[1]Macquarie University, [2]China University of petroleum-Beijing

TS2 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
I am a PhD student from Macquarie University. My study interest is exploring passive seismic datasets to jointly invert the shallow structure of the basins. I developed programs to extract Rayleigh wave ellipticity both from earthquake events and ambient noise correlations. Then the Bayesian Monte Carle non-linear inversion platform is used to combine the passive datasets to image the shallow structure of the earth.

In recent years, it has been demonstrated that the Rayleigh wave ellipticity can be reliably extracted both from earthquake events or noise correlation functions (NCFs) and the joint inversion of Rayleigh wave phase velocity and ellipticity can help constrain shallow crustal structures. In this study, taking advantages of the three components data from WAMBAT array, we extract Rayleigh wave phase velocity at periods of 2~10 s and Rayleigh wave ellipticity at periods of 5~10 s from NCFs. Then, we invert the measured Rayleigh wave phase velocities and elasticities to build a 3D model of the shallow structure of southeast Australia. Our model reveals strong spatial correlation between our velocity features and known geological units. For example, the Sydney Basin, Lachlan Fold Belt, Gawler Craton and Murray Basin are well delineated. Distinct low Vs are imaged at the Central Murray, and Sydney Basins. High velocities are associated with the Gawler Craton and the eastern subprovince of the Lachlan Orogen. Finally, a model of the sedimentary thickness across our study region is obtained from the joint inversion. Based on our model, the unconsolidated sedimentary layer of the Sydney basin is up to 1.5 km, while the unconsolidated sedimentary layer of the Murray Basin is up to ~5 km.

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Iron or sulfur cycling? Characterising the metabolisms of microbial life present during the rise in atmospheric oxygen, c. 2.4 Ga

Barlow E[1,2], Van Kranendonk M[1,2], Jeon H[3], House C[4], Kong C[5]

[1]Australian Centre for Astrobiology, School of Biological, Earth and Environmental Sciences, [2]Australian Research Council Centre of Excellence for Core to Crust Fluid Systems (CCFS), [3]Centre for Microscopy, Characterisation and Analysis, [4]Department of Geosciences, [5]Electron Microscope Unit

Biography:

Erica is a third year PhD student at the Australian Centre for Astrobiology at UNSW, Sydney. She is a field geologist who is interested in the diversity of life in the Precambrian, and how this early life is preserved in the geological record.

For the past 6 years, Erica's research has focused on characterising stromatolites and microfossils in 2.4 byo rocks from the Pilbara in Western Australia. She enjoys piecing together a picture of what early life looked like and the types of environments it inhabited.

The Great Oxidation Event (GOE) is a period of time, c. 2.4 Ga ago, where there was a significant and irreversible increase in atmospheric oxygen. The fossil record from this time period is sparse and well-preserved outcrops are rare. This makes it difficult to determine the impact of the increase in oxygen on the biosphere, and has resulted in a limited understanding of the diversity of microbial forms, the types of environments inhabited, and the specific metabolisms utilised during this time period.

A well-preserved succession of fossiliferous rocks has recently been documented from within a ~15 km long ridge that forms part of the c. 2.45-2.22 Ga Turee Creek Group in Western Australia. This ridge contains several varieties of shallow-water dolomitic stromatolites, as well as numerous microfossil morphologies preserved in deeper-water units of black chert. Both the shallow-water macrofossils and deeper-water microfossils have recently been described in detail, highlighting that life preserved from this time is more diverse than previously thought.

One of the microfossil communities consists of very long, filamentous forms that are preserved in distinctive tangled, cob web-like masses. These particular microfossils have been interpreted by previous authors to represent remnants of either sulfur or iron cycling metabolisms.

We present new data, including in situ C and S isotopes and high resolution FIB-TEM maps of these long filamentous microfossils, to better constrain the likely metabolisms used. This study increases our understanding of what primitive life was like on the early Earth, c. 2.4 billion years ago.

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Triassic Tectonics and Sedimentation on the North West Shelf

Elders C[1]
[1]*Curtin University*

TS2 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Chris Elders is Professor of Petroleum Geology at Curtin University. Having graduated from Oxford University with a BSc and PhD, he spent four years with Shell and 20 years at Royal Holloway (University of London) before moving to Perth where he has enjoyed spending the last 5 years helping to unravel the complex evolution of Australia's continental margins

The Triassic is a surprisingly complex period in the evolution of the northern and western continental margins of Australia. In the Northern Carnarvon and Perth Basins it comprises a relatively uniform sequence of marine shales succeeded by thick fluvio-deltaic sediments that are generally regarded as marking a period of post rift subsidence following significant Permo-Carboniferous extension, and preceding younger Mesozoic extension.

There is however evidence of localised Triassic extensional tectonics and igneous activity in the Northern Carnarvon Basin. By contrast, recently released seismic data from the adjacent Roebuck Basin provides evidence of extensive Triassic volcanism and the subsequent development of enigmatic circular basins. In the onshore Canning Basin, an intra-Triassic unconformity is interpreted as a phase transpressional deformation (the Fitzroy Movement). How far it extends beyond the Canning Basin is questionable, although an equivalent unconformity in the Browse Basin most likely marks the end of a phase of extension.

Recent studies have also suggested that large scale fluvial systems draining across Australia from Antarctica are responsible for the supply of detritus to the thick sequences of the Mungaroo Formation in the Northern Carnarvon Basin. The aim of this paper is to integrate these different observations to provide a more coherent picture of Triassic tectonics on the North West Shelf and to consider the implications for the deposition of important hydrocarbon reservoirs of this age.

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AusRES3D: A predictive resistivity model for the Australian continent

Soeffky P[1], Heinson G[1]
[1]*University Of Adelaide*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

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Modelling and inverting magnetotelluric data in the 3D space requires significant computational resources. In order to reduce the amount of resources required, we have developed the AusREF3D reference model for Australia. The model is designed for long period MT responses and utilises; bathymetry data, sedimentary thickness, depth to the Moho, depth to the Lithosphere-Asthenosphere boundary, velocity of the mantle, oceanic lithosphere resistivity, and global deep resistivity data to derive resistivity information. The AusREF3D model consists of up to 60 layers of increasing thickness and extends from the sediments and upper crust through to the asthenosphere to a depth of 1000 km. Each layer consists of a grid of 481 x 577 10 km2 cells containing resistivity information derived from the data sources. A strong correlation is observed between the responses of the AusREF3D model and the real Australian Lithospheric Array Magnetotelluric Project (AusLAMP) data. We are exploring the use of the reference model as a seed for 3D inversion, and for targeted forward model studies in which subsections of the model are explored.

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Lessons learned from microbial mats and carbonate microbialites important to carbon sequestration in mine environments.

Southam G[1]
[1]The University of Queensland

TS2 - 3.2.3 Petroleum and its co-products & 3.2.5 Geoscience aspects of the storage of energy related waste, Room R2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Professor Southam received his BSc (Honours) and PhD in Microbiology from the University of Guelph. Following his post-doctoral appointment, funded by Western Mining Corp., Australia (1990-1994), Southam accepted a faculty position in the Department of Biology and Centre for Environmental Sciences at Northern Arizona University. In 2001, he joined the Department of Earth Sciences at the University of Western Ontario when he was appointed Canada Research Chair in Geomicrobiology (2001-2011), and Director, Centre for Environment and Sustainability (2010-2012). In 2012, Professor Southam joined the School of Earth Sciences at the University of Queensland as the Vale-UQ Chair of Geomicrobiology.

Carbonate cementation in near surface habitats, e.g., stromatolites, and intertidal low-latitude beachrock sediments, occurs via growth of biofilms that play a key role in stabilising and preserving these materials. While a range of chemical and biological factors are thought to influence carbonation, alkalinity generation by cyanobacteria activity is considered to be the primary driver in these contemporary geological systems. Though no single biogeochemical feature or process is responsible for carbonate precipitation in microbialites, recent work has highlighted the importance of microbialites that are well below the photic zone, in the consolidation / architecture of stromatolites. Cements in natural and synthesized beachrock, and in a Shark Bay stromatolite were characterised using X-ray fluorescence microscopy (XFM) and by using secondary electron and backscattered electron, scanning electron microscopy, suggesting that heterotrophic microbialite activity plays an important role in secondary carbonate precipitation. Locally, dissolution of trapped and bound materials via boring by endolithic bacteria generates high concentrations of soluble calcium and magnesium. In near surface environments, cyanobacteria (photosynthesis) creates alkaline microenvironments, which, when combined with high cation concentrations and inorganic carbon from heterotrophic activity, produces supersaturating conditions. Microbial communities also aid in cement formation through the generation of extracellular polymeric substances, which provide nucleation sites for carbonate mineral precipitation. The challenge now, lies in the application of these natural processes to mine environments, specifically to ultramafic materials, e.g., chrysotile mine waste, that provide magnesium for mineral carbonation reactions.

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Tectonic geography of the Lower Roper Group, McArthur Basin, Northern Australia, using detrital geochronology and shale geochemistry

Cassidy E[1], Blades M[1], Collins A[1], Payne J[2], Farkas J[1], Cox G[1], Gilbert S[3]
[1]Centre for Tectonics, Resources and Exploration (TRaX), Department of Earth Sciences, The University of Adelaide,
[2]University of South Australia, [3]Adelaide Microscopy

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Eilidh Cassidy is an honours student at The University of Adelaide where she is currently undertaking a project that is constraining the age and provenance of the Lower Roper Group which forms the most upper part of the Mesoproterozoic McArthur Basin, Northern Territory, Australia.

The informally termed greater McArthur Basin, covers a wide extent of northern Australia, spanning from Western Australia to Queensland. The basin spans the Mesoproterozoic and preserves within its sedimentology, evidence for the tumultuous tectonic events that surrounded the basin during its formation. The lower Roper Group is a mid-Mesoproterozoic siliciclastic succession that occurs high up in the McArthur Basin succession and consists of alternating formations of mudrocks and cross-bedded and glauconitic sandstones. LA-ICP-MS detrital zircon U-Pb, Lu-Hf and REE data presented here provide new constraints on the maximum depositional age and spatial and temporal provenance changes within the Lower Roper Group. Rb-Sr and REE data from glauconites and shales within the subgroup have been collected using LA-QQQ-ICP-MS and TIMS are presented here to help better constrain the absolute age of deposition of the subgroup as well as to better understand REDOX conditions at the time of deposition. By combining various provenance and dating techniques it is possible to help constrain evolving tectonic boundaries and understand the paleogeography during the deposition of the Lower Roper Group.

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Leveraging seismic acquisition in mining

Schijns H[1], Battig E[1], Madero G[1]
[1]BHP

TS8 - 4.2 Mining geology and geometallurgy, Room R6, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Heather Schijns is a geophysicist with experience exploring in the Americas, Australia and Africa for a range of commodities, including nickel, copper, lead-zinc and coal.
She's a graduate of the University of Alberta, where she completed an MSc and a PhD in geophysics with a focus on rock physics and seismic in hard rock. Heather worked for Aurora Geosciences, TerraNotes and MMG in Canada prior to moving to Australia in 2017 to join BHP as Principal Geoscientist, Seismic Geophysics.
Now based in Perth, Heather works with the BHP exploration and operations teams to deliver value to the company using geophysics.

Seismic methods can allow high resolution imaging of the structural framework of a mineral deposit, and allow improved depth determination and resolution compared to other geophysical methods. Despite the proven imaging and detection capability of seismic, however, seismic methods are infrequently utilized in mining or mineral exploration environments due to the perception that survey costs are too high to be viable. Methods to reduce survey costs therefore have a direct impact on the ability of the minerals industry to leverage the potential of seismic. Reflection seismic costs can be reduced by utilizing improved methods; source costs often drive the overall price of a 3D reflection survey, with source savings possible through the implementation of non-standard acquisition techniques. Where the resolution of 3D reflection seismic is not necessary, or may not be feasible due to logistical or budgetary concerns, but acoustic properties remain of interest, lower cost tomographic techniques can assist with achieving imaging objectives.

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First continuous high-resolution record of climate variability spanning the LGM from the Cooloola Sandmass.

Welsh K[1], Krak D[1], Moss P[1], Gadd P[2], Jacobson G[2], Field E[1], Macalalad J[1], Shulmeister J[1]
[1]University Of Queensland, [2]Australian Nuclear Science and Technology Organisation

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Kevin Welsh is a Lecturer in Sedimentology and Palaeoclimate at the University of Queensland, School of Earth and Environmental Science

Past changes in regional hydrology during periods like the Last Glacial Maximum (LGM) can be useful for predicting future precipitation scenarios, however in many areas there is a lack of reliable continuous records that span this time period, especially in the Australian Subtropics. Whist an increasing number of records of environmental variability that span the LGM can be found on North Stradbroke Island in the Australian Subtropics there are no continuous, high-resolution records from the Great Sandy Region approximately 200km further to the north. Those that exist from perched lake systems contain major hiatus around this time which has lead some to postulate that southward migration of the East Australian Current caused variations in the precipitation regimes of these two regions during the LGM/ deglacial. We present a new multi proxy record from the Cooloola Sandmass, just south of Fraser Island which contains a continuous archive of climatic variability since ~48 cal Kyr BP. Pollen, stable isotopes, humification and XRF data provide a multiproxy assessment of environmental variability that appears to show a positive moisture balance during the LGM and similar environmental variability as is observed in records from North Stradbroke Island including some hints of millennial scale variability. We suggest that on local hydrological sensitivity of perched systems accounts for the apparent disparity between North Stradbroke Island and Fraser Island sites.

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Current state and future modernisation of geoscience data delivery in Queensland

Greenwood M[1], Dhnaram C[1], Stead A[2], Crosswell D[1], Murtagh P[2]
[1]Geological Survey of Queensland, [2]Statewide Operations - DNRME

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Courteney Dhnaram has worked within Minerals group at the Geological Survey of Queensland for over 10 years, focusing on regional to camp scale studies on copper and gold mineralisation within North and North West Queensland.

The Geological Survey of Queensland (GSQ) currently offers geoscience data for delivery through a number of systems including QDEX Reports, QDEX Data, QSpatial and MinesOnlineMaps. The current environment delivers multiple terabytes of data and reports for download and has some cross platform integration, but lacks modern robust search and discovery tools, the ability to accept large data and is increasingly costly to run.

The Geoscience Data Modernisation Program (GDMP) is a 4-year program to transform the way the GSQ collects, manages and provisions data. The goal of the GDMP is to enable data driven exploration, unlocking the full value of geoscience data to increase exploration success. The GDMP is exploring big data approaches for the ingestion, automatic validation, storage, delivery and analytics of geoscience data. Creation of a new pilot cloud hosted environment is currently underway to assess the viability of this approach.

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Tridacna Derived ENSO Records From The Philippines During MIS5e and MIS7 Show Similar ENSO Activity

Welsh K[1], Morgan Z[1]
[1]*University Of Queensland*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Kevin Welsh is a Lecturer in Sedimentology and Palaeoclimate at the University of Queensland, School of Earth and Environmental Science

Modeled predictions for changes to the relative strength and frequency of ENSO under mean warming conditions suggest an increase in the number and strength of ENSO events in the future with major socio-economic implications. There now exist a large number of annually resolved ENSO reconstructions from the current interglacial and a small number of the recent glacial period, however there are almost no seasonally resolved records of ENSO variability during previous interglacials which may provide good analogues for future ENSO scenarios. This is because reliable archives such as corals are not generally well preserved over hundreds of thousands of years, however molluscs with a denser and more robust skeleton may fill this gap where they can be found. Here we present multi decadal Tridacna gigas derived stable isotopic time series from a coral terraces on the islands of Cebu and Bohol in the Philippines that formed during MIS5e and MIS7 respectively. Dating of the coral terraces is based upon geomorphology and U/Th dating of corals. The Tridacna gigas are extremely well preserved and stable isotope time series show clear annual signals. We compare wavelet analysis of these time series and note no significant differences in ENSO between the interglacials. Though these are relatively short records they provide further windows into ENSO activity from this important time period and demonstrate this area may be provide more opportunities to gather these important archives of past ENSO activity.

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Sampling from coiled tubing drilling in mineral exploration

van der Hoek B[1], Giles D[1], Tiddy C[1], Blaine F[2], Mostofi M[3], Soe S[4]
[1]University of South Australia, [2]Imdex Limited, [3]Curtin University, [4]Deep Exploration Technologies Cooperative Research Centre

TS6 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Ben is a research associate in the Future Industries Institute at the University of South Australia. Ben's research has been conducted with the Deep Exploration Technologies CRC.

RoXplorer® is a coiled-tubing (CT) drill rig developed by Deep Exploration Technologies Cooperative Research Centre (DET CRC) for mineral exploration in hard rock environments. Coiled-tubing drilling uses a continuous length of steel drill pipe and downhole fluid-powered tools to drill a hole; returning rock cuttings (instead of core) to the surface in the circulating drilling fluid. Without the physical core sample, it is critical to develop and demonstrate robust sampling techniques for the particulate material to support CT drilling in exploration.

We developed and tested sub-sampling equipment and protocols for sampling material produced from CT drilling. A 3d-printed prototype was deployed for testing at two CT drill holes that twinned diamond core holes in South Australia and Victoria, Australia. Consecutive volumes of drilling fluid with cuttings were collected for geochemical analysis from key intervals across geological boundaries and grain mounts were prepared from the largest cuttings for a visual record and assessment. Duplicate sub-samples were also collected for comparison of geochemistry and particle size distribution analysis.

Geological boundaries identified in the twinned diamond holes are accurately reproduced in the CT cuttings (to within <1 m) as sharp visual and geochemical boundaries. Additionally, duplicate sub-samples have equivalent mass, particle size distribution, and geochemistry. The depth-accuracy of the cuttings and representivity of the sub-sampling approach demonstrates that CT drilling can be a viable exploration method providing geochemical information analogous to diamond-core sampling, coarse material for visual logging, and grain mounts for in-situ mineral analysis such as texture, trace-element deportment, and dating.

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Exploring the potentially early evolution of complex life

Soares G[1], Van Kranendonk M[1]

[1]*Australian Centre for Astrobiology (ACA) and Pangea Research Centre, School of Biological Earth and Environmental Sciences, UNSW*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:

Georgia is a PhD candidate with the Australian Centre for Astrobiology at the University of New South Wales, Australia. Her research interests include astrobiology and evolutionary biology. Her PhD project is focused on the adaptation of life to the Great Oxidation Event, within rocks from the 2.4 Ga Turee Creek Group, Western Australia.

The transition to an oxygenated world had immense and lasting consequences for life. Importantly oxygen acted as a driver for complexity, enabling life, especially in the Neoproterozoic, to become much more diverse. Though the oxygenation of Earth occurred incrementally over billions of years, the first influx of oxygen during the Great Oxidation Event (GOE) had an immediate effect.

This is evidenced in the 2.4-2.3 Ga Turee Creek Group (TCG) in Western Australia, which contains a rare, well-preserved stromatolite-thrombolite reef assemblage deposited in the immediate aftermath of the GOE (Barlow et al., 2016). The reef has a diverse and abundant array of life, from shallow water stromatolites to deep water microbial communities (Barlow et al., 2016; Barlow and Van kranendonk in review). These are more complex than Archean microbial communities and contain life forms that are unique to the reef, including millimetric fossils with complex branching and anchoring structures (Barlow et al., 2016). Phosphatised microbial mat fragments and apatite-rich peloids have been found in the shallow water units, adjacent to these unique branching structures. The presence of microbially mediated phosphorus indicates that oxygen was present in the shallow waters of the reef.

There is a clear interaction in this reef between oxygen and life, life that was unusually complex and unique for the Paleoproterozoic. So, is it possible that in the aftermath of the GOE complex life evolved?

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The late Palaeoproterozoic Glyde package in the greater McArthur Basin, Northern Territory

Munson T[1]
[1]*Northern Territory Geological Survey*

TS8 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Tim Munson has Honours and PhD degrees from the University of Queensland. He has been with the Northern Territory Geological Survey for 18 years, and was previously at the Department of Geology at the Australian National University for 15 years. Tim is a co-author and compiler of the 'Geology and mineral resources of the Northern Territory' (2013) and the 'Petroleum geology of the Northern Territory' (2014). His current research interests include the stratigraphy, sedimentology, geochronology and tectonics of Proterozoic sedimentary basins in northern and central Australia.

The Glyde package in the greater McArthur Basin, as defined by NTGS, comprises the McArthur Group, host to the McArthur River Pb-Zn deposit (southern McArthur Basin), Vizard Group (central McArthur Basin), Balma and Habgood groups (northern McArthur Basin), Limbunyah Group (Birrindudu Basin) and Namerinni Group (Tomkinson Province). The package is exposed on highs and fault-uplifted areas towards the greater McArthur Basin margins. Elsewhere, the package is at depth; there are few to no drill interceptions in these areas, but seismic evidence demonstrates subsurface continuity between exposures. Interpretation of new detrital zircon U–Pb geochronological data have enabled stratigraphic correlations within the package to be refined.
The McArthur and Limbunyah groups are dominated by carbonate and mixed carbonate/fine-grained siliciclastic rocks; coarser-grained siliciclastic rocks are minor. Successions become increasingly siliciclastic to north (Balma/Habgood groups) and south (Namerinni group). Overall upward-coarsening trends are apparent in the Birrindudu and northern McArthur basins.
Palaeoenvironments are dominantly shallow-marine to emergent in all areas of exposure. Stromatolitic carbonate rocks, and supratidal and subaqueous evaporitic sedimentary rocks are abundant in all successions. Deeper-water palaeoenvironments are uncommon and largely confined to structural sub-basins in the Walker and Batten fault zones (McArthur Basin). The nature of the Glyde package is largely unknown in central basinal areas (eg Beetaloo Sub-basin region).
The range of facies is consistent with a large epicontinental, hypersaline, enclosed basin model. There are no modern analogous basins at this scale and complexity, but smaller-scale analogous (in part) modern basins include the Dead Sea, Baja California and Persian Gulf.

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High-resolution hyperspectral imagery from the Canadian Malartic gold deposit, Quebec, Canada: Characterizing mineralogy and mineral chemistry.

Lypaczewski P[1], Rivard B[1], Gaillard N[2], Perrouty S[3], Linnen R[4]
[1]University of Alberta, [2]McGill University, [3]Laurentian University, [4]Western University

TS2 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
PhD candidate at University of Alberta - Hyperspectral imaging applied to economic geology

The Canadian Malartic gold deposit is located in the highly gold endowed Abitibi region of Québec. A large part of the mineralization is hosted within Archean metasedimentary rocks, which are challenging to characterize by conventional core logging. Shortwave infrared (SWIR, 1000-2500 nm) hyperspectral imagery was acquired at high spatial resolution (<1.0 mm/pixel) on several kilometers of drill core, and allowed to map the presence of biotite, chlorite, and white mica. Electron microprobe analysis (EMPA) was used to establish correlations between mineral chemistry and spectral response of white mica and biotite, and the high-resolution spectral imagery allowed the identification of a correlation between mineral chemistry and downhole Au grades. Mineralized intervals are characterized by the presence of texturally complex phengitic white mica (>2206 nm, <1.65 AlVI, 11 O) and Mg-rich biotite (<2249 nm, Mg# > 65). In unaltered samples, white mica-bearing layers show muscovitic compositions (<2202 nm, >1.75 AlVI apfu), which are in sharp contact with white mica free greywacke beds. Biotite/chlorite are of intermediate composition (Mg# 50-60) and show little textural variability. Over 800 point measurements were also collected with a portable spectrometer from outcrops in an 8 x 12 km region surrounding the deposit. These data revealed a multi-km hydrothermal alteration halo in white mica chemistry.
Additional hyperspectral imagery was acquired on drill core using a longwave infrared system (LWIR, 8000-12000 nm). These data allowed the estimation of the relative abundance of quartz, which is well correlated to the degree of silicification obtained from conventional core logging.

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Do We Really Want It? New technology adoption in the mineral exploration

Cleverley J[1]
[1]*Imdex Limited*

TS6 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
James is regarded by many as a bit of a pain, but really just tries so hard to be awsome in his passion to drive change in the way we work

The last 5 years has seen a confluence of economic and technological drivers, including automation, artificial intelligence and a fiscal need to address productivity concerns, that has opened up many opportunities for technology adoption within the minerals industry. Mineral exploration, often perceived as a cost centre or high-risk investment, is facing challenges of increasing technical hurdles in new search frontiers leading to falling discovery rates and lowering of productivity and return on expenditure.

Clearly, a prime business for the integration of new connected technology needed to address the technical and productivity issues. Therefore, a plethora of hackathons, start-ups and buzz words begins.

However, all is not well in the juncture between mineral explorers and technology developers. While we are seeing many new and exciting technology prototypes, ideas and analytical systems, all designed to address the exploration industry challenges, we rarely see whole scale adoption or uptake of these into business practice. Why are we languishing on the wrong side of the chasm? What are the barriers to adoption and integration into current working practice? Are we building the right solutions or do we really want to change?

This talk explores some of the challenges facing research and technology providers, potential customers, and adoption facilitators in crossing the chasm from “wow we need that” to a sustainable business, that delivers value to customer and provider. Highlighting the opportunities for change and the way we might to address these.

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Modern Halimeda Algal Bioherms in the Great Barrier Reef

Nothdurft L[1], McNeil M[1], Webster J[2], Beaman R[3], Erler D[4], Hua Q[5], Ximenes G[1]
[1]School of Earth, Environmental and Biological Sciences, Science and Engineering Faculty, Queensland University of Technology, [2]Geocoastal Research Group, School of Geosciences, University of Sydney, [3]College of Science and Engineering, James Cook University, [4]Centre for Coastal Biogeochemistry, School of Environment, Science and Engineering, [5]Australian Nuclear Science and Technology Organisation

TS6 - 1.3 Marine geoscience - The evolving oceans, Hall E1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Dr Luke Nothdurft is a Senior Lecturer at QUT and has a research focus on the sedimentology, biomineralisation, microstructure and diagenesis in marine carbonates. This includes skeletal and microbially-precipitated minerals, biogeochemical pathways, and geochemical signatures of these systems in both modern and ancient settings. He has expertise in microanalytical techniques including electron microscopy, vibrational spectroscopy and synchrotron science.

The Halimeda algal bioherms are the second largest living structures in the Great Barrier Reef (GBR) Marine Park after coral reefs and are an important inter-reef benthic habitat and carbonate sink. Despite their importance, the bioherms have received very little scientific attention since primary geological and biological work in the 1980s. The modern Halimeda algal bioherms in the northern Great Barrier Reef form extensive (>6,000 km^2) carbonate sediment deposits on the outer continental shelf. The Halimeda bioherm spatial extent and geomorphology was mapped using new high-resolution airborne lidar and multibeam bathymetry datasets. Bathymetry data reveals that Halimeda algal bioherm morphology is far more widespread and complex than previously thought, and suggests that previous sedimentological interpretations surrounding their formation should be reviewed. Complex reticulate and annulate ring-shaped morphologies observed with the new data overturn the long-standing morphological interpretation of the bioherms. Legacy resources including seismic profiles and extant biodiversity data, and vibrocore and sediment grab samples will be analysed to answer a range questions relating to the genesis and significance of the bioherms. Comparable analyses of new bathymetry data in the Swain Reefs region in the southern GBR shows similar morphological complexity of bioherms albeit with a different distribution on the shelf to the northern GBR. These findings raise questions about whether this complex morphology is unique to the modern Halimeda bioherms, or may also apply to interpreting algal bioherm morphology in the geological past.

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A Cryogenian biostratigraphic update: hold the ice.

Allen H[1], Grey K[1], Haines P[1], Edgoose C[2], Normington V[2]
[1]Geological Survey Of Western Australia, [2]Northern Territory Geological Survey

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Heidi Allen is a senior geologist at the Geological Survey of Western Australia where she has been employed for the last decade. Heidi works within the Basins and Energy team where she has worked on projects that include regional mapping and targeted stratigraphic revisions. She has worked as a palaeontologist during the remapping of the West Australian portion of the Amadeus and Murraba Basins.

The Cryogenian Aralka Formation of the Amadeus Basin, deposited during the interglacial period flanked by the Sturt and Elatina glaciations, is a unique interval for the Earth's biosphere. Although originally restricted in known distribution, investigation during recent revisions of Neoproterozoic–Cambrian stratigraphy has resulted in its recognition across much of the basin. The formation is predominantly recessive siltstone but includes minor stromatolitic carbonate. The discovery of new stromatolite occurrences in outcrop and drillcore prompted a systematic revision of Aralka Formation biostratigraphy.

A distinct stromatolite assemblage, characterised by the presence of Tungussia inna and Atilanya fennensis, has been recognised from outcrop and drillhole intersections across the Amadeus Basin. The assemblage also contains other stromatolites not yet systematically described that are similar to Forms in the Cryogenian Umberatana Group of the Adelaide Rift Complex. The Aralka Formation is commonly barren of organic-walled microfossils, but a new species, Vandalosphaeridium sp. nov., has been documented from NTGS stratigraphic drillhole BR05DD01. The species is abundant in a single sample and combined with stromatolite data could prove to be a valuable stratigraphic marker if encountered elsewhere in the basin or beyond.

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Magnetotelluric imaging of intracontinental deformation zones: example of the Musgraves Province in Central Australia

Goleby B[3], Heinson G[2], Thiel S[1,2]
[1]Geological Survey of South Australia, [2]The University of Adelaide, [3]OPM Consulting Pty Ltd

TS2 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Stephan Thiel is the Program Coordinator for Lithospheric Architecture at the Geological Survey of South Australia and an Affiliate Senior Lecturer at the University of Adelaide. He obtained his PhD from the University of Adelaide in 2008 and a Master's degree from the Freiberg University of Mining and Technology.

Central Australia has some of the largest geophysical anomalies in the world, indicating this region has undergone and continues to retain evidence of significant whole of crust, perhaps whole of lithosphere deformation. The Musgrave Province, situated in the southern region of Central Australia, is a region of complexly deformed Mesoproterozoic crystalline basement material. It is situated at the junction of the Southern, Northern and Western Australian cratons and has undergone widespread magmatic and ultra-high temperature metamorphism at the end of the Mesoproterozoic (c. 1220-1150 Ma). More recently, reworking during the 570 Ma - 530 Ma intraplate Petermann Orogeny resulted in changes from weak to strong lithosphere and significant Moho offsets up to 15 km. The respective expressions in the long-wavelength gravity anomalies exemplify the importance of this area for intraplate deformation and lithospheric strength.
We present new AusLAMP Magnetotelluric data that was collected across the Musgraves Province, from Western Australia to South Australia as part of the South Australian component of the Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP SA) project.
This new MT data illuminates the structure of the crust and mantle beneath the Musgraves Province, mapping resistivity structure throughout the continental lithosphere which in turn provides constraints on the tectonic evolution of the Musgraves Province. Initial results show a number of significant lower crustal conductors coinciding with high gravity anomalies. These zones coincide with significant Moho offsets and likely represent the lower crustal response to the recent Palaeozoic deformation during the Petermann Orogeny.

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Eruption frequency, style and composition variations at Kelut volcano, Indonesia, based on 1500 years of tephra records

Goode L[1], Handley H[1], Cronin S[2], Abdurrachman M[3]
[1]Department of Earth and Planetary Sciences, Macquarie University, [2]School of Environment, University of Auckland, [3]Department of Geological Engineering, Bandung Institute of Technology

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Heather Handley is an Australian Research Council Future Fellow and Associate Professor at Macquarie University in Sydney.

Heather's research interests include: (i) the integration of field volcanology and volcano geochemistry, (ii) magma genesis at subduction zones (petrological, mineralogical, geochemical and isotopic perspectives) (iii) timescales of magmatic processes using U-series isotopes and elemental diffusion in volcanic minerals, (iv) behaviour of U-series isotopes during weathering and erosion and the U-series constraints on the formation age of sediments, (v) geochemical investigations into contaminated land and water.

Heather is Co-Founder and President of the Women in Earth and Environmental Sciences Australasia Network (WOMEESA)

Well-constrained, long pyroclastic records of volcanoes are a useful tool when integrated with geochemical studies to understand the time-variability of volcanic systems and reliably forecast eruptive behaviours. This study constrains the variation of volcanic activity at Kelut volcano, Indonesia over the last ~1500 years. A total of 25 eruptive events are recorded from tephra sequences. New radiocarbon dates of charcoal preserved in deposits shows activity from ~AD 560 to 2014. Variations in major elemental analyses of glass shards from each eruptive event indicate that a range of magmatic processes govern the eruptive frequency and style at Kelut volcano. The earliest eruptions (~AD 560 to 1000) have some of the coarsest and thickest lapilli fall deposits from sub-plinian to plinian eruptions, and the most evolved glass compositions (~72 wt.% SiO_2). The apparently high-explosivity of these eruptions corresponds with a low eruptive frequency (~88 years) during this period. These were long-enough to allow magmatic evolution. AD 1000 marked a change in deposit character and thus eruptive style, with more frequent episodes (~24 years), each comprising complex sets of events prodcing PDCs and tephra falls. These eruptions were mainly dome- collapse and -growth episodes, with frequent phreatic/phreatomagmatic explosions, and vulcanian eruptions. Large variations in compositions (~64-71 wt.% SiO_2) from ~AD 1000 to 1826 indicate sudden mafic magma influxes, interrupting magmatic differentiation, by mixing to a varying extent with resident magma in the system. Distinct mafic recharge events appear to have triggered some of the largest eruptions at Kelut, such as 1586.

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AuScope's Earth Composition and Evolution Program: Trends, challenges and opportunities facing geochemistry in Australia

McInnes B[1]
[1]*Curtin University*

TS2 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Brent McInnes is the Director of the John de Laeter Centre, a $33M collaborative research infrastructure facility at Curtin University. He also serves as coordinator for the AuScope Composition and Evolution Program and as an adviser to the New Zealand Institute of Geological and Nuclear Science.

Our knowledge of the composition and evolution of the Australian continent is dependent on geochronology and isotope geoscience data. This submission will review trends, challenges and opportunities facing the geoscience community in terms of geochemical data production, management and preservation. In terms of research infrastructure, there is a growing dependency on the university sector to produce high-value data required by geoscience agencies to fulfill their mandate. Universities however, face challenges in meeting the high operating costs, let alone the replacement cost, of geochemical facilities. Requirements for responding to these trends and challenges will be discussed.

Unprecedented volumes of high-value analytical data are now available due to technological advances in instrumentation. Arguably, geochemical data management infrastructure has not kept pace with productivity and unpublished or improperly archived data files are likely to be lost, damaged, forgotten or made obsolete by continuing technological change. Addressing these challenge using eResearch tools such as persistent identifiers (e.g., International GeoSample Number) and open access data repositories (e.g., National Argon Map project, AuScope Discovery Portal) can serve to support both the research publication process and the preservation of datasets for future generations. Consideration should also be given to infrastructure investments that allow legacy research collections to be made discoverable and re-useable.

Geochemical research infrastructure - be it in the form of facilities, data or samples – is a fundamental backbone of Australian geoscience endeavour. AuScope offers a unique opportunity for Australian geosurveys and research institutions to collaborate in the production of geochemical datasets of national importance.

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New dimensions to biostratigraphy

Kachovich S[1], Aitchison J[1]
[1]*The University of Queensland*

TS3 - 2.1 The origins and development of life & 2.2 Ediacaran and Cambrian Symposium, Room R1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Biostratigrapher - Radiolarian Micropaleontologist

I explore new technologies, including 3-D X-ray micro-computed tomography to understand Early Paleozoic radiolarian phylogenetic and taxonomic relations

Micro-computed tomography (μ-CT) has been adopted in fields as diverse as the mineralogical, biological and anatomical sciences. Although the implementation in palaeontology has been steady, μ-CT has not displaced more traditional imaging methods, despite its often-superior performance. The focus of this presentation is to progress, previously stagnant, research in radiolarian evolution and systematics, whilst overcoming limitations to the μ-CT method.
Spherical radiolarians are hitherto under utilised but a valuable stratigraphic tool. Much of the success of using this group of radiolarians for biostratigraphical purposes depends upon the degree of development of their systematics. The relevance of the internal morphology of a radiolarian skeleton (generally >50 μm) for the foundations of evolutionary studies has been recognised but is not yet fully used in radiolarian taxonomy due to limitations of observations. The main problem is the typical state of preservation with older deposits, where radiolarians lose their transparency rendering transmitted light optics difficult. Exceptional preservation in ancient radiolarians presents a rare opportunity to perform detailed evolutionary investigations with the μ-CT. We present the results of twenty-five radiolarian models from the Middle Ordovician Piccadilly Formation, Western Newfoundland. Moreover, when using the μ-CT in micropaleontology the major restriction is the maximum resolution limit of the machine, where scans are more sensitive to problems that are not normally an issue for general μ-CT scanning. In doing so, we aim to clarify the decisions made for those who wish to use μ-CT by identifying the best approaches to apply this powerful technique.

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Scale reduction in MT shines a light on the Olympic domain, South Australia

Thiel S[1,3], Robertson K[1,3], Jiang W[2]
[1]Geological Survey of South Australia, [2]Geoscience Australia, [3]The University of Adelaide

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Stephan Thiel is the Program Coordinator for Lithospheric Architecture at the Geological Survey of South Australia and an Affiliate Senior Lecturer at the University of Adelaide. He obtained his PhD from the University of Adelaide in 2008 and a Master's degree from the Freiberg University of Mining and Technology.

Recent results of the Australian Lithosphere Architecture Magnetotelluric Project (AusLAMP) across the Gawler Craton have revealed zones of enhanced crustal conductivity along the eastern margin of the craton coinciding with the prospective IOCG belt and connected to a mantle plumbing system. It suggests that the margin of the Eastern Gawler Craton has experienced significant crustal deformation accompanied with a fluid and magmatic overprint. These broad zones are well constrained in the mid crust and deeper through the ~50 km spaced AusLAMP grid.
We present new preliminary results of the Olympic Domain Magnetotellurics survey of over 320 audio-magnetotelluric and broadband (0.00001 s – 2000 s) MT sites with variable site spacing between 1.5 km and 5 km across an area of approximately 100 km x 100 km. The area extends west of Lake Torrens and covers mineral prospects such as Carrapateena, Fremantle Doctor, Red Lake, Maslins, Punt Hill, Emmie Bluff and Mount Gunson. An airborne EM survey is co-located with the work presented here and will form a seamless EM data set across all scales. The shift from long-period (10 – 10,000 s periodicity) AusLAMP MT data, spaced every ~50 km, to the survey here has a reduction in site spacing by almost a factor of ten. It will greatly enhance our understanding of the deformation zones and fluid pathways through the entire crust up to the sedimentary cover of the Olympic Domain.

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Problem based learning: A real-world approach for secondary students to solve complex problems using geoscience knowledge and skills

Nicholls B[1]

[1]*Adelaide Botanic High School*

TS8 - 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Bronte is currently Assistant Principal at the new Adelaide Botanic High School and has been a Senior Leader in government and non-government schools. She has held senior positions with state-wide responsibilities in the South Australian Department of Education and SACE Board. She has taught Year 12 Geology and has been involved in senior secondary curriculum and assessment in the science area since the late 1980s. She is also a Senior Officer of the International Geoscience Organisation. Most recently she has been a writer for the SACE Board developing the Earth and Environmental Science Senior Secondary course from the ACARA curriculum.

Students are regularly confronted with ethical and environmental issues of a global, regional or local nature which require knowledge of the geosciences to solve. Having the skills to engage, explore and evaluate these problems enhances student's capacity for creative, real-world problem solving. Problem Based Learning in the context of this paper is defined as a method of teaching and learning which allows students to engage in learning goals through meaningful contexts. An unfamiliar 'ill-structured' problem is presented to the students by the teacher and the students are required to determine for themselves how they will go about solving the problem. This process occurs through small groups of students working collaboratively and allows sharing their prior knowledge, skills and understandings to identify gaps in their collective understanding as they attempt to offer solutions to the problem. The examples chosen are based around problems requiring significant time in the field where secondary students come to know and understand the problem in greater depth while developing scientific field investigation skills.

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The importance of measuring flows in long-screened or open wells

Poulsen D[1]
[1]*NCGRT, Flinders University*

TS6 - 3.3.2 New groundwater technologies and approaches, Room R5, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
David has a B.Env.Sc majoring in Hydrogeology (1st Class Hons) from Flinders University and he has worked as a hydrogeologist in industry and government since graduating in 2003. He is currently working on a PhD as part of a collaborative study between the NCGRT, Flinders University and mining industry partner Rio Tinto based in the Pilbara region of Western Australia. Groundwater recharge, flow and residence time in this complex geological setting are being examined. The work aims to contribute some broadly relevant science while helping to inform environmental impact assessment and future mine decommissioning in the Pilbara.

Effective groundwater management depends on understanding heterogeneity at a relevant scale both vertically and spatially in an aquifer system. Studies usually rely on data from wells, which are expensive to install, so use of available infrastructure is the economical approach. Despite potential complications, long-screened or open wells can provide valuable data and insight, if used correctly. Quantifying the in-well flow regime is essential. In un-pumped conditions, a flow profile shows the producing and receiving zones of vertical flow, the relative vertical head gradient in the aquifer system, and potential bias in water chemistry samples. A flow profile while pumping can be used to quantify aquifer heterogeneity and the sampled water mixture. This presentation describes a new tracer dilution method to determine the pumped flow regime in a well that can be used instead of, or complementary to, a wireline borehole flowmeter. A steady-state EC tracer dilution profile is established under constant injection and pumping. A 1D solution of the advection-dispersion equation for solute transport is fitted to the data by visually identifying producing zones and assigning a fraction of yield to each zone. This test is distinct from transient “moving front” tracer dilution methods because there is no concern about the rate of fluid column wash-out, the analysis is independent of time and the effect of dispersion is minimised. Like the borehole flowmeter, the method is particularly suited to high yield long-screened wells, where other methods such as packers or liners are not effective.

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Earth's Adolescence: Isotopically tracking the global transition from the Hadean to the Modern Earth

Bennett V[1], Nutman A[2]
[1]Research School of Earth Sciences, The Australian National University, [2]GeoQuest Research Centre, School of Earth and Environmental Sciences, University of Wollongong

TS3 - 1.1.4 Crustal evolution of Archean Cratons, Hall A, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Vickie C. Bennett is a Professor at the Research School of Earth Sciences, Australian National University and the Head of the SPIDE2R Isotope Geochemistry Facility. Her research applies a range of isotopic approaches to understanding the origin and evolution of Earth's continental crust and mantle reservoirs, early planetary differentiation, and geosphere–biosphere interactions in deep time. She is a Geochemical Society Fellow, Geological Society of America Fellow and currently Vice-President of the Geochemical Society.

Chemical evolution of the crust and mantle has been connected through plate tectonic processes for at least the last 2 billion years. Questions remain, however, as to when plate tectonics became the predominant geodynamic framework for the Earth and what came before. Essential clues are provided by investigation of the large-scale patterns of radiogenic isotopic variations recorded through the geologic record to the oldest, ~ 4.0 Ga rocks, as these are linked to changes in mantle dynamics. For example, most Phanerozoic and Proterozoic crustal rocks demonstrate highly correlated εHf-εNd isotopic evolution reflecting specific source characteristics and continental crust formation. In contrast >3.6 Ga rocks have distinctly decoupled, εNd and εHf isotopic patterns, with for example, the majority of juvenile Eoarchean rocks worldwide now being shown to have near chondritic initial εHf isotopic compositions, but variable initial εNd. Many >3.6 Ga rocks also possess signatures of now extinct nuclides in the form of ^{142}Nd and ^{182}W isotopic anomalies. These signatures are largely absent in modern terrestrial rocks and are evidence of chemical fractionation processes occurring within the first 10-300 million years of solar system history.
We interpret the large-scale temporal changes in the patterns of radiogenic isotopic signatures as reflecting initiation of some form of plate tectonics prior to 3.6 Ga. Within the period from 3.6 Ga to 3.0 Ga there was a global transition from early differentiation signatures, likely associated with planetary accretion, to more modern tectonic regimes.

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Relative timing of deformation across a dome-keel transect in the East Pilbara by in-situ Rb-Sr LA-ICPMS dating of mica

Murphy D[1], Wenham L[1], Allen C[1], Wiemer D[2]
[1]Queensland University Of Technology, [2]University of Western Australia

Biography:
David Murphy
Lecturer in Geology
Queensland University of Technology

The nature and timing of the formation of classic dome-and-keel architectures in Archean cratons is of critical importance for understanding how Earth's early continental crust formed, stabilised and subsequently evolved. Greenstone keels display relatively low metamorphic grade, whereas the adjacent margins of granitic dome-complexes are often dominated by higher grade gneisses and migmatites. Structural observations indicate a common deformation history for both dome and keel components linked to episodes of partial convective overturn[1].

In the studied East Pilbara, it has been proposed that three major deformation cycles occurred between ca. 3460-3200 Ma[1]. This model may be biased as it is based on using regional geochronological data of U-Pb zircon emplacement ages of granitic dome rocks to infer the timing of successive deformation events[1].

Here, we attempt to detect and test the timing of deformation events within a single dome-keel transect by employing in-situ Rb-Sr dating of mica following the new NO_2 reaction cell LA-ICP-MS method[2]. We will investigate biotite in previously dated granitic gneisses from the Muccan Granitic Complex[1] and muscovite in schists from the adjacent Doolena Gap greenstone belt.

Our data will provide useful insights for dating deformation Paleoarchean mid- to upper crustal rocks and associated formation of dome-keel crustal architecture.

1. Wiemer, D., Schrank, C.E., Murphy, D.T., Wenham, L. & Allen, C.M. Nature Geoscience 11, 357-361 (2018)

2. Hogmalm, K.J., Zack, T., Karlsson, A.K.O., Sjoqvist, A.S.L. & Garbe-Schönberg, D. Journal of Analytical Atomic Spectrometry 32, 305-313 (2017)

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Constraining the timing and conditions of fluid-catalysed metamorphism and melting: insights into intraplate dynamics

Varga J[1], Raimondo T[1], Kelsey D[2], Morrissey L[1], Hand M[2]
[1]School of Natural and Built Environments, University of South Australia, [2]School of Physical Sciences, University of Adelaide

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
The research I do integrates metamorphic geology, geochronology, tectonics, structural geology and fluid- and melt-rock interaction to investigate the thermochemical and mechanical processes that consequently shape the architecture of Earth's crust below us—a story that is directly written into stone. My PhD investigates the fluid-rock interaction and thermochemical evolution of the eastern Alice Springs Orogen, central Australia. Additionally, my work involves experimental petrology in collaboration with Macquarie University to assess: (1) monazite solubility and reaction in the presence of granitic melt; (2) dry versus hydrous gabbro melt reaction; and (3) granodioritic gneiss equilibrium experimentation.

The Entia Gneiss Complex (EGC) is located in the eastern Alice Springs Orogen (ASO), central Australia, and represents a deeply exposed core complex containing the highest grade metamorphic assemblages identified along strike of the ASO. It is characterised by an anhydrous granulite-facies Palaeoproterozoic protolith. Outcrops are dominated by orthogneiss, but rare metapelites located at lower and higher structural levels inform the metamorphic conditions during intraplate Paleozoic reworking (680 ˚C and ~9.0 kbar in the EGC core and 650–680 ˚C and ~7.0 kbar at its margins). Ingress of fluid of enigmatic origin during the interval c. 380–300 Ma catalysed retrogression of the granulite basement to kyanite-bearing amphibolite facies assemblages, marking a shift in rheology and strain partitioning. Subsequently, voluminous pegmatite intrusions occurred during the interval c. 340–300 Ma along the southern EGC margin. The contrasting structural complexity of superimposed pegmatite bodies reveals three main categories: (1) layer parallel; (2) boudinaged south-west into the pervasive fabric; and (3) cross-cutting, demonstrating that a pre-existing fabric was exploited and punctuated by pegmatite emplacement in a sustained high-temperature environment. In this study, the integration of petrographic observations, phase equilibria forward modelling, and monazite and xenotime U–Pb geochronology and trace elements is used to constrain the timing and thermal evolution of the EGC. This represents the first modern metamorphic framework for high-grade intraplate basement reactivation in the eastern ASO.

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The filling and spilling of Lake George, New South Wales

Pillans B[1], Clark D[2], Papp É[1]
[1]Australian National University, [2]Geoscience Australia

TS6 - 5.2 Prediction, process, place: Geomorphology, Room R8, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Brad Pillans is a research professor at ANU and Lead CI on ARC Linkage Project, LP1400911, 'From ancient to modern environments in southeastern Australia: evidence from the unique natural archives of Lake George". His research interests include regolith geology, geochronology, Quaternary stratigraphy, landscape evolution and paleoenvironmental reconstruction.

Lake George, or Weereewa, in the Southern Highlands of NSW, is an internally draining basin with no surface outlet. The lake is impounded on its western side by the Lake George Fault. A combination of magnetostratigraphy, biostratigraphy and cosmogenic nuclide burial dating indicates an age of ~4 million years (mid-Pliocene) for the base of the up to 165 m thick sedimentary sequence underlying the lake floor. Dated gravels in the base of drill holes on the downthrown side of the fault are approximately 250 m lower than correlative quartz-rich fluvial gravels on the upthrown (western) side of the fault.
Over the last 200 years, water level fluctuations of approximately 7 - 8 m have occurred, largely controlled by the balance between rainfall and evaporation. At times, including in 2018, the lake has been completely dry.
Using a Digital Elevation Model of the Lake George Basin, derived from LiDAR data, we have identified shoreline deposits up to 35 m above the present lake floor, consistent with the presence of a lake much deeper than in historic times. At a depth of ~35 m, the lake may have overflowed. Potential spill points include Geary's Gap to the west into the headwaters of the Murrumbidgee River, and Dry Lagoon to the north into the Lachlan River catchment.

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NVCL Analytics

Warren P[1]
[1]CSIRO

TS1 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Peter is an experienced software engineer working in the Minerals Business unit of the CSIRO. He is responsible for designing, developing and directing the implementation of spatial data publication systems and analytical tools. He has been working in the AuScope Grid and NVCL teams to apply his skills to a range of geoscience data from airborne and satellite data to borehole magnetics and spectroscopy.

The National Virtual Core Library project uses AuScope Grid's Spatial Information Services Stack to capture and publish spectrally sampled drill core data and associated mineral characterisation products. With all 7 State and territory geological Surveys utilizing this infrastructure the volume of data available is rapidly increasing and it has become necessary to assist researchers to target their efforts. The NVCL Analytics endeavours to solve this problem by providing 2 new components, a complex filtering component and an analytical processing engine. The complex filtering component allows users to make complex content based filters to delve deeply into the millions of data points to find the boreholes that warrant further examination. And the analytical processing engine allows users execute their own algorithms or use an existing one from our library to generate new data products across the entire NVCL collection.   The NVCL Analytics is available to all users via the AuScope's data Access portal (http://portal.auscope.org). In this presentation I will demonstrate a mineral content filter and show how researchers can generate their own. I will also execute a commonly used spectral interpretation algorithm and display the results.

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Eruptive mechanisms at monogenetic volcanoes: Wiri Mountain, Auckland Volcanic Field, New Zealand

Foote A[1], Handley H[1], Nemeth K[2], Lindsay J[3]
[1]Department of Earth and Planetary Sciences, Macquarie University, [2]Institute of Agriculture and Environment, Massey University, [3]School of Environment, Auckland University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
April Foote is a PhD candidate in the School of Earth and Planetary Sciences at Macquarie University, member of the Volcanic and Magmatic Research Group, and secretary of WOMEESA.

The Auckland Volcanic Field (AVF) of New Zealand is a Quaternary monogenetic basaltic field that has produced 53 eruptive centres over c. 200 ka (eg. Hopkins, et al., 2017). The city of Auckland is the largest in New Zealand with a current population of 1.5 million people, many living within close proximity of past eruptive centres.
Wiri Mountain is one of the southernmost volcanic centres in the AVF and is estimated to be 32-34 ka old (Lindsay, et al., 2011). Quarrying activities since the late 1950's have removed most of the volcanic deposits and features of Wiri Mountain, with the exception of a well-preserved lava tunnel that has been protected as a scientific reserve. There has been little prior study of the volcanic stratigraphy, magma ascent and eruption dynamics of Wiri Mountain.
A spectacular 200 m-long outcrop has been exposed by quarrying, and features a section through an initial basal tuff ring and a nested tuff ring. These host surge dominated, alternating ash and lithic rich beds rich in accretionary lapilli. These gradually grade upwards to more juvenile rich deposits that represent a change from phreatomagmatic activity to explosive magmatic activity along a fissure within the crater, producing a scoria cone. These were later covered, along with the underlying tuff ring, by alternating lava spatter and lava flows.
The deposits exposed at Wiri reveal a very complex volcanic history that will contribute greatly to the understanding of fine scale volcanic and plumbing system evolution of small volume monogenetic basaltic systems.

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Multiple sulfur isotopes as indelible tracers of ore-forming processes in magmatic and hydrothermal mineral systems

Caruso S[1], Fiorentini M[1], LaFlamme C[1]
[1]*University Of Western Australia*

TS8 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Stefano Caruso obtained both bachelor and master degrees in geology at the University of Milan. He started a Ph.D. in 2015 at the Centre for Exploration and Targeting
of the University of Western Australia. His research aims to
improve the understanding of multiple sulfur isotopes addressing the mechanisms underlying the development of
isotopic anomalies and their preservation in the Archaean.
In particular his research focuses on evaluating the effects
of geological processes on the sulfur isotope signature of sufide bearing ore deposits.

In the past decade, the investigation of multiple sulfur isotopes applied to mineral systems has been radically revolutionized through the discovery that isotopic anomalies due to mass-independent fractionation (MIF) of sulfur are chemically conservative and nearly indelible. Thus, they represent excellent tracers of geological and ore forming processes. Consequently, MIF signatures have been utilized to fingerprint the sources of sulfur and metals in a large variety of mineral systems. For instance, largely positive Δ33S anomalies in Archean orogenic gold mineralization testify the relevant input of sedimentary-derived sulfur to the gold-bearing fluids. Whereas variable Δ33S signatures in komatiite-hosted deposits define a genetic framework that associate negative Δ33S signature with the assimilation of exhalative material proximal to vents, positive Δ33S signatures are thought to be associated with more distal systems, where thermos-mechanical erosion of distal sulfidic shales is the prevalent ore forming process.
Through a series of new studies, we demonstrate that further insights can be revealed by combining MIF signatures with the more traditional δ34S signatures as well as detailed microchemical analysis. In komatiite-hosted deposits, the isotopic effects originated from crustal assimilation can be resolved from those derived from either magmatic devolatilization of sulfur, or imparted by multiple hydrothermal events. In orogenic gold systems, the specific δ34S signatures and sulfide trace element compositions can uniquely fingerprint the deposition mechanisms. We suggest that through this integrated approach, multiple sulfur isotope analyses provide more reliable and robust insights to improve the current understanding of ore-forming processes.

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Emerging groundwater quality concerns in the Australian context

Wallis I[1]
[1]*Flinders University*

TS1 - 3.3.1 Groundwater challenges and opportunities & 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Ilka Wallis is a hydrogeologist with areas of expertise in quantitative hydrogeology and geochemistry. Ilka focuses on the development of reactive geochemical transport models which integrate fundamental processes that are normally studied in isolation (hydrogeological, mineralogical, geochemical and biochemical).
In the past, Ilka worked at the Geological Surveys of South Africa, Great Britain and Germany and at Aquaterra Simulations Pty, Australia and has lectured at Rhodes and Pretoria University, South Africa and Bremen University, Germany. Since 2016, Ilka is a Lecturer in Hydrogeology and Hydrochemistry at Flinders University.

The deterioration of groundwater quality has become a global issue of concern as human populations grow, and agricultural and industrial use of water expands. In Australia, groundwater is a vital resource, particularly in arid areas where access to surface water is limited. Western Australia, South Australia and the Northern Territory rely particularly heavily on groundwater and usage has increased substantially over the past 30 years as a result of increased development and surface water shortages. Australia-wide 30% of total water consumption is now provided by groundwater (NWC 2008). As population growth increases demand and climate variability continues to impact the availability of water supplies in Australia, water quality has become a major focus in a bid to safeguard Australias' available groundwater resources (Australian Government, 2013). This work highlights the emerging key groundwater quality concerns in the Australian context.

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Morphology and preservation modes of an enigmatic macrofossil from the Emu Bay Shale Konservat-Lagerstätte on Kangaroo Island.

Schroeder N[1], Paterson J[1], Brock G[2]
[1]University Of New England, [2]Macquarie University

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I got hooked on palaeontology through volunteering at Dinosaur Cove in the mid-1980s, and have worked in the fossil scene ever since, in Victoria and South Australia, and in Canada. I'm now Collection Manager at Geoscience Australia in Canberra, where I look after their fossil and mineral collections. In 2007 I began working with the team excavating Buck Quarry in the Emu Bay Shale on Kangaroo Island, where I became captivated by the early Cambrian. I am now studying for my PhD on the subject, through the University of New England

Ongoing excavation of the Cambrian Series 2, Stage 4 Emu Bay Shale (EBS) has revealed a diverse biota, with many taxonomic similarities with faunas of other Cambrian Konservat-Lagerstätten, especially those from South China. One relatively common organism found, referred to as 'petalloid' for its superficially flower-like form, appears to be unique to the EBS. Its form and taxonomic affinities are perplexing, even by Cambrian standards.
Articulated petalloids consist of radially-arranged rigid, hollow, petal-shaped bracts, whose proximal ends converge at the centre. They range in size from about 15 to 55 mm in diameter, and can have up to about 50 bracts, though isolated 'petals' are also often found.
As is the case with the majority of EBS non-biomineralised fossils, most petalloids are preserved as part and counterpart moulds, though are often replicated by iron oxide, suggesting pyritization as the most typical mode of preservation. However, the EBS is also known for the remarkable preservation of labile tissues such as gut structures and muscle, via phosphatization, as well as extracellular structures such as the visual surface of arthropod eyes, via pyritization or phosphatization. Both these disparate modes of preservation are found in petalloids, where early diagenetic mineralization has replicated the internal surfaces of the bracts in exceptional detail.
Here we present new data on the morphology, original histology, preservational pathways and possible affinities of this enigmatic organism.

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A quantitative estimation of mid-late Holocene precipitation rates in the Sydney region, Australia

Lound S[1], Birch G
[1]The University Of Sydney

Biography:
Stephen is a PhD candidate at the university of Sydney. The primary focus of his work is on sedimentation in the Sydney estuary, including erosion, sediment transport, mapping, sediment modelling, contamination, and climate modelling.

This study presents an estimation of mid-late Holocene precipitation in the Sydney region by comparing local modern rainfall records with those at Lake George, a lake in the Southern Tablelands region of New South Wales. The Lake George study successfully analysed sediments and geomorphology of the lake to recognise former shorelines and the endorheic nature of this lake allowed these shorelines to be used to calculate precipitation rates. Radiocarbon dating was applied to sediments from these abandoned shorelines to calculate the periods that the lake reached various water levels from 7.5ka to the present day. These two, independent quantitative datasets were merged and used as a basis for the current study. To account for regional differences, modern rainfall records over a 102-year period from Sydney and Lake George were compared and a model was created for calculating precipitation rates in the Sydney region based on those found at Lake George. This formula was then applied to Holocene precipitation rates from the Lake to estimate precipitation in the Sydney region for the mid-late Holocene period. Currently, no estimates of Holocene precipitation exist for this region, hence these new data provide valuable information for studies of past and future climate change in the Sydney region. This period also coincides with the critical time of the sea level recovery to its present position in the southeast coast of Australia and highlights the usefulness of the new dataset in fluvial loading and sedimentation research.

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Geoscience workflows towards discovery in South Australia

Reid A[1], Hill S[1]
[1]Geological Survey of South Australia

Biography:
Anthony is a geoscientist with the Geological Survey of South Australia. His primary goal at present is to facilitate the geoscience team within the Geological Survey to achieve high quality applied geoscience that covers the spectrum of geological and geophysical techniques, in order to benefit South Australians.

Recent major geoscientific endeavours in South Australia have largely been focused towards two regional drilling programs. These programs recovered subsurface drill core sample that enabled characterisation of both sedimentary cover and crystalline basement in the southern Gawler Ranges and Coompana regions. In addition, both programs supported application of new technologies such as trials of the Coiled Tubing Rig of the Deep Exploration Technologies Cooperative Research Centre.

However, regional drilling programs are but one point in the overall geoscientific workflow, rather than an end in themselves. Drilling programs, such as will be undertaken as part of the newly initiated MinEx CRC, require significant investment in pre- and post-drill geoscience in order to maximise the outcomes.

A data acquisition workflow involves a whole of lithosphere approach within which the mapping of mineral systems is the primary aim. As such it is critical to undertake a process that includes:
- investigating lithospheric architecture via magnetotelluric, seismic and potential field data integrated with isotopic data;
- characterising cover through mapping regolith, neotectonics, bio- geochemistry and groundwater chemistry;
- understanding basement tectonic evolution via mapping, drill core logging and associated geochemistry, metamorphic analysis, geochronology etc;
- mapping the footprints of mineral systems via regional geochemical and mineralogical characterisation.

By undertaking such a geoscientific workflow, including undertaking strategic drilling campaigns, we can address the major themes of the UNCOVER initiative and thereby facilitate mineral exploration and discovery.

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What is a global sigmoid?

Asadiyan Falahiyeh M[1]
[1]Payame Noor Univercity

Biography:
Born in 1953 in Abadan/Iran. Bs in geology and Doctora in tectonic from Shiraz University, Ms in geophysic from Tehran University. Has a new concept in global tectonic named Spiral Tectonic.

Global sigmoid (GS) in the Earth like hysteresis curve in the ferromagnetic materials originates from a point (Mecca) and grow with increasing of rolling/spreading-field (Dahw/Tahw-field). d and t are components of geodynamics, the directions of these components like electromagnetic components are perpendicular. Vortex of sigmoid represents Earth-dahwing and its extending represent Earth-thawing; its shape represents the reologic property of the Earth's Crust. This research's aim is to find a missing link between micro-tectonic and macro-tectonic.
GS is a big null which created between two inverse rotation's nods: Aleutian and Scotia. Inverse rotation applied to the Earth due to the difference of rotation between North Pole and South Pole. Progressive rotation/folding of the trails (Head and tail of GS) are approximated by two wings: A and B, which are rolled toward the central bar (Mecca). A-wing (convex shore) bounds divergent gps-velocity vectors (source) and B-wing (concave shore) bounds convergent gps-velocity vectors (sink). The highest divergent velocity starts from Nazca (inflection line of GS) and ends (converges) toward the Mariana Trench. This point denotes; tectonic controls by gravity.
What is named boudinage in classic texts actually is train of spirals connected to each other like climate cyclones; in other word boudin-structures are formed by spiral dynamics not simply as extending dynamics. Global sigmoid (Order-0) like O originates from Aleutian and return back to Aleutian (single pole), global sigmoid (Order-1) like S originate from Aleutian and ended in Scotia (dual pole). Sigmoidal structures are traces of cycloidal paths of material in the Earth.

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The Cambrian island arc basement of the Macquarie Arc, SE Australia

Meffre S[1], Belousova E[2], Zhukova I[1], Leslie C[1], Wells T[1], Garcia-Cuison A[3]
[1]University Of Tasmania, [2]Macquarie University, [3]Emmerson Resources

TS4 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
After graduating with a PhD from the University of Sydney, Sebastien began working at the University of Tasmania, looking at tectonic reconstruction of the south-western Pacific, Tasmania and eastern Australia, with a focus on developing better techniques to constrain ancient plate movements. This focus was then broadened to include exploration of the link between ore deposits and plate tectonic movements in south-east Asia as well as south-east Australia.
Over the past five years this work has been increasingly focused on gaining an understanding of how and when ore deposits form and where particular elements reside within the ore.

The Macquarie Arc in NSW represents an intra-oceanic island arc that was active between the Early Ordovician and the Early Silurian. The oldest rocks in the Macquarie Arc are the Early Ordovician volaniclastic rocks of the Mitchell Formation and the Nelungaloo Volcanics (approx. 489-483 Ma). The arc is thought to have been deposited on oceanic crust based on geochemical constraints, Nd, Hf and Pb isotopes, however, the exact nature of the basement has not been documented to date.
New U-Pb zircon dating on Cambrian intrusive rocks (498±5 Ma) from a drill hole near Barmedman (between Temora and West Wyalong) show that subduction-related magmatic rocks occur in this area. The Hf isotopes from the zircons in these rocks indicate that they are sourced from a relatively juvenile mantle typical of intra-oceanic island arc systems. The zircons have inherited cores that crystallised from 520-570 Ma with similar Hf isotopic characteristics. Inherited cores in zircons in Early Ordovician intrusive rocks from the Wellington area and Ordovician intrusive rocks from the Lake Cowal area with similar age and Hf isotopic character were also analysed. These analyses indicated that Cambrian island arc rocks underlie a significant portion of the Macquarie Arc. No zircons older than 570 Ma were recovered, confirming the lack of continental crust beneath the Macquarie Arc in the Ordovician and indicating that the arc probably originated by reversal of a Cambrian arc system.

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Geochemistry and provenance of the Turquoise Bluff Slate, NE Tasmania: tectonic significance

Berry R[1], Goemann K[1], Thompson J[1], **Meffre S[1]**, Bottrill R[2]
[1]University Of Tasmania, [2]Mineral Resource Tasmania

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
After graduating with a PhD from the University of Sydney, Sebastien began working at the University of Tasmania, looking at tectonic reconstruction of the south-western Pacific, Tasmania and eastern Australia, with a focus on developing better techniques to constrain ancient plate movements. This focus was then broadened to include exploration of the link between ore deposits and plate tectonic movements in south-east Asia as well as south-east Australia.
Over the past five years this work has been increasingly focused on gaining an understanding of how and when ore deposits form and where particular elements reside within the ore.

The Ordovician Turquoise Bluff Slate in northeast Tasmania represents a critical part of the Lachlan Orogen. It is a two km thick section dominated by sedimentary rocks with bimodal grain size distributions typical of turbidite TE1, 2 facies. The slates have high SiO2, high Ba and high V characteristic of hemipelagic deep water deposits, which, combined with the thickness suggests they formed from muddy turbidites, possibly reworked by debris flows from a muddy continental shelf. Chemical U-Th-Pb dating of small xenotime pressure shadows supports previous evidence that the dominant cleavage in this unit formed during the Benambran Orogeny. The high Cr content from the slates and other Mathinna Supergroup rocks indicates the Eastern Tasmania Terrane was closer to Western Tasmania in the Palaeozoic than other similar age rocks in south eastern Australia. However, the age spectra of detrital zircons provides evidence for a Gondwana zircon provenance similar to most other early Paleozoic sedimentary rocks across the region.

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Important Concerns on Proved Reserves Evaluation in Different Development Stage under SEC

Yi Y[1], yang h, yuan r, fa g, wang z, shao x
[1]*Petrochina research institute of petroleum exploration & development*

Biography:
Yanjing Yi, Senior Reservoir Engineer. Graduate from China Petroleum University in Year 2006. And work in Petrochina Institute of Petroleum Exploration & Development for more than 10 years. My studies focus on the reserves evaluation and management under SEC or PRMS for overseas assets of Petrochina.

The petroleum reserves estimation of companies listed in American stock market must follow the SEC rules. However, there are no specified guidelines leading the reserves evaluation besides the published general regulations. This paper concludes the procedures and key concerns for reserves evaluation in different development stages which are summarized from many studied cases. In the early development stage, the general evaluation method covers volumetric and analogy methods, and the key concerns including the well test data, initial well productivity, recoverable volumes assessment, five-year development workload and investment, reservoir connectivity etc. In the plateau development stage, the general evaluation method contains performance trend analysis and analogy method, and the key concerns including the evaluation unit classification, historical performance identification, five-year development workload and investment, reservoir connectivity, operating cost split, etc. In the late development stage, the general evaluation method includes performance trend analysis and analogy method, and the key concerns including the evaluation unit classification, historical performance identification, five-year development workload, operating cost split, etc. This paper also presents the key concerns and estimating methodology for different reserves classification such as PDP, PDNP and PUD.

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Cryptic crustal structures as key district-scale metallogenic controls – examples from orogenic gold provinces in eastern Australia

Lisitsin V[1]

[1]*Geological Survey Of Queensland*

TS4 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Vladimir Lisitsin holds a PhD in Geology from UWA. He is an economic geologist in the Geological Survey of Queensland, with broad research interests in the mineral system analysis and prospectivity modelling applied to exploration targeting

Effective predictive exploration targeting at a scale of tens of kilometres remains one of the major challenges in the exploration geoscience. The nature of some metallogenic controls operating at that scale has been widely recognised (cratonic margins, crustal to lithospheric-scale faults, regional intrusive domes and anticlinoria). However, some distinct richly endowed metallogenic zones and belts lack clear spatial associations with any obvious regional structures (such as faults), suggesting more cryptic linear metallogenic controls.

Such controls operated in the Victorian and Hodgkinson orogenic gold provinces in eastern Australia. Gold endowment in both provinces is strongly concentrated in linear zones oblique to the regional structures – but closely corresponding to inferred positions of deep crustal domain boundaries (the Selwyn Block in Victoria and the Etheridge Province – extending under the Hodgkinson Province). Their positions have only subtle expressions in the surface geology by changes in metamorphic grades and timing and geochemistry of magmatism.

Similar cryptic metallogenic controls by deep crustal to lithospheric domain boundaries (and other major inherited basement structures), are increasingly recognised for diverse mineral systems. Their effects are likely to be due to regional zones of structural weakness propagating through overlying younger geological complexes during subsequent tectonic events – potentially acting as steep linear zones of anomalous focussed flux of mineralising fluids. Identification of such controls requires a careful analysis of several complementary regional datasets (crustal seismic, geophysics, geochemistry, basin stratigraphy, regional deposit patterns) and still remains a major challenge.

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Processes controlling natural organic matter in groundwater

Andersen M[1,2], Rutlidge H[1,2], Oudone P[1,3], McDonough L[1,3], Huang H[1,2], Nawzad S[1,3], Brügger C[1,2], Mustonen O[4], Marjo C[4], Meredith K[5], O'Carroll D[1,2], Baker A[1,3]

[1]Connected Waters Initiative Research Centre, UNSW Sydney, [2]School of Civil and Environmental Engineering, UNSW Sydney, [3]School of Biological, Earth and Environmental Sciences, UNSW Sydney, [4]Mark Wainwright Analytical Centre, UNSW Sydney, [5]Australian Nuclear Science and Technology Organisation

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Martin S Andersen is a groundwater researcher with over 66 journal publications in a diverse range of topics including physical, geochemical and ecological processes in aquifers and their interactions with surface waters. Martin is an Associate Professor at UNSW, Sydney and the Director of the Connected Waters Initiative Research Centre (CWI: http://www.connectedwaters.unsw.edu.au/) and the Program Director of the NCRIS Groundwater Infrastructure Program (http://www.connectedwaters.unsw.edu.au/ncris).

Carbon plays a crucial role for all biological systems on Earth and for regulating the atmospheric heat budget. For instance, in the subsurface organic carbon is the ultimate electron donor for microbially mediated redox-process. Despite the size of the global groundwater store the processes controlling the natural dissolved organic carbon (DOC) in groundwater are poorly understood. This ARC Discovery project aims to answer the question: under what conditions groundwater DOC is a source or sink for carbon? and quantify processes that control concentration and character of DOC. The question will be answered via sampling of various subsurface environments and laboratory experiments of biodegradation and sorption. Samples from field, sorption and biodegradation experiments were analysed by Liquid Chromatography-Organic Carbon Detection (LC-OCD), a chromatography technique separating DOC into five fractions based on mass, plus a hydrophobic fraction. The results show that groundwater DOC concentrations are significantly lower than terrestrial (soil, sediment and river) concentrations indicating that DOC fluxes towards the subsurface are attenuated by sorption to minerals and/or biologically processed. The experiments show that the humics fraction is predominately adsorbing onto mineral surfaces and low-molecular weight neutrals (LMW-N) are predominantly being biodegraded. For field samples the humics fraction is more abundant in the total DOC than LMW-N. We therefore infer that sorption is more dominant than biological degradation. Changing environmental conditions could lead to a release of adsorbed carbon. The results will provide better understanding of the role of DOC for subsurface processes and inform guidelines for the management of groundwater resources.

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On the use of Morse-Smale Complex for Intra-Plate Earthquake Analysis

Jayawardena C[1], Weeraddana C[2], Asirimath C[3]

[1]The Department of Earth Resources Engineering, University Of Moratuwa, [2]The Department of Electronic and Telecommunication Engineering, University of Moratuwa, [3]The Department of Electrical and Computer Engineering, Sri Lanka Institute of Information Technology

Biography:

Chulantha Jayawardena received the Ph.D. degree from University of Wollongong in 2013. He is currently working as a senior lecture in the department of Earth Resources Engineering, University Of Moratuwa, Sri Lanka. His research interests include rock mechanics and neotectonics.

B.Sc.Eng.(Hons)(Moratuwa), PhD(Wollogong), AMIE(SL) E-mail:chulanthaj@uom.lk, Ext.: 5013
Specialized in: Mining and Rock Mechanics
Researchgate Profile: Chulantha Jayawardena

Plate boundary earthquakes dominate seismic records, even though the plate interior earthquakes are of similar significance, in the context of hazards caused. An accurate assessment of the earthquake risks in such regions is difficult in particularly where previous earthquake activities are infrequent, or doesn't record from the known fault zones. Hence, determining the earthquake recurrence intervals or forecasting future rupture patterns are still at primitive stages.

Attempts to calculate earthquake recurrence intervals based on the stratigraphic offsets had been the traditional practice. Advancements in GPS technology enabled certain mechanisms to understand possible future movements. Statistical analysis of seismic records could highlight some trends in earthquake occurrence. However, its potentials become minimal due to the complexity of earthquakes in plate interiors.

In this study, given a data set of earthquake records, a method to extract patterns of earthquake activities is explored based on computational topology. Specifically, a structure called the Morse-Smale (MS) Complex is computed by using earthquake records. It provides a zoning of the underlying geographical area based on the earthquake magnitudes, which is referred to as MS zoning. Seismic records from the Flinders Seismic Zone is used for the analysis as it is one of the most seismically active intraplate regions in South Australia. MS zoning compliments the zoning based on strike-slip dominant faulting, demarcating junctions of possible extreme stress activities. The proposed method can further be extended to accommodate data of epicentre details and sequence of occurrences to determine possible recurrence intervals and future rupture forecasting more effectively.

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Tectonic control on the Ordovician Sandstones and Permo-Carboniferous Dwyka Glaciation of Gondwana.

Grantham G[1]

[1]*University Of Johannesburg*

TS2 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

PhD completed 1993 on the Maud Province, western Dronning Maud Land, Antarctica.

Have worked on the Mesoproterozoic to Cambrian metamorphic belts of South Africa, Mozambique, Malawi, Antarctica and Sri Lanka since 35years with 13 field seasons in Antarctica. Interests focus on the crustal evolution of the formation and breakup of Rodinia and Gondwana between ~1200Ma and 180Ma.

Recent descriptions of detrital zircon age-data from various glaciogenic ~300Ma Dwyka Group localities in South Africa suggest ice transport from wider areas than previously thought with ages of between 600-900Ma and 2600-2700Ma in samples from the Cape, KwaZulu-Natal being consistent with derivation from Mozambique and Zimbabwe.

Data from detrital zircons in Ordovician-Silurian sandstones in southern Africa and Antarctica suggest sources consistent with Mesoproterozoic to Neoproterozoic basement in Mozambique and Antarctica. The East African and Kuunga Orogenies involved in Gondwana amalgamation, which involved collision between E. and W. and N. and S. Gondwana respectively, between ~700Ma and ~480Ma, would have formed partially eroded highland areas between ~490- 300Ma. Polar wander paths indicate that between ~410Ma and ~330Ma the geographic pole moved over southern Africa in Gondwana.These mountainous areas would have crossed the polar regions, resulting in an extensive ice cap, probably aerially similar to that covering Antarctica today.

This combined tectonic-paleoclimatic erosion-depostion setting contributed to the extensive sandstone deposits of the Cape Group and correlatives, interlayered with diamictites in the Cape Group and younger Dwyka Group tillites. Paleo-ice transport directions from Gondwana-age crustal blocks plotted on a reconstructed Gondwana map show widely divergent ice transport directions, most of which imply transport away from the orogenic belts of ages ~700-490Ma. These data provide support that mountainous areas formed during the Kuunga and East African Orogenies resulted in divergent ice transport directions and also sourced material with varying ages, over extensive areas of southern Africa and adjacent continental blocks in Gondwana.

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Photovoltaics in Nigeria – Awareness, attitude and expected benefits based on a qualitative survey across regions.

Nwokocha C[1]
[1]*Alvan Inkoku Federal College Of Education Owerri.*

Biography:

Born on the 15th of Jan, 1977.He started his career at Central school and Mater Ecclesiae Seminary. He proceeded to Enugu State and Imo State Universities respectively where he graduated in industrial physics and Atmospheric Physics.
He has interests in Environment and Energy Physics. He is currently in Physics department of Alvan Ikoku Federal college of Education Owerri.
Cecily is a co- Investigator of an institution based research Project Developing Mechanism for Optimal Utilization of Renewable Energy in Nigeria which is on-going.
Currently he is pursuing his PhD in Environmental Physics at the University of Portharcourt, Nigeria. He is married.

Abstract:
Photovoltaic (PV) as a viable option for renewable energy has significant potential in Nigeria to provide the desired sustainable energy needs. However, among many of the major barriers faced in its penetration into effective implementation is awareness and information gap. In contributing to alleviating such gaps as they vary across locations, the awareness and information on PV penetration in Nigeria has been studied. The objectives are to present contemporary information and statistics on the awareness of solar PV energy, the attitude towards utilization of PV resources and the expected benefits from PV energy resources using the Likert-Scaled questionnaire as the primary data source. The reliability of the latent scales has been tested using Cronbach's alpha whereas the responses to the scale items have been analyzed using descriptive statistics. The results present pointers in remediating PV energy challenges in Nigeria and are vital inputs to energy infrastructure planning, renewable energy investments and national policy.

Keywords: Renewable energy, Photovoltaic, Awareness, Attitude, Benefits.

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Evidence for the Toarcian mass extinction in Queensland's Surat Basin

Brearley Z[1]
[1]*University Of Queensland*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
I'm a keen geology student undertaking my honours research this year whilst working part time for a consultancy in the coal industry. My main field of passion is sedimentary basin development and sequence stratigraphy.

Episodes of extreme climate change in the Early Toarcian saw the development of oceanic anoxia, and resulted in a mass extinction event. Now thought to be related to the outgassing of the Karoo-Ferrar Large Igneous Province (LIP), this period saw large scale perturbations to the carbon cycle, and significant taxanomic loss of benthic marine fauna. Whilst there is a great deal of literature focused on the Toarcian-Pliensbachian mass extinction event, a large proportion of this work has focused on deep marine sequences that were distal to the LIP. A distinct oolitic ironstone-black shale succession in Queensland’s Surat basin may provide key insights into the effects of this climatic event on terrestrial settings. Through the development of a chemo-stratigraphic section of the lower Surat basin, carbon cycle perturbations recorded in this terrestrial setting can be quantified and analysed, granting a unique understanding into how the extreme changing climate affected the continents during the Early Jurassic.

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Facies analysis and basin evolution in the Mount Isa Inlier during the amalgamation of Nuna

Nordsvan A[1], Li J[1], Pourteau A[1], Volante S[1], Kirscher U[1], Collins W[1], Li Z[1]

[1]*Earth Dynamics Research Group, ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS) and The Institute of Geoscience Research, School of Earth and Planetary, Curtin University, Bentley, WA, Australia*

Biography:

My PhD research is focused on the Paleo – to Mesoproterozoic supercontinent Nuna and how NE Australia fits within current reconstructions. The aim of the project is to utilise sedimentology and basin analysis to understand the tectonic evolution of the NE Australian Proterozoic Mt. Isa and Georgetown inliers, and with detrital zircon geochronology, I'm hoping to aid in refining the reconstructions of Nuna. I'm also interested in how sediments are deposited; what sediments are preserved and how sediment deposition has changed throughout earth's history.

Proterozoic sediments corelated across 15 structural blocks in the Mount Isa Inlier are interpreted to have been deposited on a long-lived east-facing continental passive margin, suggesting an intra-Nuna ocean between Australia and Laurentia during this period. To evaluate proposed correlations and test the passive margin model, we perform facies analysis and stratigraphy on previously correlated sedimentary rocks across the Pilgrim Fault, a major north-south trending fault that separates the central MI from the eastern MI. The Ballara Quartzite (BQ), in the central MI, is characterised by basal conglomerates and minor non-marine deposits that thicken towards E-W trending normal faults and deepen up-sequence indicative of deposition in an active rift basin. The Mitakoodi Quartzite (MQ) in the eastern MI, shows no evidence of active extension and in contrast with the BQ progrades and deepens towards the SW. We also present new detrital zircon data from both sequences that equally challenge the previously proposed correlation. Detrital zircon in samples from the BQ are sourced from proximal MI igneous and volcanic rocks whilst detrital zircon in the MQ are likely sourced from Laurentian terranes. These results could indicate that the MQ is an allochthonous block or that Laurentia and Australia were connected at ca. 1.8 Ga following the Barramundi and Wopmay orogenesis which agrees with new paleomagnetic constraints for that period.

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New methods for calculating dissimilarities in detrital zircon samples to aid with identifying source areas

Nordsvan A[1], Kirscher U[1], Kirkland C[2], Barham M[2]
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Biography:
My PhD research is focused on the Paleo – to Mesoproterozoic supercontinent Nuna and how NE Australia fits within current reconstructions. The aim of the project is to utilise sedimentology and basin analysis to understand the tectonic evolution of the NE Australian Proterozoic Mt. Isa and Georgetown inliers, and with detrital zircon geochronology, I'm hoping to aid in refining the reconstructions of Nuna. I'm also interested in how sediments are deposited; what sediments are preserved and how sediment deposition has changed throughout earth's history.

Detrital zircon provenance analysis is among the most popular methods in determining the source region for sedimentary rocks. Generally, detrital zircon data is interpreted by visual inspection; however, whilst suitable for a small number of samples, visual inspection is inappropriate when dealing with large data sets. Vermeesch (2013) provided a method that uses a simple statistical test to determine the dissimilarity (D) between detrital zircon samples and plots them based on those differences. Here, we discuss the problems and pitfalls with the statistical methods used so far to calculate the dissimilarities and provide an alternative way to calculate them. Most commonly, the Kolmogorov-Smirnov (KS) statistic is used to calculate the D value. However, due to analytical uncertainty the KS test becomes unsuitable comparing samples obtained from different laboratory methods. This issue becomes particularly clear when trying to compare detrital samples with possible source regions. To account for different uncertainties between samples, we calculate the D value using an alternative method based on the area above the youngest grain age in a cumulative distribution function. Additionally, we apply Vermeesch's (2013) approach for randomly resampled cumulative distributions using normally distributed errors to get uncertainty estimates on the commonly used multidimensional scaling plots. These new methods to calculate dissimilarities between detrital zircon spectra will help with interpreting large amounts of detrital zircon data and should be used in conjunction with previously proposed methods.

Vermeesch, P., 2013, Multi-sample comparison of detrital age distributions: Chemical Geology, v. 341, p. 140-146.

577

Termite mound geochemistry: implications for mineral exploration in the Mozambique belt of South East Kenya.

Nyakinye M[1]
[1]*Ministry Of Petroleum And Mining*

Biography:
Born in 1968 in the Migori District of Kenya, I graduated with a BSc Geology from the University of Nairobi (1993) and a Master of Geoinformation Science and Earth Observation (Mineral Exploration) from ITC/University of Twente, The Netherlands (2000). I am currently the Ag. Head of Geological Data Management Division in the Ministry of Petroleum and Mining, Republic of Kenya. I have worked in gold and base metal exploration in both the Archean and Mozambique belt terranes of Kenya including the application of BLEG and Termite Mound geochemical methods.

The Late Proterozoic age Mozambique Belt (LPMB) rocks of south east Kenya consist mainly of metavolcanics, ophiolites and metasediments deposited in a passive continental shelf margin prior to the Pan African tectonic event. The rocks were then subjected to medium to high temperature and moderate to high pressure metamorphism, and later faulting and hydrothermal activity during the breakaway of Madagascar from Gondwana land.
Massive sulphide occurrences in the Kuranze area, which falls within the LPMB, have been investigated and results show that six (6) main Varimax rotated factors, which accounted for 70% of the total data variance, point to presence of sulphide mineralisation of hydrothermal origin and possibly associated with an ultramafic intrusion. Sulphide mineralisation is defined by the Ti-Fe-S-Cu-Zn-Nb-Sr-Y factor, which accounts for 51.4% of the model variance, while the Sn-W-Pt-Co and Sn-Cr-Y factors appear to infer the hydrothermal origin of the mineralisation and association with an ultramafic body respectively. Possible gold mineralisation in the study area is suggested by the As-Pb-Au-Cl factor which is further strengthened by nine (9) out of 84 termite mound samples assaying at 10 ppm Au.
Keywords: Geochemistry, termite mound, Factor Analysis, Mozambique belt, sulphide mineralisation

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Slab decapitation and the formation of metamorphic core complexes

Lister G[1], Forster M[1], Spakman W[2], Creighton R[1], Koulali A[1], McClusky S[1]
[1]Earth Dynamics, RSES, ANU, [2]Department of Earth Sciences, Utrecht University

TS4 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
A structural geologist who works in modern and ancient orogens to elucidate the physics and geodynamics of tectonic processes.

Metamorphic core complexes appear to form as the result of extreme horizontal extension caused by the retreat of adjacent subducting slabs. However, the formation of core complexes at the leading edge of an advancing continental indentor remains difficult to explain. We present a model based on the formation of back-thrusts that turn into a subduction zone. As the newly formed slab subducts, it rams, then decapitates the older slab, then rolls back, subjecting a previously formed terrane-stack to extreme horizontal extension. Slab decapitation as a geodynamic process may be prolific, e.g., decapitation may actively be in progress beneath the Hindu Kush, at the forefront of the modern India-Asia collision, resolving the paradoxical occurrence of Pliocene metamorphic core complexes while in the modern day, there is abundant evidence of compression. We suggest that collapsing internal basins routinely create rolling-back subduction zones that subject the leading edge of an advancing terrane-stack to extreme horizontal extension. Past examples inlude Sulawesi accreting into Sundaland, with an episode of high-pressure metamorphism as Australian crust subducted, then jammed, leading to back-thrusting behind the forearc, eventually triggering formation of a new subduction zone that decapitated the Northern Australia slab. There are even examples of imminent decapitation, i.e., still yet t¬¬o commence. Tectonic reconstruction using newly acquired Euler poles for the relative motion of Sundaland, Java, and Nusa Tenggara relative to the Australian plate shows that decapitation of the subducting Australian slab will eventually take place, with the currently accreting terrane-stack soon to be dismembered.

579

Metasomatic Origin of the Mokgware and Changate Granites in NE Botswana

Kehelpannala K[1], Moswaane K[1], Mosenki A[1]
[1]*Department of Geology, Faculty of Science, University of Botswana*

Biography:
He has nearly 30 years of experience as an active geoscientist with focus on field geology, structural geology, tectonics, metamorphic geology and petrology of Precambrian terrains. He was recipient of two prestigious JSPS (Japan) fellowships and Ananda Coomaraswamy Memorial medal (2015). He was the President of the Geological Society of Sri Lanka (2005) and is a life member of Sri Lanka Association for the Advancement of Science, a member of the Institute of Geology Sri Lanka (IGSL), a steering committee member of IAGR and a member of both Botswana Academy of Science and Botswana Geoscientists' Association.

The Mokgware Granite in the Mahalapye Complex of the Limpopo Belt and the Changate Granite in the SW corner of the Zimbabwe Craton in NE Botswana are microcline-bearing, medium- to coarse-grained granite-looking rocks. In the literature the Mokgware Granite has been considered as a large, post-tectonic pluton, whereas the Changate Granite as a product of anatexis of the nearby granitic gneiss. However, the present study rejects the above ideas and demonstrates that these two rock bodies are products of post-metamorphic K-metasomatism of some Neoarchaean metatonalite. The major mineral found in both rock types are fine- to coarse-grained undeformed microcline and deformed quartz and plagioclase, and biotite, chlorite, muscovite, calcite, myrmekite, rim albite, titanite and epidote occur as minor constituents. The main process of K-metasomatism is characterized by the formation of metasomatic microcline, myrmekite and minor rim albite in the presence of externally-derived K-bearing fluids, as previously shown by the first author from other regions. Inclusions of deformed quartz and plagioclase with thin albite/myrmekite rims occur in metasomatic microcline. Almost all the relicts of plagioclase co-existing with microcline are rimmed by albite and/or myrmekite. The parent metatonalite had undergone, at least, three-four ductile deformations and high-grade metamorphism prior to the K-metasomatism. The dominant mechanism of the K-metasomatism observed is the in-situ replacement of plagioclase by microcline in the presence of externally-derived K+ ions, and the other mechanisms are the formation of microcline through (a) the replacement of myrmekitized plagioclase and (b) the reaction between co-existing plagioclase-quartz.

580

Running for Cover in the Capricorn Orogen: Mapping regolith thickness on a regional scale

Annetts D[1], Davis A[1], Huaser J[1], Thorne R[1]
[1]*CSIRO*

TS5 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Aaron works as a Senior Research Scientist in the Mineral Resources business unit of CSIRO in Perth, WA. Aaron specialises in electromagnetic (EM) methods for geoscience problems in the near surface. His interests mainly reside in use of geophysics for groundwater and environmental purposes, with specialisation in the forward and inverse problems for EM above 500 m.

Located between the Pilbara and Yilgarn Cratons, the Capricorn Orogen airborne electromagnetic (AEM) survey was planned by the Geological Survey of Western Australia and managed on their behalf by Geoscience Australia as part of the Western Australia Exploration Incentive Scheme. It is a $AUD2.5M contribution to the Distal Footprints of Giant Ore Systems: UNCOVER Australia Project.

We present a systematic workflow for the estimation of the regolith cover thickness for the entire Capricorn region. Our method uses a Monte Carlo approach for clustering based on conductivity of regional rock and regolith type.

Our cover thickness map results in a smoothly-varying, realistic estimate of geo-electrical cover for the entire survey area, and caters for multiple cover and rock types with widely varying conductivity distributions.

581

didthisreallyhappen.net: Fighting everyday sexism in academia, one comic strip at a time.

Adenis A[2], Arnould M[2], Bocher M[3], Coltice N[4], Gerault M[2], **Mallard C[1]**, Ulvrova M[3]
[1]The University of Sydney, [2]Laboratoire de géologie de Lyon, UCBL, [3]Institute of Geophysics, Department of Earth Sciences, ETH Zürich, [4]ENS Paris

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Claire is a postdoctoral research associate in the EarthByte Group in the University of Sydney (Australia). She completed her PhD at the University of Lyon (France) in 2017 titled“ Tectonic analyse of the surface of mantle convection models“.

Her research focuses on the long term relationships between deep dynamics and surface tectonics and on the interactions between mantle processes and landscape evolution

Besides the institutional barriers to gender parity, sexist behaviors in the workplace contribute to discourage women to pursue an academic career, and reinforce gender stereotypes that are harmful to their progress and recognition in academia. Didthisreallyhappen.net is a community-based platform that aims at fighting against this type of sexism by means of, literally, illustrations.

The project "Did this really happen?" originated in Lyon, France, within the ERC-funded project AUGURY. We happened to be a mostly feminine team working in geodynamics, a male-dominated research area. Very quickly, we found ourselves confronted to sexist comments on a regular basis. Since then, we experimented with creating spaces and tools to talk about these issues, within our team, our department, and the whole scientific community.

To share our experiences, we translated some of the sexist situations we witnessed into comics. This project evolved into an online platform (https://didthisreallyhappen.net/) where anyone can submit anonymously testimonies on everyday sexism in academia. The stories are then translated into comics by artist Alice Adenis, and posted on the website without any comment or judgement.

During this session, we would like to share our testimony, encourage contributions to the platform, and discuss further actions.

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Tectonic and metallogenic evolution of South Australia: Insights from 5 years of AusLAMP

Robertson K[1,2], Thiel S[1,2], Heinson G[2], Reid A[1], Wise T[1], Curtis S[1]
[1]Geological Survey Of South Australia, [2]The University of Adelaide

TS2 - 1.1.5 Imaging Australia in 3D, 21 Years of ANSIR and beyond, Hall E1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Kate completed almost 8 years of study at the University of Adelaide including a PhD on the electrical resistivity of the southeast Australian lithosphere. She then started working at the Geological Survey of South Australia last year as a geophysicist in the Lithospheric Architecture team. She is the president of the SA/NT branch of the Australian Society of Exploration Geophysicists and in her spare time she enjoys trail runs and yoga

The Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP) is all but complete in South Australia, with less than 20 of 400 South Australian sites remaining to be completed this year. The collaborative project between the Geological Survey of South Australia, the University of Adelaide and Geoscience Australia commenced in 2013. 3D electrical resistivity models of the whole state to a depth of around 200 km have been produced from inversion of the long-period magnetotelluric dataset. At a crustal scale, significant similarities exist between long wavelength high-density features and conductive regions from AusLAMP data, which suggest deep lower crustal sources for these gravity anomalies. We observe correlations between the location of mineral deposits with underlying conductive pathways, beneath Olympic Dam and many other mineral deposits and occurrences. Expansive conductive regions exist where deposits are yet to be found, including areas within the Curnamona Province, inferring promising greenfields targets. The large site spacing (55 km) means there is significant scope for scale-reduction surveys, several of which have already been conducted. The imaging of major transitions in the lithosphere both laterally in age and/or tectonic evolution, and vertically as crust-mantle and lithosphere-asthenosphere boundaries are just some of the outcomes that have developed from the near completion of AusLAMP in South Australia.

583

A 30000 year sea surface temperature record for the Southern Coral Sea

Opdyke B[1], Owens R[2]
[1]The Australian National University, [2]Geoscience Australia

TS4 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Dr. Opdyke is a Paleoceanographer at the the Australian National University.

Late Quaternary paleotemperature records from the subtropical to temperate regions of the South Pacific are surprisingly rare. We constructed a 30,000 year record of sea-surface temperatures for the southern Coral Sea using magnesium-to-calcium ratios and oxygen isotopes in planktonic foraminifera. Our record captures millennial-scale temperature variability through the Holocene, Termination I, Last Glacial Maximum (LGM) and into Marine Isotope Stage (MIS) 3. We observe warming during Heinrich Stadials 1 and 2 and cooling during the Antarctic Cold Reversal (ACR), indicating that the influence of the thermal bipolar seesaw is significant at this location. During the LGM Coral Sea surface waters were 3-4 °C cooler than during the Holocene. This suggests that wintertime temperatures on the southern Great Barrier Reef (GBR) were close to the threshold for reef survival at this time. Strong influence of the thermal bipolar seesaw in this region suggests that a shutdown of deep-water formation in the North Atlantic presents an additional warming threat to the future survival of the GBR.

584

Neotectonic Evolution of Deformation Bands adjacent to the Mt Lofty and Flinders Ranges, and petrophysical impacts on uranium-bearing fluid flow

Lubiniecki D[1], King R[1], Holford S[1], Bunch M[1], Hore S[2], Hill S[2]
[1]University Of Adelaide, [2]Geological Survey of South Australia

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Drew completed his undergraduate in geology from the University of Regina in 2013, while spending a year abroad in Hawaii to study volcanology. He moved to Adelaide in 2015 to start a Ph.D. in structural geology. He is very active in the local geology community, serving as a committee member for the GSA, and chairing the current GESSS-SA student conference.

Fault-induced deformation of granular sedimentary rocks (>10% porosity by volume) is accommodated in discrete zones of localised strain, commonly known as deformation bands. These structures form as a result of compaction, due to sediment loading or high horizontal or vertical stress. Deformation bands can alter the petrophysical properties of their host rock, resulting in newly generated conduits for fluid flow, or baffling fluid flow leading to compartmentalisation. Here, we investigate the neotectonic reactivation of Mt. Lofty and Flinders ranges bounding faults, and subsequent deformation in the Lake Eyre and St. Vincent basins. Fortuitously located dilatational deformation bands positioned intermediately between the Mt. Painter Domain (uranium source) and the Four Mile uranium deposit are increasing the effective permeability of the Eyre Formation. Spatial relationships suggests dilatational deformation bands and palaeoredox roll fronts are directly related, while petrophysical data indicates dilatational deformation bands are responsible for permeability increases up to three orders of magnitude. Our results indicate Eyre Formation dilatation deformation bands are supporting surficial flow or uranium-bearing fluids between the Mt Painter Domain, and the Lake Eyre Basin. Furthermore, deformation bands are excellent indicators of discrete changes in the local and regional stress regime. For the first time, we provide quantitative evidence linking the neotectonic palaeostress evolution of the Mt Lofty and Flinders Ranges.

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Forecasting earthquakes with hybrid physical / statistical models

Steacy S[1], Reverso T[1]
[1]*University Of Adelaide*

TS4 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Sandy Steacy is an earthquake physicist and Head of the School of Physical Sciences at the University of Adelaide.

Earthquake prediction – deterministic identification of the location, timing, and magnitude of future events – is unlikely to ever be possible. By contrast, earthquake forecasting – probabilistic estimates of event likelihoods – is an area of intense study with some forecasts being released to civil protection authorities and to the general public. To date, the most successful forecast models have been purely statistical, using the early parameters of a developing aftershock sequence to estimate its evolution. However, there is strong evidence that stress changes from large earthquakes strongly influence the spatial distribution of its aftershocks yet inclusion of this effect in forecasting models has generally decreased their skill.

Here we present a new model that combines the spatial constraints from these 'Coulomb' stress changes with commonly applied ETAS statistical approach. We redistribute earthquake rate based on the sign of the stress change – not its magnitude – and on the percentage of events observed during the learning period in areas of increased stress. We test the model on the Landers, Canterbury, and Kaikoura earthquake sequences and find that it generally performs better than ETAS on its own – it never does worse. Our results suggest that inclusion of physical stress changes can improve the skill of statistical earthquake forecasting models.

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Laboratory mode of Heron Island Beachrock formation through accelerated Microbial Carbonate Precipitation

Arrieta N[1,2], Gagen E[1], Martínez-Arkarazo I[2], Madariaga J[2], Webb G[1], Southam G[1]
[1]School of Earth and Environmental Sciences, Faculty of Sciences, The University of Queensland, [2]Department of Analytical Chemistry, Faculty of Science and Technology, The University of the Basque Country UPV/EHU

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Dr. Nikole Arrieta is a Postdoctoral Researcher from The Department of Analytical Chemistry of The University of The Basque Country (UPV-EHU, Spain). Her Research Fellowship is funded by the Department of Education of the Basque Government. She is an Environmental Scientist who research biogeochemical processes. Her research is focused on the study of beachrocks and other carbonate cemented deposits. She is currently working with Professors Gregory E. Webb and Gordon Southam at The University of Queensland.The investigation she develops is focused on the definition of the influence of microorganisms and organomineralization processes on the diagenesis of beachrocks.

Beachrocks are coastal sedimentary formations derived mainly from the precipitation of CaCO3 cements in the intertidal zone. Natural beachrocks have attracted great attention as models to understand accelerated Microbial Carbonate Precipitation (MCP) and its implications for the fields of Earth Sciences, Climate Change, Geobiotechnology or Geobioengineering. Inspired by its natural ubiquitous capability to co-precipitate cement, sands, soils, minerals, metal ions, and to sequester CO2, MCP is a promising technology. Although MCP has been reproduced in laboratory-scale models with the aid of specific bioreactors, experimental approaches to grow synthetic beachrock are challenging. Therefore, strategies conducted to understand the variety of controlling factors (e.g., different microbial communities, geochemical water doping, sediment constitution) are necessary. In this work, a syringe experimental approach was conducted using an autotrophic-heterotrophic microbial ecosystem to reproduce Heron Island (southern Great Barrier Reef, Australia) beachrock through accelerated MCP. Dense Pisonia grandis forest and thousands of birds producing tones of guano cover Heron Island. The latter, enrich groundwater in phosphates and nitrates, which reach the mixing zone at the beach, where different microbial communities propagate. The mixing of fresh/marine waters create the perfect nutrient microenvironment for the microbial ecosystem. Dominant epilithic cyanobacterial pink mat and heterotrophic inoculum derived from leaves and bird guano were used. Standard BG11 and hot-water extractable organic matter from leaves and guano were respectively utilized as nutrient media. The experiment was conducted through several weeks mimicking the tidal range. MCP was investigated based on the geochemistry of the leachates and the precipitation of new carbonate sub-products.

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Rapid assessment of groundwater levels in the Northern Adelaide Plains using seismic data

Flinchum B[1]

[1]CSIRO Land and Water, [2]National Centre for Groundwater Research and Training and College of Science and Engineering, Flinders University, [3]Flinders University

TS5 - 3.3.2 New groundwater technologies and approaches & 3.3.5 Groundwater science for policy development and decision making, Room R5, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Brady Flinchum is a postdoctoral researcher at CSIRO. He specializes in utilizing near-surface geophysical methods, mainly seismic refraction and nuclear magnetic resonance to understand water storage and structure of shallow regolith .

The Northern Adelaide Plains (NAP) is the agricultural power house of South Australia. To meet a growing demand for high quality food in the near future, the NAP will require more land, energy, and water. To address the demand for water, the Bolivar waste water treatment plant has the potential to deliver an additional 20 GL of water to the NAP. To ensure long-term sustainability of this new water resource, it is critical to understand the shallow unconfined groundwater system and develop strategies and infrastructure to prevent an increase in soil salinity caused by raising the groundwater level. The highest-risk regions are areas where the groundwater level is less than 3-4 m below ground surface. We are exploring the use of near-surface geophysical methods as a tool to provide rapid assessment of groundwater depths in shallow (<10 m) unconsolidated sediments to identify high-risk regions. In this study, we collected seismic data along a 235 m profile and use first arrival times and surface waves to obtain p-wave and s-wave velocities. Because saturation significantly increases p-wave velocities but only has a small influence on the s-wave velocities, the ratio between the two velocities can be used to map the groundwater level. Our results show a flat water table between 6-8 m below ground surface consistent with a physical measurement of 6.5 m from a drill push-core. These preliminary results demonstrate the applicability of seismic methodologies as a tool to rapidly map groundwater levels in the shallow unconsolidated sediments of the NAP.

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POTENTIAL DEVELOPMENT OF MICRO-HYDRO POWER PLANT IN BRIBIN UNDERGROUND RIVER AS ENERGY EFFICIENCY ON KARST GUNUNG SEWU, GUNUNG KIDUL, YOGYAKARTA

Mugiyantoro A[1], Rekinagara I[1], Hanani A[1], Nasrul Ansony M[1]
[1]*University of Pembangunan Nasional "VETERAN" Yogyakarta*

Biography:
My name is Alwin Mugiyantoro, I used to be called Alwin. I was born in Cilacap, Indonesia October 26, 1997. I was the first child and had no siblings. I am an orphan. My education history is at SDN Karangreja (2003-2009), SMPN 2 Maos (2009-2012), SMAN 1 Cilacap (2012-2015). I am now a Undergraduate Student at the Department of Geological Engineering, University of Pembangunan Nasional "Veteran" Yogyakarta. I have written several papers and resently, I am following Regional Geoheritage Converance 2018 in Khonkaen-Thaiand. On campus I also work as a paleontology laboratory assistant covering micropaleontology and macropaleontology.

Electrical energy is one of the main needs in society. However the magnitude of demand for electricity needs, not balanced with the availability of electrical energy. As some regions in Indonesia have not received electricity. Base of The condition is the background of the emergence of small-scale electricity generating technologies such as micro-hydro that can be applied in areas that are difficult to access. One of the requirements of micro hydro energy is the presence of adequate volume and flow debit. In karst areas such as Karst Gunung Sewu often appears underground river. One of the existing underground river systems in the study area is the Bribin-Baron underground river which is one of the main river systems in the Karst Gunung Sewu region. The method used in this research is to collect secondary data from various literatures which then done field checking directly. Then performed analysis and evaluation of the data obtained. From this research it is found that Bribin river has some ideal location for developed micro-hydro power plant. There are locations that have been developed micro-hydro power plants and some places have potential to become new locations of micro-hydro power plants. Potential locations are usually located in caves through which River Bribin like Ngerong Cave. The development of micro-hydro power plants is expected to increase energy effectiveness in this area.

Keywords : Micro-hydro, Hydrogeology Karst,

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Deep learning copper exploration targets from satellite thermal imagery

Pendock N[1]
[1]*DIRT Exploration*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Neil Pendock is an applied mathematician with over 30 years experience developing algorithms and software for the processing of remotely sensed and geophysical data.

RR Loucks recently proposed an exploration strategy for copper based on trace elements. It depends on the empirical observation that copper ore forming calc-alkalic magmas typically include unusually high Sr and V and unusually low Sc and Y. Thus rare earth ratios [RERs] are regional scale tools to vector towards source rocks or fertile porphyry centres.

The OZCHEM geochemical database is a valuable resource for a regional exploration campaign. We consider the area around Cooya Pooya in the Pilbara, the site of a Wits-style gold rush.

Centered on Cooya Pooya, the database contains 700 RERs within a radius of 30 km. To extrapolate these point measurements to a continuous copper favourability surface, we applied deep learning to relate Aster satellite long wave infrared emittances to RERs.

A feed forward neural network with five inputs (thermal emittances) was trained using a hidden layer of sixteen neurons (corresponding to mineral abundances) which were then regressed against RER values in a single node output layer.

The model produced disappointing estimates for Sr/Y and V/Sc: correlations of 0.29 and 0.28 respectively between observed and modelled RERs, confirming that ratioing noisy data is rarely a good idea. This can be improved through careful editing of data.

OZCHEM also contains copper which performs much better, delivering a correlation of 0.73 which increases to 0.82 when sample locations are explicitly included in deep learning. The reason for the dramatic improvement is high correlation between observed copper and thermal abundances we interpret as Alunite-like, Sericite-like and Calcite-like minerals.

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Origin of Moho Reflections

Tamura Y[1], Fujie G[1], Ohira A[1], Takazawa E[2], Ceuleneer G[3], Michibayashi K[4], Sato T[1], Kodaira S[1], Miura S[1]
[1]JAMSTEC, [2]Niigata University, [3]CNRS, [4]Nagoya University

TS7 - 1.3 Marine Geoscience - The evolving oceans/IODP, Room R1, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
2011-present: Principal scientist, JAMSTEC
2001-2011: Senior scientist, JAMSTEC
1998-2001: Assistant Professor, Kanazawa University
1991, Ph. D. (Geology), University of Tokyo
Tamura et al. (2016). Advent of Continents--. Sci. Rep. 6, 33517.
Tamura et al. (2014). Mission Immiscible--. J. Petrology 55, 63-101.
Tamura et al. (2009). Silicic magmas in the Izu-Bonin oceanic arc--. J. Petrology 50, 685-723.
Tamura et al. (2002). Hot fingers in the mantle wedge--. Earth and Planetary Science Letters 197, 105-116.
Tamura. & Tatsumi (2002). Remelting of an andesitic crust as a possible origin for rhyolitic magma in oceanic arcs. J. Petrology 43, 1029-1047.

Moho reflections are absent below many parts of ocean floors produced along intermediate- and fast-spreading ridges. Along the respective seismic profiles, oceanic crust is thicker where clear and strong Moho reflections are observed and it is thin where Moho is diffused or absent. How is the relationship between Moho and the crustal thickness explained?
The boundary between mantle peridotite and layered gabbro from the lower oceanic crust in the Oman ophiolite consists of a dunitic transition zone (DTZ), mostly made of olivine + scattered Cr-spinel. The thickness of DTZ ranges from a few meters to a few hundred meters.
When mantle melts under hydrous conditions, the liquidus field of forsterite expands relative to that of enstatite and enstatite melts incongruently to produce dunites and andesitic melts.
We present here a new hypothesis that (1) accidental influx of seawater at the mid-ocean ridges results in hydrous melting of mantle peridotite just beneath the crust and produces thick dunite at the crust-mantle boundaries, (2) the thick dunite represents reflective Moho, and (3) this additional hydrous melting of shallowest mantle increases the thickness of oceanic crust.
Although the andesitic melts, which are the outgrowth of dunites, would be mixed with dominant basaltic melts extracted from the deeper parts of melting column of MORB, there must be systematic and significant differences between crustal materials with Moho and those without Moho. Comparative drillings of oceanic crust for future IODP expeditions will reveal the differences and examine the models for Moho.

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Searching for Zebras: the future of exploration geoscience

Beresford S[1,2]

[1]Independence Group, [2]Centre for Exploration Targeting, University of Western Australia

Biography:

Steve crosses the industry/academic divide with a career in both industry and academia. Currently Chief Geologist of IGO and Adjunct Professor at the CET. Member of the National Committee for Earth Sciences. Steve is also the co-host of the Exploration Radio podcast.

Resources provide 10% of Australia's GDP and 50% of its export earnings. The future of this contribution to our nation is however at a crossroads. The mining industry is in a state of transition (independent of metal cycles) where both the exploration for, and extraction of resources are meeting new demands.

The discovery of valuable ore deposits is a rare event, but these discoveries are in decline, reflecting the maturing of the easy to locate resources at the surface of the Australian continent. Mineral exploration is thus at the beginning of the largest change in how it operates since caveman found coloured rocks at the surface of the planet. This transition will require a step change in the science of discovery.

We foresee two major transitions in exploration geoscience over the next decade:

a. The digitalization of geoscience will broaden the Earth Sciences from a hermeneutic science to a classical 'hard science' that will allow the development of predictive power and the solving of previously intractable problems.

b. The Earth represents a complex system. The rise of systems science requires a more multidisciplinary approach with increased contributions from behavioural and mathematical discipliness

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Redlichia from the lower Cambrian Emu Bay Shale, South Australia: Soft-part anatomy and a giant new species

Holmes J[1], Paterson J[2], García-Bellido D[1,3]
[1]University of Adelaide, [2]University of New England, [3]South Australian Museum

Biography:
James Holmes is a PhD student in the School of Biological Sciences at the University of Adelaide. The main focus of his PhD project is examining patterns of growth in two species of Cambrian trilobite from the Emu Bay Shale (Kangaroo Island, South Australia).

The Cambrian Series 2 Emu Bay Shale (EBS) crops out on Kangaroo Island in South Australia. At 'Big Gully', the EBS contains a diverse Konservat-Lagerstätte with over 50 species currently known. As with most Burgess Shale-type biotas, the assemblage is dominated by arthropods, including trilobites such as Redlichia takooensis Lu, 1950, first described from South China. Collection of new material from 'Buck Quarry' since 2007 suggests the presence of two Redlichia morphotypes within the EBS, which are interpreted here as separate species.

Non-mineralised preservation in trilobites is rare, having been recorded in ~30 out of >20,000 described species. Of these, accurate reconstructions of biramous appendages have only been possible for a few. Specimens of Redlichia from the EBS show a variety of non-mineralised structures, including antennae, isolated biramous appendages, and parts of the digestive system, such as midgut glands. Here we illustrate various aspects of the soft-part anatomy of Redlichia from the EBS, including a complete reconstruction of a biramous appendage.

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Long-Lived Supercontinental-Scale Source to Sink System from Gondwana

Morón S[1], Cawood P[2], Gallagher S[1], Zahirovic S[3], Beucher R[1], Moresi L[1]
[1]School of Earth Sciences, University of Melbourne, [2]School of Earth, Atmosphere and Environment, Monash University, [3]Basin GENESIS Hub and EarthByte Group, School of Geosciences, University of Sydney

TS8 - 1.2.2 Source-to-sink sedimentary basin processes, Hall E1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Sara is a research fellow at the University of Melbourne, Australia. Her research focuses on the understanding of fluvio-deltaic systems and the controls and mechanisms governing their formation, morphology and long-term preservation into the rock record. She combines numerical modelling, geochemical and field data to understand fluvial systems. Her research is relevant for a broad range of applications spanning from hydrocarbon exploration to river and delta management. Sara holds a PhD in Petroleum Geology from the University of Adelaide and a M.Sc. in Geology from the University of Minnesota, USA.

Few modern rivers and their present courses predate the breakup of Pangea. This suggests that longevity of drainage patterns is controlled by continental assembly and dispersal cycles, with the longest systems present during supercontinent regimes. We document a Paleozoic to early Mesozoic trans-Gondwanan river system using sedimentary deposits on the Paleo-Tethyan north Gondwanan margin. Detrital zircon age spectra and Hf isotopic data from Ordovician to Triassic sedimentary deposits of the Canning, Officer and Northern Carnarvon basins in Western Australia show that the Paleoproterozoic and Mesoproterozoic-Neoproterozoic age peaks have a similar age range and Hf isotopic arrays to the Albany-Fraser Orogen as well as to the Arunta and Musgrave provinces, whereas the Neoproterozoic-Cambrian peak can be ascribed to East Antarctic sources from the Gamburtsev Range. Based on the strikingly similar three-fold age assemblage and Hf isotopic array of the Ordovician to Triassic sediments of Western Australian basins, we argue that this fluvial system was a long-lived supercontinental-scale system, with headwaters originating in Antarctica that flowed northwards to finally debouch in the margin with the Paleo-Tethyan Ocean. This drainage system eroded Proterozoic orogenic belts associated with phases of supercontinent assembly and flanked resistant kernels of Archean cratons. Remnants of this fluvial system controlled post-breakup drainage patterns in Gondwanan fragments in Western Australia. We conclude that supercontinental regimes allow fluvial systems to be long-lived as they provide abundant sediment supply, due to erosion of large-scale internal mountain systems associated with collisional assembly, and a stable, large-scale configuration that last until breakup.

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Ancient eclogites and metapelites in the Usagaran Belt, Tanzania: Pressure-Temperature constraints and implications for subduction geodynamics

Brown D[1], Hand M[1], Tamblyn R[1], Morrissey L[1]
[1]*University Of Adelaide*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
I graduated from the University of Adelaide in 2017 after completing a Bachelor of Science (Advanced) degree, majoring in Geology. I am currently studying Honours in Geology at the University of Adelaide. As a consequence of my studies focusing primarily on a range of science-related disciplines, my overarching ambition is to establish a career in scientific research. Geoscience has undoubtedly become the foremost scientific discipline that I wish to further in my pursuit of a research career.

The interrogation of mineral assemblages that preserve evidence of having reached eclogite-facies conditions provides insight into the geodynamics and thermal state of subduction regimes. One of the first appearances of such assemblages in the geological record is documented in the Palaeoproterozoic Usagaran Belt in central Tanzania, where ca. 2 Ga relic eclogite-facies assemblages are preserved. Given the antiquity of the Usagaran eclogitic assemblages, they offer an exceptional framework in assessing the geodynamic expression of plate tectonics in the early Earth. The retrogressed eclogites are situated at Yalumba Hill and preserved as boudinaged low-strain domains. Garnet is surrounded by plagioclase coronae and Na-poor clinopyroxene forms intergrowths with plagioclase, inferred to represent the breakdown of precursor omphacite. Eclogitic domains are encased by comparatively high-strain garnet-kyanite metapelitic gneisses and garnet-bearing mafic gneisses – these are well-exposed along a section of the Great Ruaha River, ca. 15 km south-west of Yalumba Hill. Preliminary results from both major and trace element zonation patterns in garnet indicates that the Great Ruaha River gneisses and the Yalumba Hill retrogressed eclogites experienced a separate pressure-temperature (P-T) history. Mineral equilibria forward modelling coupled with Zr-in-rutile thermometry will be implemented to further elucidate the P-T history of these rock packages. This multimethod approach will provide insight into the nature of ancient subduction regimes, with specific emphasis on their thermal character and exhumation dynamics.

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Whole crustal structure revealed by the Perth Basin Seismic (PBS) Array

Lin X[4], Yuan H[1,2,3], Dentith M[2], Murdie R[3], Gessner K[3]

[1]CCFS, Macquarie University, [2]Centre for Exploration Targeting, University of Western Australia, [3]Geological Survey of Western Australia, [4]Beijing Seismological Agency

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Xiangdong Lin is a visiting professor at the CET, UWA from Dec 2016 to Dec 2017. Xiangdong is from Beijing Earthquake Agency, Beijing, China. His specialty is on earthquake source inversion and crustal structure imaging using earthquake seismology.

Located along the south-western margin of the Australian continent, the Perth Basin is a nearly 1300km long north-northwest trending basin formed during the breakup of Australia and Greater India in the Permian to Early Cretaceous. Extension and trans-tension deformations during the rifting processes led to the formation of deep (up to 15km) rift basins and structurally complex crustal structure. To better define whole-crustal structural elements, in 2017 a 40-station 250-km long passive source linear array was deployed. The array is centered at the Perth Metropolitan region and is sub-parallel to the major structural boundary the Darling fault that separates the Yilgarn craton in the east. The array was composed of both 20-s and 120-s Trillium Compact sensors, which were operated from 6 months to a year to provide continuous recordings suitable for crustal receiver function and ambient noise analyses. Preliminary results show a northerly thinning crust with its Moho depth varying from ~43km beneath the southern basin to ~34km in the north. Complicated crustal structures, including dipping intra-crustal features, weak Moho conversion and signs of a fast-velocity lower crust, are consistent with the widespread rifting, basin inversion, strike-slip tectonics and volcanism associated with the basin formation and subsequent evolution.

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MANAGEMENT RISK OF OVERFLOW UNDERGROUND RIVER IN KARST GUNUNG SEWU, GUNUNG KIDUL, YOGYAKARTA

Mugiyantoro A[1], **Rekinagara I[1]**, Kusuma Aji B[1]
[1]University of Pembangunan Nasional "VETERAN" Yogyakarta

Biography:
Istifari Husna Rekinagara is an undergraduate student on Geological Department,UPN Veteran Yogyakarta. Born on Magelang, April 28th 1997. Elementary school on Magelang 7 Elementary School, then continue study on Magelang 1 Junior High Scoll, and then continue to Magelang 1 Senior High School.
Istifari used to be a vice secretary of MGEI-SC UPN Veteran Yogyakarta (2015-2016), Member of Human Resources Developmrnt Division of MGEI-SC UPN Veteran Yogyakarta (2016-2017), Head of HRD Division of MGEI-SC UPN Veteran Yogyakarta (2017-now). On November 2017 I had the opportunity to present the paper International Symposium on Earth Science and Technology 2017 (Kyushu University, Japan)

One of the dangers that can arise in the karst area is the overflow of underground rivers. The Karst region is mostly composed of limestone which is soluble in water. Underground river flows may occur when impermeable layers are blocking the flow of water infiltration from surface through the weak zone such as fractures. One of the existing underground river systems in the Wonosari Karst area is the Bribin-Baron underground river which is one of the main river systems in the Karst Gunung Sewu region. The underground river system is similar to the U pipe system where as the water volume exceeds the capacity of the river, the flow of water can appear to the surface through one of its holes. In this study using literature and secondary data collection which then conducted field checking. Then do the assessment and evaluation of data obtained and make recommendations on risk management in this area. From the analysis obtained there are several factors that can trigger underground river floods such as rainfall, morphology, geological structure. The results of the assessment and evaluation found that the good management of disaster risk overflow underground river in Karst Gunung Sewu region is required in this area. Such as to estimate the areas that could potentially become an underground river burst. From this research is expected to contribute in disaster mitigation efforts in karst area.

Keywords : Hydrogeoloyi, Karst, Sungai Bribin

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Conditioning of the Precambrian ocean: competing influences of atmospheric composition, ocean ventilation and make-up of the land surface

Kamber B[1]

[1]Queensland University Of Technology

TS5 - 2.6 Geobiology & 2.8 Earth, life and ores, Room R1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Dr. Kamber is a geochemist working on understanding the elemental cycles that operate on the Earth, particularly in the surface environment. His research spans from fundamental questions such as 'how did the earliest Earth look' and 'how did the atmosphere evolve' to environmental studies on the fate of pollutants in the environment and the supply of raw materials needed to support renewable technologies. Common to all these investigations is the need for quantitative chemical and isotopic data. His group is active in the development of novel analytical methods that transcend the boundaries between chemistry, geology, material science and environmental science.

The Precambrian is richly endowed with ore deposits, some of which unique to the early Earth and others predominantly found in Archaean or Proterozoic rocks. There is agreement that the elemental cycles of two of the most important metals for sulphidic ore deposits, Fe and S, have undergone dramatic changes in response to biological evolution, the change from an anoxic to an oxygenated atmosphere, ocean ventilation, and the mantle's capacity to produce highly magnesian lavas.

In this contribution, the roles of atmospheric oxygenation, ocean ventilation and secular changes in the composition of the exposed land surface will be juxtaposed. Central to this analysis is whether the Great Oxygenation Event (GOE) at ca. 2.35 Ga was a one-off, irreversible event or whether it was preceded by earlier oxygenation whiffs. It will be concluded that the evidence for the GOE remains strong and that if earlier oxygenation events did occur, they were restricted to oceanic oxygen oases with limited effect on global oceanic elemental cycles.

Until the GOE, the oceanic S pool was very limited and S had a short residence time in the ocean. By contrast, the ocean was rich in Fe and other metals, including Ni, Co and other transition elements that were likely sourced from weathering of a predominantly mafic to ultramafic land surface. It will be argued that the type of weathering, under a likely very CO2-rich Archaean atmosphere significantly contributed to the oceanic metal inventory and that post-GOE reduction in atmospheric CO2 led to relative metal starvation.

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Constraining the age and provenance of the basal quartzites of the Centralian Superbasin—revisiting the Heavitree Formation.

Al-Kiyumi M[1], Al-Ghafri M[1], Blades M[1], Collins A[1], Farkas J[1]
[1]*University Of Adelaide*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Mohammed Al-Kiyumi
Omani student at the University of Adeliade
Honors student in Geology working on the Heavitree formation in Amadeus Basin.

The Heavitree Formation of the Amadeus Basin, central Australia, is thought to correlate with a number of similar formations in the Officer, Ngalia, Georgina and Murraba Basins that formed the Centralian Superbasin. The Jasper Gorge Formation of the Victoria Basin and Jamison sandstone of the Beetaloo Sub-basin are also through to be corollaries. These formations are all constrained to being younger than ca. 1.0 Ga by U-Pb detrital zircon studies. However, in all cases, this is suspected to considerably pre-date the timing of deposition. Here, we present new U-Pb and Hf data from nine samples of the Amadeus Basin Heavitree Formation and laser QQQ Rb-Sr ages from detrital muscovites to a) better constrain the age of the Heavitree Formation, b) investigate the spatial variation in provenance of the Heavitree Formation, and, c) compare with other 'Supersequence 1' quartzites from the wider Centralian Superbasin. In addition, these Tonian sequences will be considered in the Li and Evans reconstruction of northern Australia rotated ca. 30° clockwise with respect to southern and western Australia.

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3D Tomography and geochemistry of drill cores reveals geological structures, minerals, textures - combine data for maximised results

Bergqvist M[1], Hansson A[1], Landström E[1]
[1]*Orexplore*

Biography:
Doctor in experimental physics. He has 10 years of experience from scientific research in detector and measurement systems, including medical imaging. Over 20 years of experience from Industrial Systems development of complex systems, in high tech companies at various positions and has long experience from international collaborations – from companies as well as from organisations. He has experience of bringing new technology to the market from several start-ups. Holds several patents.

Structural and mineralogical data, as well as textures and geochemistry is hidden within each drill core. Extracting the data has so far been done in several separate steps - many of them also destructive, and requiring long sequences of sample preparation, or being very labour intense. For instance, traces of structures being interpreted by looking at their 2D projection at the drill core surface.

By scanning drill cores using a method combining XRT and XRF and also performing 3D tomography of the core at the same time, a high resolution 3D visualisation of the structures, textures and mineral distribution can be made, as well as a display of elemental and density distribution along the drill hole.

Already having digitised data, and being able to select and annotate planar and linear features in the 3D volume, is a significant leap forward, together with the ability to export all the data into ore modelling software.

To maximise data extraction, further steps are envisioned. The use of deap lerning algorithms and pattern recognition, for automation of feature extraction and combinations, as well as elemental and mineral signature recognition, is now meaningful and its application on the drill core data is elaborated on in this article.

Making optimal use of the combined data is key, to efficient, sustainable and economically viable exploration and mining, and helps further our understaning of the geology behind it all.

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Natural climate cycles of past centuries and millennia; are there implications for the next century and millennium?

Asten M[1], Scafetta N[2], Weiss C[3], Kelsey A[4]

[1]Monash University, [2]University of Naples Federico II, Department of Earth Sciences, Environment and Resources, [3]CINVESTAV, [4]Earth and Environmental Sciences, Univ of Queensland

TS4 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:

Michael Asten is a Professor (Retired) and ongoing Adjunct Senior Research Fellow in the School of Earth Atmosphere and Environment, Monash University, Melbourne. He is a past-President of the ASEG, and served a recent three-year term as the AGC representative on the Australian Academy of Sciences UNCOVER Committee. He has published 186 scientific papers. He has developed passive seismic (microtremor) methods for 15 years, developing applications for earthquake hazard, and regolith characterization. He has applied signal processing methods to paleoclimate data sets over the past 3 years with a view to quantifying past climate cycles and equilibrium climate sensitivity.

We review a range of recent studies of natural cycles in climate change on the scale centuries to millennia. The time span 0 to 2000 CE has been considered by multiple groups with results ranging from only a minor signature of natural cycles, to dominant natural cycles without an AGW signature.

The Luedecke-Weiss analysis finds three overwhelmingly dominant centennial cycles which represent the global warming from 1850 to 1990, thus casting doubt on human-caused global warming as the sole factor in global temperature change of the past century.

The Abbot-Marohasy analysis used records for the years 50-1830CE and machine learning methodology; projecting from 1830 they find a fit between predicted and observed proxy global temperatures was achieved by incorporating an AGW component with a value ECS=0.6 °C.
The Scafetta et al approach uses proxy data 0-2010 CE to fit 8 harmonic components together with a composite GCM, and find an optimal fit using ECS=1-2.3 °C.
Asten studied alkenone temperature proxies from four temperate-zone ocean cores identifying with periods of order 10k, 6k and 2.3k years especially well developed in a core from the Okinawa trough.
The documented natural cycles invite predictions of future temperature trends. Differing projections range from a sharp sunspot-related cooling this century; a cooling of 1 °C by 2200 CE; a warming of 1.5-2°C by 2100 CE, and an additional cooling component from millennial cycles acting over the next 1000 years. We discuss compatibility/incompatibility of these results inview of parameters and assumptions used in the different studies.

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High-Ti phengite in the eclogitic rocks at Yangkou from the Sulu ultrahigh-pressure metamorphic belt, China

Zhang L[1]

[1]School Of Ocean And Earth Science, Tongji University, [2]State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences

Biography:

Engineer, School Of Ocean And Earth Science, Tongji University

The Yangkou eclogitic rocks from the Sulu ultrahigh-pressure metamorphic belt can be classified into four types based on the rock textural features: coronal metagabbro, coronal eclogite, fine-grained and coarse-grained eclogite, which formed in a prograde metamorphism during the subduction-collision between the north China and Yangtze cratons. Phengites in the four rock types range from 0.20 to 3.90 wt% TiO2, with 1.02 to 3.90 wt% in coronal metagabbro, 0.59 to 1.31 wt% in coronal eclogite, 0.65 to 1.41 wt% in fine-grained eclogite and 0.29 to 0.75 wt% in coarse-grained eclogite, respectively. Ti change of phengites may be described as the substation of AlVI + Si = AlIV + Ti in association with the substitution of Ba + AlIV = K + SiIV. High Ti contents in phengites can be attributed to the result of high-temperature metamorphism, which is evidenced by (1) high-pressure granulite facies mineral assemblages in local reactive sites in coronal metagabbro, and (2) Ti-in-zircon thermometer yields the metamorphic temperature estimates from 680 to 955 °C. Zr-in-rutile thermometer is also used to estimate the metamorphic temperatures of the rocks, which gives the temperatures from 609 to 685 °C at 2.0 GPa and 639 to 717 °C at 3.5 GPa, respectively. The systematical change of Ti content in phengite and mineral assemblages in the four rock types suggest that the Yangkou eclogitic rocks have suffered an anti-clockwise P–T path. Such P–T path is interpreted that the Yangkou protolith of eclogitic rocks came from the arc setting of hanging wall.

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Geology and Structural Control of Groundwater in Bojong Area, Wonosegoro District, Boyolali Regency, Central Java Province

Taftazani M[1], Azhim M[1]
[1]Upn "Veteran" Yogyakarta

Biography:
I'm student of Geological Engineering UPN "Veteran" Yogyakarta. I live in Java since 1997 so I will study about basins in Java such as Rembang basin and Kendeng basin. Bojong is a village that represents Kendeng fold thrust belt basin.

Hydrogeology of fold thrust belt in Bojong Village, Wonosegoro District, Boyolali Regency, Central Java is one of interesting subject to be researched because its complexity and benefit for science and socio-enviroment. The method used for the research is geological mapping, and hydrogeology mapping.
Geology of research area composed by calarenite and marl unit of Kerek Formation aged Middle-End Miocene and Holocent Deposit. Structural geology founded in the area is normal fold, overturned fold and thrust fault with trend ENE-WSW, right slip fault with trend NW-SE, and left slip fault with trend N-S with stress trend NNE-SSW. Cross cutting evidence shows that the stage of structure is fold, thrust fault, left slip fault, and right slip fault. Morphology founded in the area is folded mountain, folded valley, and point bar with drainage pattern is trelis.
Hydrogeology system shows tight relation with the geological condition of the area. Marl acts as aquiclud, while calcarenite acts as aquifer. Its acquifer type are semi-confined and fractured aquifer. Height of water table tends to be close with topography height and the water table flow heads from upper NE, NW, and SW area to lower in central and SE area. In some area, there are deflections of water table as result of structure influence.
Fold and thrust fault form high area that was play a role as recharge area, while low area and strucutural-impact weak zone play a role as discharege area. Synclin, particulary in central low area rather become recharge area and reserve amount groundwater.

603

Identification of Tectonic Control on Epithermal Mineralization in the Trenggalek District, East Java with Lineament Density Analysis Applicatio

Taftazani M[1], Nugraha A[1]
[1]*Upn "Veteran" Yogyakarta, Indonesia*

Biography:
I'm student of Geological Engineering that lives in Java since 1997. I want to study about geology of Java. Trenggalek is one of interesting field of mineralized Old Andesite Formation in Java.

Exploration is an activity that takes a long time, expensive, and applied on a large area, so it takes a fast and precise method. The application of Lineanment Density Analysis (LDA) using software on a computer can be used to accelerate mineralization prospection at regional and even semi-detailed stages. The concept of LDA implementation is one of litho-structural mineralization concept approach as the presence factor of mineralization in a certain area. The researchers applied this method to the Trenggalek district, East Java, which is part of The Southern Mountains segment that dominated by Oligo-Miocene volcaniclastic rocks. In this research, the method used are literature study, construction lineament, 5x5 km grid-and-DAS using GIS, and general direction determination with RockWorks software. The results shows a relationship between existing lineament with mineralization that associated with intrusion and influenced by regional structures, especially for epithermal vein type. The highest relative density is at intersection of the structure with value of 3-6/km2. The general direction on the lineament of each grid shows relative direction of North-South, Northeast-Southwest, Northwest-Southeast, and East-West. Existing flow pattern shows strong structural control with the highest density of 9-16/km2 in the same direction as the direction of the existing lineament. LDA results shows a relationship that is directly proportional to the ratio of the existing vein. The LDA application as a prospection of precious metal mineralization is proven to be possible and can be used to accelerate mineral exploration or other research interests in the other area.

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Uncovering an ancient landscape and helping the exploration for groundwater and minerals – The Musgrave province, South Australia

Munday T[1], Soerensen C[1], Raiber M[2], Gilfedder M[2], Krapf C[3], Costar A[4], Keppel M[4], Gogoll M[4], Love A[5]
[1]CSIRO , [2]CSIRO Land and Water, [3]GSSA, [4]DEWNR, [5]Flinders University

TS5 - 3.3.2 New groundwater technologies and approaches & 3.3.5 Groundwater science for policy development and decision making, Room R5, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Tim Munday is a Scientist and Research Group Leader in the Discovery Program of CSIRO Mineral Resources. He leads a group of geophysicists and engineers whose focus is on developing and applying technologies for exploring through Australia's challenging regolith and sedimentary cover in the search for mineral systems. He has 20+ years experience in the application of geophysical, particularly EM, technologies in exploration through regolith settings and more recently in applications relating to base metal exploration in sedimentary basins. He is also versed in the use for geophysical methods for groundwater resource assessment.

A thick and complex regolith cover hinders exploration through the Musgrave Province, a region of Mezo-Proterozoic crystalline basement, in the north of South Australia. The region is highly prospective for magmatic Ni-Cu- PGE and IOCG mineral systems, but a lack of knowledge about the variability and extent of the cover sequences increases the risk and cost of exploration. The regolith also challenges the exploration for groundwater resources which are critical for the indigenous communities present in the region. Previous studies have determined that the regolith in the Province is variably conductive, particularly relative to the unweathered basement, thereby lending itself to be mapped using airborne electromagnetic methods. Two regional-scale airborne electromagnetic surveys were undertaken using both fixed wing and helicopter platforms across the central and eastern parts of the region. The resulting data were inverted using a deterministic approach, and the derived conductivity model revealed an extensive buried palaeovalley system. Use of the inverted AEM data and an understanding of the regolith-bedrock relationships derived from prior studies through the region, allowed the application of an attribute-guided regression technique called Smart Interpretation (SI) (a machine-learning methodology), to generate a map of regolith cover thickness and complexity. The resultant model was imaged in 3D, and the defined palaeovalleys permit the geometry of the pre-Pliocene landscape to be determined.

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Exploring the evidence for Paleoarchean evaporites and their bearing on hypotheses for early microbial metabolisms

Runnegar B[1]
[1]University of California, Los Angeles

TS3 - 2.1 The origins and development of life & 2.2 Ediacaran and Cambrian Symposium, Room R1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Bruce Runnegar is a paleobiologist and astrobiologist with interests in the evolution of early life, especially during the Ediacaran, Cambrian and late Paleozoic ice age.

In his pioneering study of the sediments and lavas of the North Pole dome, Pilbara, Western Australia, John Dunlop advanced the hypothesis that the sedimentary barites of the Dresser Formation are replacements of gypsum evaporites. Some supporting evidence for widespread evaporitic conditions during the early Archean seemed to be provided by the subsequent discoveries of the sodium carbonate nahcolite in both Western Australia and South Africa.

Determining the original composition of replaced minerals is difficult because all that normally remains is the crystal morphology. However, it is fairly easy to refute Dunlop’s hypothesis for the original nature of the North Pole barites because existing crystals have the morphology of barite rather than gypsum. Other radiating aggregates of smaller crystals from the Dresser Formation and elsewhere have been more difficult to deal with because they are clearly not what they once were. Dunlop attempted to overcome the difficulty of correctly orienting pseudomorphed crystals through the use of a petrographic universal stage but this method is of limited value if the original mineralogy has been destroyed or replaced. Fortunately, the now routine application of computerized tomography to geological materials provides a convenient way to explore key properties of in situ and/or replaced crystals. In this presentation I shall review the evidence for the original composition of crystals that have been considered to be replaced early Archean evaporites and discuss how they fit with recent hypotheses for the times of origin of certain microbial metabolisms.

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Significance of the Paris Silver Deposit to South Australian Minerals Exploration

Anderson J[1], Murray J[1], Alesci A[1], Hill R[1], Hopton D[1]
[1]*Investigator Resources Limited*

Situated on the southern margin of the Gawler Range Volcanics (GRV), the Paris silver deposit was discovered in 2011 using regional soil geochemistry around limited outcrops of advanced argillic epithermal alteration at Nankivel Hill 4km from Paris. The shallow Paris deposit has a combined Inferred and Indicated JORC (2012) resource of 9.3 million tonnes at 139g/t Ag at 50g/t Ag cutoff for 42 million ounces of contained silver.

The mineralisation largely comprises very fine acanthite, primary native silver, chlorargyrite, galena and coronadite within silica, illite, pyrite and manganese carbonate alteration. The host is a polymict breccia with variable distribution of volcanic, carbonate, silica and sulphide-rich fragments. The breccia has a horizontal tabular geometry at the unconformity between basement marble/graphitic schist and overlying ignimbrite correlated with the Bitalli Rhyolite of mid-GRV age. Dykes associated with the brecciation are dated around the same age. These characteristics are typical of intermediate-sulphidation epithermal deposits in the Americas.

Paris and Nankivel are situated either side of a monzodiorite intrusive complex correlated with the 1620Ma St Peters Suite. Alunite at Nankivel was also dated as mid-GRV at 1597+/-7Ma and overlies vertically zoned argillic/propylitic/potassic alteration. These deposits are considered to comprise a post-subduction epithermal/porphyry system close to Olympic Dam age. This is also linked to the OD IOCG belt by a connecting AusLAMP magneto-telluric corridor and by the proposed correlation of the Bitalli Rhyolite with a regional pyroclastic marker indicative of an OD Mega-event offering an expanded spectrum of deposit styles and areas for new discovery opportunities.

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The challenges associated with new ground-shaking technology: How seismic could be the technological game-changer for miners

Turner G[1], Dwyer J[1], Pridmore D[1]
[1]*Hiseis*

TS8 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Greg Turner is currently a Principal Geophysicist at HiSeis.
He graduated with a BSc(Hons) in Earth Science from Monash University in 1987 and received a PhD from Macquarie University in 1994. His previous roles have included being Geoscience Manager for WMC's Technology Group and a co-founder of the Geoforce geophysical service company .

The minerals exploration community is in desperate need of new technologies that can expand the search space to greater depths. One promising technology is seismic reflection. Case histories are emerging where new mineralisation has been discovered by targeting directly off seismic reflection data and new insights on geological architecture have helped focus exploration from the regional scale to the camp scale and from there to the deposit scale.
However, there are challenges for advancing the adoption of seismic reflection. These broadly relate to:
- Unfamiliarity with the technology;
- The complexity of mineralised geology; and
- The lack of an existing analogue.

The lack of familiarity is currently being addressed by stepping through a process whereby levels of expenditure can be staged to match increasing levels of confidence that the technology can achieve defined objectives and compress discovery timeframes.
The complexity of typical mineralised geology is being addressed by establishing the links between the geology and the seismic data by rock property measurements and numerical simulations together with integrating all available data sets that can constrain the interpretation.
The lack of an existing analogue leads to tempting comparisons between alternative technologies which are lower cost but unable to map 3D geological boundaries at depths from surface to depths of multiple kilometres and provide precision targets.
A variety of case histories and demonstrate how intelligently applied seismic reflection can be a game changer for the next generation of exploration.

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CSIRO's Deep Earth Imaging Future Science Platform

McWilliams M[1]
[1]CSIRO Mineral Resources

TS2 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Michael leads CSIRO Deep Earth Imaging, a new effort aimed at helping discover Australia's future minerals, energy and water resources. His team is focused on new geophysical methods, advanced data analytics and mathematical techniques that will provide a better understanding of the subsurface from sparse, incomplete and noisy geoscience data.

Michael has served in many academic and government roles, including as CEO of GNS Science in New Zealand, Chief of CSIRO Earth Science and Resource Engineering, and Director of the DeLaeter Centre of Isotope Science in Perth. He is Professor Emeritus of Geological and Environmental Science at Stanford University.

CSIRO created Future Science Platforms to support the reinvention and creation of new industries, stimulate cross-disciplinary scientific collaboration, and grow science capability by attracting the next generation of young researchers. This is a strategic investment in frontier research and innovation growing to $A52 million annually by 2020.

CSIRO's Deep Earth Imaging future science platform functions like an internal startup company aiming to discover, design and build new tools that will allow us to more precisely and accurately image the subsurface, and to better understand and quantify energy, groundwater and mineral resources. The project is an unprecedented opportunity to build a 35 person team of early-career geophysicists, geologists, geochemists, mathematicians and computer scientists focused on [1] modelling, inversion and simulation, [2] petrophysical/geochemical knowledge integration, [3] uncertainty reduction/value of information, using [4] advanced high-performance computing.

These teams will have the opportunity to see new ideas realised through technology pre-accelerators with the potential to create connections between research, science and industry, enabling and their translation into real-world applications in 5 or more years.

Our efforts are focused on computational and numerical methods as applied to earth imaging and interpretation, rather than new sensors or data acquisition. We are partners with Geoscience Australia, adding value to our pre-competitive geoscience databases. We are particularly interested in collaborating with industry partners who see benefit in jointly pursuing high-risk, high-reward research that incorporates experimental and/or unconventional exploration datasets in the mineral, energy and groundwater sectors.

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STRATEGIC & INDUSTRIAL MINERALS LEADING THE NEXT PRODUCTION REVOLUTION

Flook R[1]
[1]*Mosman Resources*

TS4 - 3.1.5 Technology metals and minerals – the importance of non-traditional commodities in the evolving economy & 3.1.6 New frontiers in ore system research, Room R2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Dr Richard Flook has worked for both suppliers and consumers of minerals with global companies including, Steetley plc, Anglo American, Commercial Minerals (now Sibelco), Normandy Mining Ltd, Omya AG and Shinagawa Refractories.
Richard is a Fellow of the Australasian Institute of Mining & Metallurgy (FAusIMM (CP)) and the Australian Institute of Company Directors (FAICD). Richard is a graduate of Sydney University (BSc First Class Honours, PhD) and the University of NSW (Master of Commerce).
Since 2014, Richard has been the Managing Director of Mosman Resources, a private consulting business, specialising in the production and marketing of industrial minerals and chemicals.

The last decade of rapid industrialization and urbanization particularly in China led to a rapid growth of minerals particularly those required for infrastructure and construction.
The next decade will be equally dramatic but the growth will shift to the minerals required for the next production revolution including renewable energy, energy storage and energy reduction.
Minerals containing materials such as lithium, vanadium, graphite and cobalt are used in batteries and demand is estimated to grow at 14% CAGR. Other minerals such as rare earths, high purity alumina and high purity quartz are also expected to be in high demand.
The expected growth in electric vehicles will also encourage changes in the production and demand of traditional materials such as steel and glass as well as changing demand for metals such as copper and aluminium.
Understanding these changing market forces and the changing demand for minerals is essential to determine where future exploration and capital investment will be most effective.

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Semi-Automatic Seismic Interpretation - Processing Seismic Images for Fault and Unconformity Extraction

Clark S[1], Bugge A[2,3], Lie J[4]
[1]UNSW Sydney, [2]Kalkulo AS, [3]University of Oslo, [4]Lundin Norway

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
I am a geophysicist with an interest in basin formation processes in both active and passive margins. I'm also interested in the application of machine learning to automate and optimise Earth models. I completed my PhD in geodynamics at the University of Sydney in 2007 and then worked for 10 years with oil industry clients in Norway delivering R&D products and solutions. I'm currently a Senior Lecturer at the University of NSW.

In this presentation, we outline two separate methods for identifying faults and horizons from 3D seismic data with minimal user-input. Based on patterns in the acoustic impedance, we automatically identify a number of seismic horizons, with the user trialing and selecting the ideal fineness of the result. Independently, faults are identified from fault likelihood data. Our method uses functions readily available from common libraries such as MATLAB's Image Processing Toolkit (c) or python's scikit-image. Using a case-study with high-quality 3D seismic from the Polheim sub-platform of the Loppa High, Barents Sea. For the region, we show the identified unconformities and the dominating fault trends and uncertainties.

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Impact of the neighbourhood selection strategy on autonomously generated 3D volumetric models

Balamurali M[1]
[1]University Of Sydney

TS5 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
I have been working at the University of Sydney as a postdoctoral researcher within the Rio Tinto Centre for Mine Automation (RTCMA), part of the Australian Centre for Field Robotics (ACFR). My role focuses on applying a range of complex methodologies to help our industry partner Rio Tinto solve their problems. These methodologies provide support in decision making by combining mathematical and computational modeling with experimental research.

Gaussian Processes (GP) can be used to autonomously generate 3D volumetric models, such as grade estimation models for use in mine planning and decision making. This study evaluates the properties of the exploration grade estimation outcome when different neighbourhood search strategies are applied. Capturing the impact of the neighbourhood search strategy choice on the resulting models will enable to develop a methodology to autonomously select the best strategy for a given situation. Exploration holes are often drilled through to the base of the deposit and spaced at intervals sufficient to allow the lateral variations in the geology to be revealed. As the data is horizontally sparse and vertically dense and different data densities can be present in different parts of the mine, it is important to develop an autonomous robust approach for choosing the data for estimation of each block in the model in order to produce accurate probabilistic grade models.
Our case study used a typical Hammersley Ranges iron ore deposit. Geochemical assays were collected in the exploration holes and estimated into blocks using GP modelling. Histograms, section plots and 3D spatial distribution plots of the resulting block model were produced for different neighbourhood search methods and compared against the nearby drill-hole data and the samples used by the neighbourhood selection strategy to estimate the block grade. The results particularly demonstrate that different neighbourhood selection strategies can lead to different artefacts that impact the quality of the models, especially in areas that are poorly informed by the available data.

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How did the Great Barrier Reef develop during the Last Interglacial? New evidence from One Tree Reef

Patterson M[1], Sanborn K[1], Webster J[1], Webb G[2], Braga J[3], Nothdurft L[4], Murphy R[5], Humblet M[6], Dechnik B[7], Zhao J[2], Renema W[8]

[1]Geocoastal Research Group, University of Sydney, [2]School of Earth and Environmental Sciences, The University of Queensland, [3]Department of Stratigraphy and Paleontology, University of Granada, Campus de Fuentenueva , [4]School of Earth, Environmental and Biological Sciences, Science and Engineering Faculty, Queensland University of Technology , [5]Australian Centre for Field Robotics, School of Aerospace, Mechanical and Mechatronic Engineering, University of Sydney, [6]Department of Earth and Planetary Sciences, School of Environmental Studies, Nagoya University, [7]Departamento de Ecologia e Recursos Naturais, Universidade Federal do Espírito Santo , [8]Naturalis Biodiversity Center

TS2 - 2.4 Ancient and Historical Record of Life in Australia, Room R1, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

Madhavi Anne Patterson is a PhD candidate with the Geocoastal Research Group at the University of Sydney. Her current research examines the evolution, timing and nature of pleistocene fossil reef sequences in the Great Barrier Reef, Australia, with aim to produce a better understanding of the paleo-environmental conditions surrounding reef evolution in this period. Madhavi completed a Bachelor of Science (Geology and Geophysics, Geography) at the University of Sydney with a First Class Honours for her thesis titled "Traces of bioerosion in fossil coral reefs: The influence of environmental parameters on macro-bioerosion between 10-30 ka in the Great Barrier Reef".

The geological archive of fossil reefs provides insight into how reefs respond to long-term palaeoenvironmental change. Studying last interglacial (LIG) reefs allows us to investigate reef responses (i.e. growth and demise) to palaeoclimatic conditions similar to those predicted for the future (i.e. higher sea levels and temperatures). Previous LIG reef cores in the Great Barrier Reef (GBR) are scarce, poorly preserved and provide limited information on the nature and timing of reef phases on individual reef and regional spatial scales. We report on eight new cores from windward, leeward and patch reef locations on One Tree Reef, Southern GBR. The Pleistocene boundary was reached between 8.5 and 14 m below the modern surface. Closely spaced core transects allow analysis of vertical and lateral growth among specific reef zones and across the entire reef. We present new U-series dates from rigorously vetted coral samples validated by XRD, hyperspectral imaging and microfacies analysis to identify diagenetic alteration and cementation. We interpret coralgal assemblages within the context of geochronology and our multi-proxy analyses. Integrating this with all available GBR cores we aim to build a GBR-wide model of LIG reef response to palaeoenvironmental change, which may inform predictions of reef response to modern climatic change.

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The Australian built environment: Are we ready for the next big shake?

Edwards M[1], Wehner M[1], Ryu H[1]
[1]*Geoscience Australia*

TS4 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Mark Edwards is a structural engineer and Section Leader in the Community Safety Branch at Geoscience Australia. He leads a multi-disciplinary team developing information on natural hazard impact, risk and mitigation. He participates in Australian building standards committees and in an update of the building standards of Papua New Guinea. He is a research collaborator in three Bushfire and Natural Hazards CRC projects developing information on building mitigation for earthquake, wind and flood. Finally, he leads a program of engineering research with industry collaborators examining opportunities to mitigate natural hazard risk in the transport, electricity and water sectors.

Australian seismicity has historically been poorly understood and earthquakes not recognised as a significant natural hazard. Consequently, much of the Australian built environment has been constructed with no consideration of local seismic hazard resulting in significant seismic risk for some community elements. This risk has been unclear along with the impacts that might require response to and recovery from. Information is also needed on what can be done to mitigate these consequences so we can be ready for the next big shake.
In this presentation the research undertaken by Geoscience Australia to translate the latest Australian seismological knowledge through to impact, risk and mitigation information is described. Event-based modelling of the extreme consequences of rare earthquake events is being done to provide emergency management and other stakeholders insights into credible impacts, including those on critical infrastructure (CI). Scenario modelling undertaken for regional emergency management planning is described along with two projects that are developing information to inform earthquake risk mitigation investment. One is centred on the town of York in Western Australia which has many heritage-listed masonry structures that are inherently vulnerable to the local seismicity. How this collaborative project is developing information on cost effective mitigation approaches and virtually applying these to the town is described. The second is the Earthquake Impact and Risk Assessment of Perth and Supporting Infrastructure project with its six collaborative partners that is providing insights to the managers of CI and key government agencies on the vulnerability of infrastructure assets to rare earthquakes.

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Public perceptions of groundwater issues

Commander P[1]

[1]IAH, [2]Geological Society of Australia, [3]Australian Institute of Geoscientists

TS7 - 3.3.5 Groundwater science for policy development and decision making, Room R5, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Philip Commander has a MSc in hydrogeology from the University of WA and retired after 38 years in the WA Geological Survey and Department of Water, working on groundwater resource investigation throughout the state, and advising on groundwater management, and environmental impacts. He is a former President of IAH Australia, and former Adjunct Associate Professor at UWA.

Recent public campaigns involving groundwater use by industry, and twenty years of permanent water restrictions in the southwest have sensitised the public to value groundwater, and have made it a big issue in development proposals.

On the one hand, older residents of Perth believed ‘bore water’ to be inferior – smelly and iron rich, on the other, the mostly younger green generation, targeted by water conservation programs, are convinced WA is ‘one of the driest places on the planet’ and value its groundwater as ‘precious’.

Groundwater –quantity and quality - was the recurrent theme amongst the 9500 public submissions to the WA fracking inquiry.

Perceptions of quantity vary – a domestic consumer who might pay more than a dollar just for a 600mL bottle of water, considers a million litres to be a huge quantity – whereas a megalitre to an irrigator or miner is commonplace. In general, there is little appreciation of the rate of groundwater flow, its considerable age, and of the variability in natural quality.

Activist groups have used groundwater to raise concern – the image of setting fire to a water tap is a very powerful message to stop gas development, although natural methane in US/Canadian black shale environments can already be at a dangerous level in water wells.

After the proposal to pump water to Perth from the SW Yarragadee aquifer in 2005, the public is less well informed than before – now believing things which are incorrect, and this will be hard to remedy.

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Pumped hydro energy storage: a key enabler of 100% renewable electricity for Australia

Blakers A[1], Lu B[1], Stocks M[1]
[1]ANU

Biography:
Dr Matthew Stocks is a Research Fellow at the ANU. He has more than 25 years research and development experience in renewable energy. His current research efforts focus on integrating high amounts of renewable energy in Australia's electricity network, enabled through a combination of effective transmission and storage. Previously Matthew was Chief Technologist at Transform Solar where he spent ten years commercialising the ANU invented SLIVER solar cell technology.

Solar photovoltaics (PV) and wind are now the #1 and #2 generation technologies in terms of new capacity installed worldwide each year, with coal in third place. PV and wind have already exceeded 50% of total electricity generation in South Australia. PV and wind are likely to accelerate away from other generation technologies because of their lower cost, large economies of scale, low greenhouse gas emissions and the vast availability of solar and wind resources.
Although solar and wind are variable energy resources, the methods to support them to achieve a reliable 100% renewable electricity grid are straightforward: strong interconnection between regions to shift energy from regions with excess generation and storage to shift energy from times of excess.
Pumped hydro accounts for 97% of energy storage worldwide (> 160 GW) because it is the most mature, lowest cost, large-scale energy storage technology. Pumped hydro systems have a lifetime of 50 years or more. While Australia has developed most of its conventional hydro, there is a vast potential for pumped hydro energy storage in Australia.
Using GIS searching, ANU has identified 22,000 potential pumped hydro sites across Australia, more than 100 times more than required to balance a 100% renewable grid. In this presentation, we will present our pumped hydro site searching methodology and results for Australia and energy modelling results showing the additional cost of transmission, spilled energy and storage for the Australian Electricity Market is less than 2.5c/kWh.

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Unravelling the plumbing system feeding Ohakune and Pukeonake vents (TVZ, NZ) through a high-resolution compositional study of zoned phenocryst populations

Welsh O[1], Ubide T[1]
[1]*The University Of Queensland*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Undergraduate student at the University of Queensland studying the subsurface volcanic processes within mafic satellite vents in New Zealand under the supervision of Dr Teresa Ubide.

The study of eruptive mechanisms and pre-eruptive magmatic history provides insight into Earth dynamics and the understanding of the processes that lead to hazardous volcanic eruptions. This study encompassed the petrographic, geochemical and thermobarometric analyses of compositional variations within pyroxene phenocrysts, as indicators for the conditions within the magma complex prior to eruption. The focus was on two small volcanic vents (Pukeonake and Ohakune) that are encompassed within the larger Tongariro Volcanic Centre, which is part of the volcanically active Taupo Volcanic Zone (New Zealand). The rocks are porphyritic basalt scoria clasts that contain phenocrysts of pyroxene, olivine and plagioclase. Compositional changes throughout the phenocrysts growth suggest magma recharge as the main instigator for volcanic eruptions in the past. Furthermore, petrographic, geochemical and thermobarometric analyses indicate that both magma systems experience stagnation at depths where mafic rejuvenation promotes magma migration throughout the magma systems. The magma system feeding Pukeonake is a combination of deep and relatively shallow mush systems, whilst Ohakune was fed by a deep seated magma system. The composition of the recharge magma, however, is similar in both locations, suggesting a common magma source and different migration paths towards the surface. This study suggests that volcanic eruptions at the Taupo Volcanic Zone can be triggered by magma recharge at a range of crustal levels. Further research will look at the trace element geochemistry within the phenocrysts to further understand the magmatic processes that are occurring, with the aim of guiding the interpretation of future geophysical signals of unrest.

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The Future of Mineral Exploration in Australia – Addressing the Challenges

Cairns C[1,2], Coombes J[3,2], Jeffress G[4,2], Masters S[5,2]
[1]Stavely Minerals Limited, [2]AIG JORC Representatives, [3]Coombes Capability, [4]CSA Global, [5]CS-2 Pty Ltd

TS3 - 3.4 Resources sustainability – responsible investment and management, Room R2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Christopher Cairns completed a First-Class Honours degree in Economic Geology in 1992 and has since gained extensive exploration and development experience in Australia, the Philippines, Indonesia and China. Mr Cairns is the former Managing Director of Integra Mining Limited a successful WA gold explorer turned producer. In 2008 Integra was 'Australian Explorer of the Year' and in 2011 was 'Gold Miner of the Year'. In January 2013, Integra was taken over for $426 million.
Mr Cairns is a Member of JORC, Chairman of the Australian Prospectors and Miner's Hall of Fame and is the Managing Director of Stavely Minerals Limited.

Australia's mining industry, with 68% of total exports in 2016-2017, is the single largest export industry by value. As a significant component of the economy, it is essential that the sustainability of the resource base be maintained.
However, while Australia is well endowed with identified mineral resources for the bulk commodities, it is apparent that future base and precious metal production levels are not sustainable at current rates of production. This lack of sustainability in base and precious metals is primarily due to declining orebody discovery rates of quality mineral deposits relative to production rates.
Mineral exploration, which underpins Australia's rate of orebody discovery and feeds into eventual production, is facing a number of challenges including:

- Decreasing quality of discoveries
- Technological challenges associated with exploring under increasing cover;
- Talent shortage;
- Policy and access constraints;
- Land access; and
- Funding or access to capital.

Land access is a critical issue and the minerals industry, especially at the exploration stage is being challenged by social movements which are highly effective in restricting land access for exploration.
Access to capital and funding incentives continue to hamper exploration. Government policy and incentives can play a significant role in ensuring continued pipeline of discovery that underpin the Australian economy.
This paper highlights some of the challenges to maintaining a sustainable minerals industry and seeks to stimulate constructive debate that can enhance Australia's ability to address the challenges and stimulate exploration towards the discoveries Australia needs.

620

Detrital zircon provenance of the Precipice Sandstone

Ciesiolka R[1]
[1]*University Of Queensland*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Rachael is currently undertaking her Honours program part time at UQ, while dipping her toes part time in the coal industry. She is interested in all things provenance - particuarly the meeting places between geochemistry and sedimentology/stratigraphy.

Petrographic (QFL) and detrital zircon (U-Pb) data are used to investigate provenance and diachroneity of the Late Triassic-Early Jurassic Precipice Sandstone, Surat Basin. 8 samples from key intervals in the main depocentre of the lower Surat and upper Bowen succession are integrated with previous sedimentological, mineralogical and palaeocurrent data to determine relative source rock contribution through time. Data is further compared to 7 samples from the Precipice Sandstone located in the south west margin of the system, to examine the basin's younging and changes in sandstone composition and potential provenance. The results will shed light on early Jurassic sediment dispersal systems of the east Gondwanan margins and potentially improve predictive stratigraphic modelling of this unit.

621

Methane production and genomic exploration of a coal-degrading methanogenic microbial consortium.

Gong S[1], Greenfield P[1], Midgley D[1], Sestak S[1], Tran-Dinh N[1], **Vergara T[1]**
[1]*Csiro*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Tania Vergara is an analytical chemist in CSIRO's energy business unit. She received her master's degree in Analytical Chemistry from University of New South Wales in 2015. Working alongside microbiologists and geochemists, her current research interests include well reservoir characterisation as well as stable isotopes.

Biogenic methane within coal seams represent a significant energy resource that is potentially able to be enhanced through various interventions. The water filled cleat network within coal seams is a habitat to some ~50-400 species of bacteria and archaea. In this environment, microbes work to degrade the coals, though relatively little is known about the contribution of individual microbes to the process. In the current study, a methanogenic microbial consortium from eastern Australian coal seam formation water was grown under anoxic conditions in the laboratory. This consortium readily produced methane from coal as a sole source of carbon. Its ability to undertake these degradations was examined using metagenomics sequencing. The genetic potential within the metagenome was examined from a holistic perspective and also when genomes were subject to individual binning as genomes. Genes and organisms with potential activity against simple mono-aromatic compounds were detected and are described. Future directions in this field are explored from the perspective of improving microbial methane generation from coal.

622

Exploration undercover - What can we learn from the Canadian experience?

Rowins S[1]

[1]*Centre For Exploration Targeting, University Of Western Australia*

TS1 - 3.1.1 Effective exploration and discovery under cover, Hall E2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:

Stephen Rowins is the Director of the Centre for Exploration Targeting and Professor of Mineral Geoscience at the University of Western Australia. He was previously the Chief Geologist and Executive Director of the British Columbia Geological Survey. He has held academic appointments at the University of British Columbia and the University of Victoria, and has worked for major, mid-tier, and junior companies. He was Vice-President Exploration of Northern Abitibi Mining Corp., which was named the 2010 Prospector/Explorer of the Year (Newfoundland Branch) by the Canadian Institute of Mining and Metallurgy for the discovery and delineation of the Viking gold deposit

Grassroots mineral exploration historically has avoided areas of cover owing to drilling costs, difficulties identifying the bedrock source of mineralization, and the absence of efficient and cost-effective exploration tools. Although subsurface modelling methods to determine bedrock topography and depth of sedimentary cover have been used for years in hydrogeological and geotechnical engineering projects, and in petroleum exploration (‘isopach mapping’), the construction of 3D depth-to-bedrock block models for metallic mineral exploration is rare. Recent efforts, however, have used public well-water records for first-order estimates of cover and proprietary digital datasets from industry (diamond drilling logs, outcrop maps, and gridded soil surveys) for more accurate, district-scale, estimates. The other major tool used for exploration under cover are indicator minerals such as apatite, magnetite, epidote, tourmaline, zircon, chalcopyrite, and gold. Their use in Australia has received less attention than in glaciated areas such as occur in Canada, where samples are routinely collected for mineral separations during regional till surveys, and commercial laboratories offer analytical packages that target specific minerals and deposit types. This makes it relatively easy for exploration companies to incorporate indicator minerals into grassroots exploration programs. Some indicator minerals are more developed than others, and some (apatite, magnetite) target a wide variety of mainly magmatic-hydrothermal deposit-types whereas others (e.g., epidote, tourmaline, zircon, chalcopyrite) target specific styles of mineralization such as porphyry systems. Together, the subsurface mapping methodologies and indicator mineral techniques provide a powerful set of new tools for undercover exploration

623

Recent and rapid ice unloading in Antarctica unveils the solid Earth's viscoelastic rheology (GSA Mawson Medal Lecture)

King M[1]

[1]*University Of Tasmania*

TS5 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Matt King is Professor of Polar Geodesy at University of Tasmania where he specialises in geodetic observation of solid Earth deformation, notably glacial isostatic adjustment, and measurement of ice sheet and sea-level change. He particularly focuses on Antarctic deformation associated with past and present ice sheet changes. His research has been recognised by the Royal Society (London) who awarded him the 2015 Kavli Medal and, most recently, by the Australian Academy of Science's award of the 2018 Mawson Medal and Lecture.

Commencing in the 1990s a series of floating ice shelves broke up in the northern Antarctic Peninsula. While this did not directly affect sea level, the ice shelves provide buttressing forces to upstream glaciers, which almost instantly sped up and commenced thinning. This near-instantaneous commencement of surface mass unloading resulted in rapid changes in bedrock uplift in this region as captured by nearby GPS stations. The deformation could not be explained by a purely elastic response to surface loading changes but requires a viscous component. Forward modelling of viscoelastic deformation suggests an upper mantle viscosity of around 10^18 Pa s in this region. It is now 16 years since the most recent major unloading event and this presentation will provide an update on this and other contraints on upper mantle viscosity in this region.

624

Organic matter-metal interactions in the Cambrian metalliferous shales from South China

Pages A[1], Barnes S[1], Schmid S[1], Le Vaillant M[1], Ryan C[1], Fan H[2], Wen H[2]
[1]CSIRO Mineral Resources, [2]State Key Lab of Ore Deposit Geochemistry

TS5 - 2.6 Geobiology & 2.8 Earth, life and ores, Room R1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Anais Pages completed her BSc in Earth and Marine Sciences, at the University of Bordeaux in France and MSc in Environmental Sciences between Bordeaux University, Southampton University (UK) and Griffith University. Dr Pages then undertook her PhD in organic and isotopic geochemistry at Curtin University. After her PhD, Dr Pages joined CSIRO as a Postdoctoral Fellow to work on euxinic metalliferous black shales from China and Australia.
Dr Anais Pages is currently working as a Research Scientist to characterise the role of organic matter on metal transport and accumulation in sedimentary basins and regolith environments.

About 542 million years ago, a transition from oxygen-deficient to oxygenated oceans triggered the evolution of complex multicellular life at the Precambrian-Cambrian boundary. At this time, both the evolution of metazoan radiation and the deposition of sub-economic metalliferous black shales were triggered in the shallow waters of the Yangtze platform in South China. The thin accumulation of Ni, Mo, Au, Ag, Se, Cr, V, Zn, U, REE and PGEs can be traced along the same stratigraphic horizon over distances of several hundreds of kilometers. This is one of the most enigmatic examples of a sediment-hosted base and precious metal deposit showing an association of ore-grade metals with organic matter.

The present study aims to investigate in details the spatial distribution of metals in this rare ore layer, providing further insights into the genesis of this ore layer and paleoenvironmental conditions associated with the Cambrian explosion in South China. Complimentary techniques such as whole rock geochemistry, Synchrotron-based x-ray fluorescence microscopy and microprobe analysis were used to investigate specific micro-scale distributions of phosphorite nodules, metals and organic-rich matrix. This fine-scale study of metals and organic matter allows a greater understanding of organic-inorganic associations in this unique, highly anoxic and sulfidic sedimentary system, in the context of the Cambrian bioradiation of metazoans.

625

Mapping of areas at risk of flooding in the alluvial plains: case of Fombap (plain of Mbo, west-Cameroon)

Djukem Fenguia S[1], Nkouathio D[1]
[1]*University Of Dschang*

Biography:
assistant Professor of Applied Volcanology, University of Dschang- Cameroon, Faculty of Science, Department of Earth Sciences

An analysis of the environmental factors responsible for the floods in the locality of Fombap has shown that the natural conditions of this environment coupled with human activity are very favorable to the flood process. Indeed, geomorphologically, the locality of Fombap consists mostly of flat terrain with slopes that vary from low to steep. Geotechnically, soil texture is dominated by sands and clays. Thus, sandy soils promote a rapid rise in the water table while very clay soils induce a waterproofing of the latter. Hydrologically, precipitation is high and falls very sharply over very long periods. The water table is very close to the surface and is very quickly loaded after the first rains; which prevents the waters from continuing their infiltration generating floods. Remote sensing and GIS were used to map areas at risk of flooding in the study site. As a result, 69.41% of the total area of Fombap is subject to a significant risk of flooding. Potential effective solutions for risk prevention in the area concern the deepening of river beds and rivers, particularly the Menoua watercourse, the creation of water retention basins and the raising of the level of houses by ratio to the height of the floods.
Key words: flood risk, alluvial plain, Fombap, GIS, soil permeability, soil particle size, risk mapping

626

Low level gold determinations using pXRF: towards a new paradigm in gold exploration

Bolster S[1], Lintern M[2], Williams P[1]
[1]Portable ppb Pty Ltd, [2]C/o Portable ppb Pty Ltd

TS7 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Simon is a geoscientist with more than 30 years mineral exploration experience with work across 5 continents and more than 30 countries from the Tundra to the Tropics. Much of his career has revolved around gold exploration and geochemistry and how to account for the 'regolith factor' and apply this to mineral exploration. He has worked for a number of large companies including Normandy Exploration, Anglo American and Newmont Mining. He is now the Managing Director of Portable ppb Pty Ltd which is focused on research and development of CSIRO's detectORE technology.

With the rate of new gold discoveries decreasing and most of the "low hanging fruit" being picked, the gold exploration business is in dire need of a new exploration paradigm; we can't afford to keep exploring in the same way as we have over the last three decades. Discovery costs are being predicted to increase by a further $10/oz in the near term, adding to the current high of $70/ounce (Schodde, 2018).

The recent invention of the detectORETM technology by the CSIRO in Perth incorporating portable XRF enables explorers to determine gold concentration to ppb gold concentrations within 24 hours from a field camp. This is a quantum shift in gold sensitivity using off-the-shelf pXRF, and this opens up the possibility of being able to complete continuous gold exploration at meaningful low gold concentration levels without the need to transport samples and await assay results before deciding on the next step of the exploration program. The detectORETM process is being tested across the full range of exploration samples from stream sediments to drill samples, initially in Western Australia but expanding out to Africa and beyond, as our company undertakes extensive fit-for-purpose field trails and prepares this Patent Pending process for global commercial release.

The talk will demonstrate results using this new technology compared with those from conventional assays and go on to demonstrate the impact of having near immediate results, enabling gold exploration programs to be adapted and focused on-the-fly in the field.

627

Low level gold determinations using pXRF: towards a new paradigm in gold exploration

Bolster S[1], Lintern M[2], Williams P[1]
[1]Portable ppb Pty Ltd, [2]C/o Portable ppb Pty Ltd

Biography:
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The talk will demonstrate results using this new technology compared with those from conventional assays and go on to demonstrate the impact of having near immediate results, enabling gold exploration programs to be adapted and focused on-the-fly in the field.

628

Sandbox Modeling and 3D Analysis of Fold-Thrust-Belt Deformation: implications for New Hydrocarbon Play of Eastern Indonesia

Sapiie B[1], Hadiana M[1], Al Furqon T[1]
[1]*Institut Teknologi Bandung*

Biography:
1987 Bsc. in Geology from Institut Teknologi Bandung (ITB), Indonesia. 1998 Ph.D degree in Structural Geology and Tectonics from The University of Texas at Austin, Texas, USA. 2009-2010 Visiting research scientist as geomechanics for nuclear waste deep bore hole project at Nuclear Sciences and Engineering (NSE), MIT, USA. Research scientist and consultant for several major oil and gas company in various regional exploration study in Indonesia. Research interest include; understanding fault and fractures, fault-seal analysis, balancing cross-sections, sandbox modelling, geomechanics and regional tectonics.

Fold-Thrust-Belt (FTB) geometry is one of the most complicated structural geology. Therefore, special techniques need to be applied for studying their fault geometry and mechanism. In this paper, we introduce an integrated 3D analysis of FTB using 3D seismic interpretation, balancing cross-section and analogue sandbox modeling. Internal deformation and mechanism of FTB was evaluated using particle velocity analysis for understanding fault sequences as well as timing. In addition, the result of the study was applied in evaluating hydrocarbon potential along Timor and Tanimbar FTB of Eastern Indonesia. 3D seismic interpretation shows three different styles of deformation occurred in the study area including early normal faults following by fold-thrust belt and late normal faults system. Using balancing cross-section approaches we generated 3D palinspatic reconstructions of the FTB and the result was used as based for conducting sandbox modeling. The quantitative comparison between modeling and field data was done in term of fault dips, fault sequences, morphology of the FTB including their slope. Our analysis suggested that development of FTB is mostly controlled by several geological parameters such as interbedded lithology types, layer thickness as well as pre-existing geological condition such as basement configuration. Three different cases and 5 experimental setting were run to get better match between analogue modeling and field data. The results exhibit that FTB in the study area experienced more than 36% shortening with flat-ramp geometry involving Cretaceous stratigraphy as major detachment. Hydrocarbon prospect was identified as structural traps mostly formed 3-way dip closure involving Tertiary carbonate sequences.

629

Exploring New Hydrocarbon Potential in the Bird Head Area, Papua Indonesia

Sapiie B[1], Gunawan I[1], Rudyawan A[1], Harsolumakso A[1], Abdullah C[1], Kusumadjana A[1], Hadiana M[1]
[1]*Institut Teknologi Bandung*

Biography:
1987 Bsc. in Geology from Institut Teknologi Bandung (ITB), Indonesia. 1998 Ph.D. degree in Structural Geology and Tectonics from the University of Texas at Austin, Texas, USA. 2009-2010 Visiting Research Scientist, NSE-MIT, USA. Research interest: understanding fractures and fault, fault-seal analysis, geomechanics, sandbox modelling, regional tectonics

Recent fieldworks result in the Bird Head area including Halmahera, Biak and Yapen Islands generated several new exploration targets for hydrocarbon potential in the eastern Indonesia region. Geologically, this region is divided into two tectonic element which are Australian and Pacific plates affinity. Australian continental sequences are known as prolific hydrocarbon target where Pacific plate is more oceanic with little evidence hydrocarbon occurrences. In general, exploration in the area have been slow due to several dry well experienced in the past. New exploration concepts as well as plays need to be generated in order to invite more participation from foreign oil and gas companies. This new data sets were collected during fieldworks campaign utilizing new road constructions in various locations in the island. Fresh and new outcrops were found exposing geologic information which help to generate new targets particularly related to Mesozoic stratigraphy. Analysis of source rocks samples were collected from Permian, Triassic and Miocene shales refill excellent information related to time of maturity, charging and migration in the area. New Triassic and Cretaceous sandstone reservoir target were also concluded from several outcrops locations. Integrated surface geological information and subsurface data particularly well and seismic suggested several new exploration target areas such as below Lengguru Fold-Thrust Belt, Aru Through and Southern Central Range of Papua. In addition, fieldworks in the eastern Halmahera island found excellent Eocene lacustrine source rock as well as carbonate reservoir target.

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Scientific deep drilling in Koyna, India: achievements and perspectives

Bansal B[1], Roy S[2]
[1]Ministry Of Earth Sciences, [2]Borehole Geophysics Research Laboratory

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Brijesh Kumar Bansal is currently heading Seismology and Geosciences Division, Ministry of Earth Science, Government of India. He specializes in the field of seismology and has more than 30 years' experience as pro-active researcher and science planner. Under his leadership and guidance science of seismology has witnessed major growth including transitions from analogue-digital-real time monitoring, induction of inter-disciplinary programs for high resolution imaging of crustal structures and dynamics. His personal research accomplishments in field of seismic hazard assessment have paved way for technology based microzonation studies all over the country.

Scientific drilling is a powerful modern tool of Earth Science research spanning a wide range of problems from tectonics through exploration of sustainable geo-resources to climate change. A major scientific drilling programme has been taken up by the Ministry of Earth Sciences (MoES), to investigate recurrent reservoir triggered seismicity (RTS) during the past five decades in the Koyna region, western India. Under the exploratory phase of drilling combined with land and airborne geophysics, nine core boreholes, up to 1522 m in depth, were drilled at selected sites along the periphery of the Koyna seismogenic zone. Several new findings such as the thickness of Deccan Traps (412-1251 m), nature of the underlying granitic basement rocks, subsurface temperature, physical and mechanical properties of rocks, etc. provided invaluable information required for carrying out further deep drilling in the region.
As a part of the project, drilling of a pilot borehole to a depth of 3km has been completed recently. Passing through 1247 m of Deccan Traps followed deeper by crystalline basement, this is the deepest borehole drilled through such hard rock formations in the country. Rock samples have been collected at regular intervals for detailed laboratory studies. The pilot borehole not only tested the capability of drilling to such depths in hard rock but also opened up new possibilities for addressing fundamental problems in understanding earthquake mechanisms using near-field datasets. The pilot phase will be followed by deep drilling up to 7 km to set up a deep borehole observatory.

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Best practice for determining baseline methane conditions in aquifers – practical application for tight shale developments

Gornall D[1]
[1]Santos, [2]NA

TS7 - 3.3.5 Groundwater science for policy development and decision making, Room R5, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
David is senior environmental advisor and hydrogeologist at Santos. He provides groundwater advice regarding Government policy and legislation as it pertains to the development and operation of Santos' onshore oil and gas projects located in Queensland, South Australia and the Northern Territory. He also oversees the delivery of groundwater assessments, monitoring and management within Santos. As part of his role, David also sits on several councils, committees and working groups that report to peak bodies, government departments and research institutions in relation to the potential for oil and gas industry interference with groundwater resources.

Various drivers for baseline monitoring of subsurface methane emissions exist for the upstream gas industry. Drivers may include the regulatory approval of project environmental impact assessments, the reporting of greenhouse gas emissions, and the need for transparency to maintain a social license to operate.
Regulatory and industry policies for baseline monitoring of subsurface methane continue to evolve. Historically, the baseline monitoring strategy for upstream unconventional gas industry typically comprises detection of dissolved methane concentrations taken opportunistically from groundwater samples in water bores located on-tenement. However baseline sampling strategies can comprise many other sample types, locations and testing techniques. However application of these techniques may be costly to deploy and interpretation of results requires specialist expertise.
This paper proposes a seminal framework for determining effective baseline monitoring of subsurface methane.
An understanding of potential gas sources and migrations pathways should be developed via a conceptual model. The conceptual model would synthesise available knowledge of reservoir geology and hydrodynamic forces to highlight potential historic and future migration pathways. Baseline monitoring strategy should be designed to test and refine the understanding presented by the conceptual model, as well as determine the extent and characteristics of different subsurface gas sources. As more data become available throughout the baseline monitoring period, both the conceptual model and baseline monitoring strategy should be periodically reviewed. This approach ensures that the conceptual model continues to reflect the evolving knowledge, and that the monitoring strategy addresses the most critical knowledge gaps and remains cost effective.

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Geochemical exploration criteria of zircon within basement and cover sequences

Brotodewo A[1,2], Tiddy C[2], Giles D[2], Fabris A[3], Plavsa D[2]

[1]University of South Australia, [2]Futute Industries Institue, [3]Geological Survey of South Australia

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:

PhD candidate at Future Industries Institute, at the University of South Australia, and is undertaking her research as part of MinEx CRC. She previously completed a Bachelor of Science (Mineral Geoscience) with Honours at the University of Adelaide in 2016. Adrienne's current research is focusing on establishing a geochemical exploration criteria in mineral phases within basement and cover sequences in the Gawler Craton.

With the increase in population, technology and rising standards of living, an increase in deposit discovery is necessary to meet growing global metal demand. Consequently, the exploration frontier is moving to progressively deeper terranes, therefore there has been a shift towards understanding how the cover can be used to aid exploration rather than hinder it (e.g. Forbes et al., 2015: J. Geochem. Geol.; De Cartitat et al., 2016: AJES).

Zircon can be associated with hydrothermal mineral growth and has a resistate nature, making it an ideal mineral indicator for targeting mineralisation in regions with thick sedimentary cover. Few studies have investigated the potential of zircon as a pathfinder mineral through analysing its geochemistry (e.g. Cao et al., 2011: J. Rare Earths; Lu et al., 2016: Soc. Econ. Geol. Sp. Pub. 19), however little work has been done on this within the Gawler Craton. This project will investigate the broad differences in zircon chemistry from various rock sequences in the Gawler Craton, through analysing distinct textural and chemical characteristics. This information will be used to identify geochemical anomalies in zircon grains over selected mineral deposit case study areas. Focus will be placed on mapping the geochemical footprint of zircon within the basement rocks that host mineralisation, and how this signature may be translated into overlying, younger cover sequence materials. A final synthesis will lead to the establishment of an exploration criteria using the chemistry of zircon, which would be applicable to exploration within both basement and cover sequences in South Australia.

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A perspective on the formation and evolution of Earth's first stable continents

Johnson T[1]
[1]*Curtin University*

TS4 - 1.1.4 Crustal evolution of Archean Cratons, Hall A, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Tim Johnson's research has concentrated on the study of crystalline rocks from a variety of geodynamic settings and what these can tell us about fundamental lithospheric processes. His expertise lies in metamorphic petrology, in particular the application of phase equilibria modelling using internally consistent thermodynamic data.
Johnson has specific interests in the generation, segregation and migration of melt in the crust and upper mantle, the fundamental processes driving the evolution of the lithosphere. More recently his research has concentrated on early Earth processes, in particular in Archaean geodynamics and the generation and modification of Earth's first crust.

There is growing consensus that the bulk of Earth's primary (juvenile) continental crust had already formed by the end of the Archaean Eon. The surviving remnants of this ancient continental crust mostly comprise variably deformed and metamorphosed magmatic rocks of the tonalite–trondhjemite–granodiorite (TTG) suite that formed by partial melting of hydrated basaltic rocks. However, the geodynamic regime under which TTG magmas formed is a matter of ongoing debate. Uniformitarian views hold that the bulk of juvenile Archaean continental crust formed as supra-subduction zone magmatic arcs in some form of plate tectonic (or 'mobile lid') setting. However, proponents of non-uniformitarian views suggest that most formed near the base of a thick, deformable, more-or-less continuous mafic crust (a 'stagnant lid' setting). Distinguishing between these end-member scenarios is difficult, due in part to the antiquity and resultant complexity of the rocks, which have generally undergone intense polyphase deformation and high-grade metamorphism. Here I highlight the controls of upper mantle temperature on lithosphere geodynamics in the early Earth and their probable consequences for the (early) Archaean rock record. I will argue that numerical modelling provides a powerful analytical tool whose predictive powers will improve as we refine the inputs from other avenues of investigation, including field geology, mineralogy and petrology, geochemistry, stable and radiogenic isotopes and equilibrium thermodynamics. While the debate will continue to rage, much of the progress made in recent years suggests that a view of the early Earth as being dominated by uniformitarian processes is becoming increasingly difficult to justify.

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Depositional history of the Condamine Palaeo-valley: a unique sediment record

Bianchi V[1], Caldicott C[1], Dallanave E[2], Esterle J[1]
[1]University Of Queensland, [2]Munich University

TS4 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
In 2008, Valeria successfully completed a Master of Science in Petroleum Geology. The project was focused on outcrop and subsurface study of the Eocene sedimentation in foredeep basins of the Northern Italy.

In 2014 she awarded a PhD in Sedimentology at the University of Padua, Italy. Her research aimed at studying alluvial systems in incised valleys, with attention to climate and tectonic control on sedimentation.

Valeria is currently Postdoc for the Energy and Resources Group, at the University of Queensland. Her expertise spans from sedimentology, stratigraphy, geophysics interpretation to 3D stratigraphic forward modelling.

Although intense weathering was a dominant condition throughout Australia during the Middle-Late Tertiary, the Condamine Palaeo-valley was infilled by alluvial sediments, preserving a unique sedimentary record. The Condamine Palaeo-valley is located in SE Queensland and hosts groundwater resources for this area. Furthermore, the valley is known for its important palaeontological Megafauna discoveries, such as the Diprotodon. The Tertiary and Quaternary surface geology was recently mapped by the Geological Survey of Queensland, however, the stratigraphy of those units has not been published.

This research aims to develop a stratigraphic framework for the palaeo-alluvium using an integrated approach of sedimentology, X-Ray Fluorescence (XRF) elemental analysis and magnetostratigraphy. The sedimentology assists in understanding the depositional environments during the infill of the palaeo-valley. The XRF analysis highlights a stratigraphic zonation and helps to speculate on the sediment provenance. The magnetostratigraphy contributes to time constraining the depositional history. The dataset consists of two drill cores that intersect the whole valley infill in the northern and southern area.

Analysing the variations of the depositional environment over time helps to determine the Tertiary-Quaternary climatic factors that controlled the sedimentation. This result is significant to complete the record of recent climatic variability and enhances the knowledge of the environmental changes. Potentially, this research can add to the understanding of the physical landscape where Megafauna lived and died.

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New developments in analytical techniques for efficient characterization of geologic materials: research outcomes of the Deep Exploration Technologies CRC

Uvarova Y[1], Tassios S[2], Francis N[1], LeGras M[1]
[1]CSIRO Mineral Resources, [2]CSIRO Manufacturing

TS7 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Dr Yulia Uvarova is a Principal Geochemist and Research Group Leader in CSIRO Mineral Resources. For the last 6 years, Yulia has been leading research in one of the projects within Deep Exploration Technologies CRC, which will lay the foundations of future Lab-at-Rig® platforms that will take advantage of new sensor technologies and develop the application beyond current deployment in greenfields exploration.

Portable X-ray fluorescence (pXRF) spectrometry has applications in a wide range of studies, including alloy metals industry, environmental sciences; archaeology; non-invasive analysis of museum artefacts; rapid screening of toxic elements in various media; and soil analysis and agriculture. In the last decade, pXRF analysis has also emerged as an important analytical technique for exploration and mining. Portable XRF offers rapid and cost-effective analysis of geologic samples and provides data of high quality and accuracy where appropriate calibration and quality assurance/quality control protocols are followed. Conversely, until now powder X-ray Diffraction (XRD) has been a technique that is used mainly in research. With the advancement in hardware technology, namely X-ray tubes, detectors and processors, and more powerful and sophisticated software packages, X-ray diffraction (XRD) has become a qualitative and quantitative tool for the identification of crystalline materials, and has tremendous potential applications in exploration and mining. With the current progress in development and implementation of automated algorithms for data processing, XRD has the potential to become a routine technique for analysis of geologic materials. Laser-induced breakdown spectroscopy (LIBS) is also emerging as an analytical tool for analysis of geologic materials particularly due to its ability to yield information on elemental composition including essential light elements (B, Li, C, Na, Mg at low levels) that are currently not measured by air-based pXRF detectors. Our study demonstrates new developments in XRD and LIBS analytical techniques that are the results of a collaborative research effort within Deep Exploration Technologies Cooperative Research Centre.

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Mineral Resources, Mining & Sustainability: Critical Issues, Critical Metals and Australia's Opportunities

Mudd G[1]
[1]*RMIT University*

TS5 - 3.4 Resources sustainability – responsible investment and management & 3.5 Technology integration, Room R2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Gavin Mudd is an associate professor of Environmental Engineering at RMIT University, Australia. He is a renowned global expert on the environmental impacts and sustainability of mining, encompassing most commodities including uranium, base metals, precious metals, critical metals and bulk minerals. Gavin is also Chair of the Mineral Policy Institute, an Australian civil society organisation focused on assisting communities affected by mining projects and achieving industry reform through improvements to policy, law and practice. He has published over 200 book chapters and journal and conference papers - all with a strong reputation internationally - a truly unique career to date.

Mining is simple yet complex – it provides the energy, metals and minerals we use directly or indirectly every day but would be considered unsustainable since resources are finite (except renewable energy). Yet describing mining as contributing to sustainable development is now the stated aim of the global mining industry. In reality, mining is now bigger than ever and society is demanding an ever more complex mix of metals for uses such as consumer electronics, telecommunications, military technology, renewable energy generation and storage, medical equipment, etc (e.g. rare earth elements, indium, selenium, gallium, tellurium, germanium, lithium, platinum group elements). Many of these metals are labelled as 'critical' due to their fundamental importance in modern technology – but very little is known about them and even less about their resources and mining. What we do know is that most critical metals are produced almost exclusively as by-products at base metal smelters or refineries and mines rarely (if ever) receive payment for the presence of such metals in concentrates. The lack of data in mining, smelting and refining is often confused with lack of (or potential to increase) supply. Given this dependence on base (and precious) metals, there are significant opportunities for Australia to become a reliable supplier of critical metals to a tech-hungry world – but this hinges on many issues. This presentation will present a unique overview of the key sustainability issues facing mining and especially the role of critical metals in the future of the industry.

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Sulfur isotope cycles in deep time; relationships to ocean chemistry and large igneous provinces

Large R[1], Ireland T[2], Gregory D[3], Steadman J[1], Mukherjee I[1]
[1]University Of Tasmania, [2]ANU, [3]University of California Riverside

TS1 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Ross Large was the foundation director of CODES. He is now an emeritus distinguished professor at University of Tasmania undertaking research on pyrite chemistry related to mineral exploration and fundamental Earth questions.

A new dataset set is presented of sulfur isotopes measured by microbeam on the SHRIMP SI, from carefully selected sedimentary pyrites in marine black shales, distributed throughout the Precambrian and Phanerozoic. The data defines two coherent populations termed P1 and P2. Population P1 dominates the Archean pyrites, has a mean of d34S = 3 per mil and is considered to represent S of mantle origin. P1 can also be identified in sedimentary pyrite at certain times in the Proterozoic and Phanerozoic, which correspond, within error, with the timing of fifteen major LIP events. Population P2, appears toward the start of the Proterozoic, dominates the Phanerozoic, has a mean around +20 per mil and is considered to represent S of seawater sulfate origin. LA-ICP-MS analyses of sedimentary pyrite grains from P1 show that many have significantly elevated concentrations of Pt, Au, Co, Ni and Te compared with pyrite from P2, which shows comparatively elevated As, Mo, Se, Ba and Sb. The combined anomalism of S-isotopes of mantle origin, metals commonly associated with mantle melts (Pt, Au, Ni, Co), and timing coinciding with fifteen recorded LIPs through time, is strong support for derivation of these anomalous components in P1 pyrites, from major LIP eruptive centres which ejected aerosols containing mantle S, Pt, Au, Ni and Co into the stratosphere, eventually, to be dispersed in the oceans and ultimately become trapped in sedimentary pyrite. Constant cycling of sulfur isotopes is a feature of post Archean oceans.

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In situ LA-ICPMS Rb-Sr dating of phengite in eclogite; bench marking against zircon U-Pb and garnet Lu-Hf

Tamblyn R[1], Hand M[1], Gilbert S[2], Zack T[3]
[1]The University Of Adelaide, [2]Adelaide Microscopy , [3]University of Gothenborg

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Renée Tamblyn is a PhD candidate at the University of Adelaide, in her second year. Her PhD focusses on high-pressure metamorphism, specifically the emergence of cold subduction-style metamorphism on Earth.

Eclogite and blueschist facies assemblages are formed during high-pressure low-temperature metamorphism of oceanic crust, conditions exclusive to subduction zones. As such, eclogites and blueschists are important indicators and recorders of palaeo-subduction, and have been used widely to indicate the location, timing and physical conditions of subduction zones. However, a difficulty lies in constraining the age of mineral assemblages. Accessory minerals such as zircon are typically very fine-grained, and in mafic rocks U–Pb dating of rutile and titanite is commonly hampered by low U. Lu–Hf and Sm–Nd dating of garnet and lawsonite offers a way to directly relate age data to modelled mineral parageneses, but is difficult to implement on extensive sample sets. Ar–Ar provides little information about the timing of deep burial. A potential new avenue that offers rapid age characterisation is in-situ LA-ICP-MS Rb–Sr dating of white mica. Rb–Sr closure in white mica is thought to be around 500 C, meaning it will preserve ages in many low-temperature high-pressure rock systems, and is able to be modelled in mineral equilibria forward models, meaning the age data can be directly linked to the mineral paragenses. We show that in-situ Rb–Sr data from prograde zoned white mica in eclogite at Port Macquarie in the southern New England Fold Belt is consistent with peak metamorphic ages from zircon, garnet and lawsonite. In-situ Rb–Sr geochronology of mica may be a way to rapidly characterise metamorphic age patterns in high-pressure terranes.

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A machine learning approach to national scale geochemical predictive maps

Chua S[1], Wilford J[1], Champion D[1], De Cariat P[1]
[1]*Geoscience Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Sean Chua is passionate about innovative solutions to environmental issues and effective science communication for public good and policy outcomes. The tools he employs in this problem space includes statistics and geostatistics, spatio-temporal analysis, remote sensing machine learning along with field based validation methods.

His passion for science communication has also lead to projects in programming for the visual arts and music in an effort to explore new areas and engage with a variety of stakeholders and different audiences.

Understanding the distribution of surface geochemistry at broad scales is a significant challenge. This is due to the sparse nature of point data observations and the complex characteristics of the 'critical zone' (near surface zone between tree tops and groundwater aquifers). Here is where the biogeochemical processes that alter the substrate occur. Creating predictive maps of the major elements deepens our understanding of their spatial distribution within exposed rocks and regolith.

Using a predictive modelling approach based on machine learning, we leverage environmental datasets as covariates to understand their relationship with point observations of the major elements. This process models continuous geochemical surfaces that provide a more nuanced understanding of the geochemical landscape than typical interpolation methods such as Kriging. We generated national predictive maps for each of the major elements at 90 meter resolution. These geochemical maps have applications in understanding the near-surface processes of the Australian continent, improving geochemical exploration and environmental management. They also provide insights into the complex interactions and processes occurring within the 'critical zone'. This approach generates uncertainties of model predictions and provides a repeatable and transparent workflow. Thus this process can be systematically applied to updated covariates and target data as they become available.

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Pixels to Answers

Eaton N
[1]*Ngis Australia*

TS1 - 4.4.1 The Geoscience of Where, Room R7, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Nathan is the Director of Services at NGIS Australia, working with the executive team to deliver effective and innovative location solutions to clients across many different industries. Nathan is a qualified Surveyor and has multiple university qualifications in spatial sciences. Nathan has been instrumental in establishing the partnership between NGIS and technology providers such as Google which have extended the reach and application of map based technology in APAC. As a former Young Spatial Professional of the Year for the Asia Pacific region Nathan has been at the forefront of the location industry and the evolution of map based solutions.

With more and more data available from a variety of sensors geoscientists are now being challenged with distilling information into usable products. Once products have been defined and created the challenge then shifts to putting this information into the hands of the end users who will ultimately use the information to make better, more informed decisions. The level of data capture and availability within sectors such as mining and environmental science is high and seemingly ever increasing whereas the level of use of this data is not appreciating at the same rate. From LiDAR systems attached to heavy vehicles, to unmanned aerial vehicles with thermal imaging the sensor rich future requires new and evolving approaches to producing usable information products. Singular data applications such as sensors for autonomous vehicles (UAV's) have the potential to be used for a variety of applications across operations where the value of individual data products is multiplied through the combination of a many datasets intrinsically linked through location. Whereas in the past a survey of a stockpile was used simply for end of month volumes, data from UAV's can be used for much more than a single stockpile figure.
A number of industry leading approaches for turning pixels into answers will be showcased including visualisation and intelligence platforms in the mining industry, cutting edge cloud based computing in the agricultural sector and openly available self service platforms for climate change and environmental monitoring.

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Rhodonite in the Rosebery mine, Tasmania – the Broken Hill links

Bottrill R[1]
[1]*Mineral Resources Tasmania*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Ralph is a geologist, mineralogist and petrologist working for Mineral
Resources Tasmania (Geological Survey of Tas) where I run the mineralogy/petrology labs and rock collection; and study various Tasmanian mineral deposits, rocks and minerals. I am an associate curator for minerals with both the Tasmanian Museum and the Queen
Victoria Museum.

The Rosebery mine in western Tasmania is one of the worlds largest Pb-Zn-Ag mines. It is an exhalative sulphide deposit, hosted in volcano-sedimentary rocks of the late Cambrian Mt Read Volcanics. The mineralised sequence is locally barter-rich and carbonate-rich, notably with Mn-rich carbonates: rhodochrosite and kutnohorite. The metamorphic facies is mostly lower greenschist, but in the deeper levels of the mines some higher grade metamorphic minerals occur: Mn-rich garnet, biotite, danalite, pyrophanite and rhodonite. These assemblages appear to result from metamorphism and metasomatism due to underlying late Devonian granites, of the Heemskirk-Pine Hill batholith. The Mn-rich minerals (rhodonite, spessartine and pyrophanite) have formed from the metamorphism and decarbonation of Mn-carbonate-rich assemblages, with quartz, mica and Ti-oxides.

The Broken Hill exhalative Pb-Zn-Ag sulphide deposit is also characterised by Mn-rich minerals in meta-volcano-sedimentary rocks, particularly rhodonite and spessartine, and is locally carbonate-rich. No higher oxides of Mn have been found as primary minerals in these deposits. The deposit has been metamorphosed to granulite facies. The deposit is commonly described as forming by metamorphism of exhalative deposits of sulphides and Mn oxides. However some Mn oxide deposits elsewhere have been metamorphosed to granulite facies and show no sign of reduction of higher oxides of Mn to minerals containing Mn2+. Deposits like Rosebery also show that Mn silicates like rhodonite and spessartine form readily by metamorphic carbonation of Mn carbonates. This suggests that the Broken Hill deposit probably also form by metamorphism of deposits rich in Mn carbonates rather than Mn oxides.

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Delivering Geoscience through Google Earth Engine

Eaton N
[1]*Ngis Australia*

Biography:
Nathan is the Director of Services at NGIS Australia, working with the executive team to deliver effective and innovative location solutions to clients across many different industries.

Nathan is a qualified Surveyor and has multiple university qualifications in spatial sciences. Nathan has been instrumental in establishing the partnership between NGIS and technology providers such as Google which have extended the reach and application of map based technology in APAC As a former Young Spatial Professional of the Year for the Asia Pacific region Nathan has been at the forefront of the location industry and the evolution of map based solutions.

Google has been at the forefront of innovation with access to digital mapping content from 2001 when Google Earth was born then in 2005 when Google Maps was released. These two products have completely transformed how we use maps and location in both our work and home lives. The latest innovation from Google is how the Google cloud can be used to process and deliver geoscientific data at a scale that really hasn't been possible before. Google Earth Engine combines a multi-petabyte catalogue of satellite imagery and geospatial datasets with planetary-scale analysis capabilities and makes it available for scientists, researchers, and developers to detect changes, map trends, and quantify differences on the Earth's surface. Google Earth Engine uses Google's enormous cloud infrastructure to provide a distributed processing capability that allows huge archives of satellite imagery to be computed in near real time. Google is enabling organisations to spend more time gaining insights and applying data to real world applications as opposed to managing data workflows and infrastructure.
A dive into the capabilities of Google Earth Engine will be explored including existing implementations of this product for a variety of use cases and organisations including precision agriculture, environmental monitoring and the integration of commercial products with data from NASA and ESA.

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A stochastic approach to estimating mine dewatering requirements at an open pit mine

Brown K[1], Bailue K, Cooper G
[1]Rio Tinto Iron Ore

TS6 - 3.3.2 New groundwater technologies and approaches, Room R5, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Keith has worked as a hydrogeologist predominantly in the mining industry for the last 30 years. for the last 5 years leading the groundwater modelling team at Rio Tinto iron ore Pilbara operations.

Stochastic methods coupled to a 'simplified' approach to groundwater modelling was adopted to assess hydrogeological uncertainty in mine dewatering volumes at a large scale open cut iron ore mine located in the Pilbara region of Western Australia. Predictive uncertainty was incorporated into a risk based framework and cost benefit analysis undertaken.
As a tool the modelling approach is arguably a better way to quantify uncertainty over more complex models due to its flexibility and quicker run times. Stochastic methods also permit utilisation of our extensive datasets; a priori, and more suitably account for the large variability in hydraulic parameters such as hydraulic conductivity and temporal changes due to rainfall recharge variability that is used in the model. Accounting for the variability in the key parameters used in the model, even though local information may be lacking, from a regional viewpoint provides some confidence that model predictions are based on the most likely range of inputs, thus avoiding a type 2 statistical error or Black Swan event.
By attempting to quantify and communicating the uncertainty through risk analysis we are attempting to move the uncertainty in the prediction away from the modeller to broader areas of the business, and in doing so allow them to make informed decisions.

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Determining groundwater recharge in the Pilbara, on balance is it simply a matter of outflow?

Trott S[1], Brown K
[1]*Rio Tinto Iron Ore*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Shane has worked as a hydrogeolgist predominantly in the mining industry for nearly 20 years, for the last three years as Principal at Rio Tinto Iron Ore.

Establishing the water balance is essential in the development of a hydrogeological conceptual model. That is the quantification of inputs and outputs that interact with the hydrogeological regime over a defined domain. Appropriate quantification of groundwater recharge is a key component of the water balance and whilst considered minor, has in our view, been consistently overestimated as an input into groundwater models in the Pilbara.
It is recognised the determination of groundwater recharge is difficult and cannot be directly measured. There are, however, numerous techniques to estimate groundwater recharge. The methods most commonly used are based on either an empirical relationship between rainfall intensity and recharge or chloride mass balance (CMB).
While the former method is advantageous in translating the rainfall-recharge relationship into a model, it potentially disregards well understood hydrogeological processes. In relation to the CMB method, a key assumption in its application is that groundwater is modern and consistently replenished by rainfall rendering the method invalid. While CFC data shows modern recharge is occurring, obtaining groundwater from discrete hydro-stratigraphic horizons to overcome issues of intra-borehole mixing is not common practice and to-date has prevented more detailed analysis.
Both methods have potential to overestimate recharge that in turn results in a requirement to adjust models to remove excess modelled groundwater at points of outflow.
A review of groundwater outflow at catchment boundaries in the Pilbara show little evidence to support the estimates of inflow. We argue that the water balance is best estimated by determining outflow; baseflow and evapotranspiration.

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Correlation of large igneous provinces and black shales during “the Boring Billion”

Zhang S[1], Ernst R[2], Pei J[1], Zhao Y[1], Zhou M[3], Hu G[1]
[1]Insitute of Geomechanics, Chinese Academy of Geological Sciences, [2]Department of Earth Sciences, Carleton University, [3]Department of Earth Sciences, The University of Hong Kong

TS5 - 2.6 Geobiology & 2.8 Earth, life and ores, Room R1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Dr. Shuan-Hong Zhang's research interests include structural and tectonic evolution of the North China Craton, the Central Asian Orogenic Belt, the East Antractica and paleogeographic reconstruction and evolution of the Columbia and Rodinia supercontinents. From 2006, he has published 21 scientific papers in international journals such as Earth and Planetary Science Letters, Earth-Science Reviews, Precambrian Research, Geological Society of America Bulletin, Lithos, Journal of the Geological Society London, International Journal of Earth Sciences, Tectonophysics, Journal of Structural Geology, Geological Magazine, Gondwana Research and Mineralogy and Petrology.

Phanerozoic large igneous provinces (LIPs) have a significant influence on global climate changes and mass extinction events. Most of the Global Boundary Stratotype Section and Points in the Phanerozoic international chronostratigraphic scale are coeval with global-scale LIPs and are marked in the sedimentary record by mass extinction events and/or by ocean anoxic events (OAEs) represented by black shales. However, due to limited knowledge on atmospheric oxygen concentrations, ocean redox conditions and early fossils during the Meso-Neoproterozoic Era prior to the Ediacaran period, little is known on the climate and environmental effects of LIPs during this period of a billion years. In this presentation, we provide evidence for a temporal and genetic link between the remarkably intense ~1380 Ma LIP activity and coeval black shales in the Nuna (Columbia) supercontinent. We propose that the ~1380 Ma LIPs and black shales represent a global-scale geological event and provide a robust natural marker for the Calymmian–Ectasian boundary at 1383 Ma. Our results demonstrate that the Meso-Neoproterozoic global-scale LIPs and black shales can potentially be used as natural markers in the geological record and are of great significance for subdivisions of the international chronostratigraphic scale. The results also suggest that OAEs related to global-scale LIPs may have occurred at other times during “the Boring Billion” (1800–800 Ma) where virtually nothing of Earth’s climate and mass extinction events are known, implying relatively high atmospheric oxygen concentrations and suboxic or mildly oxygenated marine basins interrupted by transient oceanic anoxia engendered by LIPs during this period.

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Leaving a trail: reconstructing past climates from clumped isotope analysis of snail shells

Falster G[1,2], Tyler J[2], Kluge T[3], Dux F[4], Drysdale R[4], Chivas A[5], Tibby J[2], Reed L[2]
[1]Geoscience Australia, [2]The University of Adelaide, [3]Heidelberg University, [4]University of Melbourne, [5]University of Wollongong

TS3 - 1.4 Earth's climate, past, present and future, Hall E1, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Georgy completed her undergraduate studies in geology at the University of Adelaide, where her Honours research was focused on sedimentology and carbonate isotope geochemistry. She worked for Santos Ltd for two years before returning to university to undertake a PhD with Dr Jonathan Tyler, using high-resolution qualitative analyses in conjunction with discrete quantitative analyses, to reconstruct past climate change in southern Australia. She is currently a participant in the Geoscience Australia graduate program, where she is undertaking a rotation in the Collections and Visitor Services team.

Global climate variability during the late Pleistocene is often framed in terms of a pattern of asynchronous temperature variation between the northern and southern polar latitudes. The response of climates in temperate south-eastern Australia to these global changes has attracted increasing recent interest, in part because the landscape is often amenable to the preservation of continuous records throughout the late Pleistocene. This has resulted in the production of several high-resolution records, particularly for the period around 40,000 to 10,000 years before present, which spans the Last Glacial Maximum and subsequent deglaciation. However, these records have mostly been qualitative.

The 'carbonate clumped isotope thermometer' is a novel technique, which relies on the thermodynamic tendency of the heavy stable isotopes of carbon and oxygen (^{18}O and ^{13}C) to 'clump' together in the carbonate mineral lattice. This tendency increases as temperature decreases, allowing estimation of the temperature at the time of carbonate precipitation. This is independent of both source water oxygen isotope composition ($\delta^{18}O$), and specific carbonate phase. However, the carbonate clumped isotope thermometer is still in the early stages of development, and has not yet been tested for all carbonate phases. Here we present temperature and source water $\delta^{18}O$ estimates from modern land snail shells, collected from a broad climate gradient across Australia. We compare the results with observed weather at the time of shell growth to determine the suitability of snail shells for palaeoclimate reconstruction. We then apply our findings to late Pleistocene-aged shells from the Naracoorte Caves, in south-eastern Australia.

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Significance of ferruginous pisoliths in exploring areas covered by sand dunes:
An example from the Yamarna Terrane, Western Australia

Salama W[1], Anand R[1], Saliba L[2], Rogers G[2]
[1]CSIRO, [2]Gold Road Resources

TS7 - 3.1.1 Effective exploration and discovery under cover, Room R2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Dr Walid Salama graduated from Faculty of Science, Cairo University, Egypt. He got his PhD degree from Cairo University in Egypt in collaboration with Friedrich-Schiller University, Jena, Germany. He joined CSIRO since 2012 as a post-doc fellow in the regolith geoscience team and was involved in 11 research projects about mineral exploration in areas of transported cover in Western Australia, Queensland and Botswana.

Areas of transported cover present a great challenge for mineral exploration in Australia. The most north-eastern Yamarna Terrane of the Yilgarn Craton in Western Australia is underexplored without mining activities compared to more than 100 years of exploration and mining activities in the surrounding terranes. The main exploration hurdles are poor outcrop, deep weathering, and a lack of historical mineral discoveries.
The Permian glacial sediments in southern Yamarna truncate the deeply weathered Archaean landscape, which is saprolite dominated with minor areas of exposed ferruginous duricrusts. Erosion of the Archean rocks and Permian sediments produced a blanket of ferruginous pisoliths that are covered by extensive aeolian sand sheets. A new generation of authigenic pisoliths formed near-surface in the aeolian sands. Our findings suggest that Au and As derived from the Smokebush and Toppin Hill mineralisation migrated through the Permian cover and formed surface anomalies in authigenic pisoliths. Gold was extracted by K iodide and cyanide suggesting its particulate and soluble nature, whereas As was extracted by 0.1M tetra-sodium pyrophosphates suggesting its association with organic compounds. The geochemical composition of the pisoliths is not only accurately delineating the location of the Au mineralisation, but also its mineralogy and chemical signature. Pisoliths are anomalous in Au and As over mineralisation where Au is associated with arsenopyrite. Conversely, when Au mineralisation is associated with pyrrhotite, these pisoliths are only anomalous in Au. Therefore, these pisoliths represent a new sampling medium that has not been used before in similarly challenging areas covered by sand dunes.

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The Miocene is the Future: What Past Climates Tell Us Now

Huber M[1]
[1]*Purdue University*

PS1 - Plenary Session: Earth Climate - Past And Future (Hall C), Hall C, October 15, 2018, 9:30 AM - 10:30 AM

Biography:
I work on developing a better understanding of--and ability to predict-- the dynamics of the climate system with an emphasis on investigating past warm climates as a window into future behavior. Much of this work focuses on atmosphere-ocean dynamics with an emphasis on hot conditions, e.g. the tropics. Always in my mind is the implications of changing climates for life and humanity. At present, much of my focus is on reconstructing the dynamic range of past tropical climates and inferring thermal limits of terrestrial and marine organisms as they apply to the future.

While paleoclimate data have their uncertainties and paleoclimate models are far from perfect, much can still be learned about the physics of climate change and it's interactions with the biosphere from studying past climates. In my talk I will discuss what we have learned about basic climate and earth system patterns and processes from studying the warm climates of the Eocene and Miocene. I will emphasize linkages between terrestrial and marine realms as well the often tumultuous relationship between equator and the poles. It is clear from Eocene and Miocene climate records that tropical oceans were much warmer than modern and polar climate was warmer still by a factor of 2. Implications of this huge dynamic range of climate for life will be explored, especially vis a vis heat stress on plants and animals. In the end, we will find that the mid-Miocene may offer our best analogue for future equilibrium climate, with global mean temperatures 4-8C warmer than modern, roughly half modern day ice volume, and pCO_2 in the 450 ppm range. It is difficult to model such warm climate at such low pCO_2, but this challenge teaches us something important about climate models and their biases.

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Significance of interface sampling for exploring areas covered by glacial sediments: An example from the Duketon Greenstone Belt, Western Australia

Salama W[1], Anand R[1], Culver K[2]
[1]CSIRO, [2]Duketon Mining Ltd.

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Walid Salama graduated from Faculty of Science, Cairo University, Egypt. He did his PhD on the lateritic iron ores of the Western Desert of Egypt in collaboration with Friedrich-Schiller University in Jena, Germany. *He joined CSIRO since 2012 as a post-doc fellow in the regolith geoscience team and was involved in 11 research projects about mineral exploration in areas of transported cove in Western Australia, Queensland and Botswana.*

Areas of thick Permian glacial cover in the Western Australia, formed as glaciers gouged unweathered bedrock and deposited diamictites in disconnected valleys and basins. These areas now present the greatest challenge for mineral exploration in the Yilgarn Craton. At the Lancefield North prospect, in the southern part of Duketon Greenstone Belt, Permian diamictites with an average 40 m in thickness cover fresh basalt hosting Au mineralisation. The basal Permian diamictites consist of unweathered, boulders of felsic and mafic rocks cemented by ferroan calcite, dolomite, chlorite and pyrite. These diamictites are stable under alkaline and reducing conditions below the water table. Detrital, unweathered sulphides and opaques oxides such as pyrite, chalcopyrite, sphalerite, arsenopyrite, gersdorffite and galena, chromite, ilmenite and magnetite are identified in the unweathered diamictites and these are identical to those in the mineralisation. Weathering of diamictites and oxidation of sulphides above the water table produced several Fe- and Mn-rich redox fronts.
Interface samples (a composite of 1 m above and 1 m below the unconformity) show Au, As, Zn, Ni, Co and Cd anomaly over the mineralisation versus background. However, these elements are low in concentration in the redox-fronts, where Fe is correlated with As, Cu, Mo and Sb, and Mn is correlated with Co, Ni and Ba. Gold is concentrated in the basal unweathered diamictites over the mineralisation, but no Au was identified from heavy minerals concentrates. Interface sampling is found to be the most useful sampling medium for delineating Au anomalies in cover at the Lancefield prospects.

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Marine Sampling Field Manuals for Benthic Monitoring

Nichol S[1], Przeslawski R[1], Foster S[2], Monk J[3], Barrett N[3], Bouchet P[4], Carroll A[1], Langlois T[4], Lucieer V[3], Williams J[5]

[1]Geoscience Australia, [2]CSIRO, [3]University of Tasmania, [4]University of Western Australia, [5]NSW Department of Primary Industries

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Scott is a coastal geomorphologist and sedimentologist with over 30 years experience in marine geoscience research. Research themes include stratigraphic reconstruction of modern coastal and shallow marine depositional systems, interaction of physical and biological processes, and the impacts of extreme events and human activity on sedimentation processes. He has maintained a strong emphasis on field-based empirical and interdisciplinary research, with published studies from projects in Australia, New Zealand, Canada, USA, Ireland, Maldives and Antarctica.

Australia is uniquely placed to develop standardised national approaches to monitor the marine environment, and we have therefore released a suite of field manuals for the acquisition of marine benthic data so that data are directly comparable in time and through space. The manuals include selected frequently-used sampling platforms: Multibeam sonar, autonomous underwater vehicles, baited remote underwater video, towed cameras, grabs and box corers, and sleds and trawls. Due to the importance of survey design in data analysis and interpretation, we also developed a field manual describing statistical considerations in marine surveys. The main challenge in the development of these manuals was to find a balance between being overly prescriptive (such that people follow their own protocol, ignoring the manuals) and overly flexible (such that data is not consistent and comparable). A collaborative approach was paramount, and ultimately, over 65 individuals from 30 organisations contributed to the field manuals. This not only improved the content but also increased the potential for adoption across multiple agencies and programs. Future work is based on the understanding that sampling protocols should be periodically updated, lest they become superseded or obsolete. Version 2 of the field manual package is due for completion in late 2018, including potential new manuals and a long-term plan for their management and integration into a national Australian monitoring program.

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Introducing the Papua New Guinea Geoscience Network

Holm R[1], Saroa D[2], Lunge M[2]
[1]Frogtech Geoscience, [2]Mineral Resources Authority

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Rob Holm is a Senior Geoscientist with Frogtech Geoscience. He has worked extensively on the tectonics of the southwest Pacific with a focus on the development of Papua New Guinea. Rob's recent work together with the Mineral Resources Authority of Papua New Guinea is yielding very exciting results with significant implications for the regional tectonic evolution. This collaboration is also working towards the progression of geosciences and growing the institutional capacity within Papua New Guinea.

The Papua New Guinea Geoscience Network is a new initiative to promote sustainable geoscience in Papua New Guinea (PNG) and bring together the next generation of researchers and geologists. PNG offers vast opportunities for advancement of geoscience frontiers through, for example, a resources economy open to industry collaboration, a necessity for public communication, particularly with regard to geological hazards, an emerging market for geotourism, and real scope to make new and exciting research discoveries.

The network and associated website (www.pnggeoscience.com) will provide a mechanism for greater communication between disparate researchers and PNG-based collaborators, for example, the PNG Geological Survey (a division of the Mineral Resources Authority). The network aims to bring together fragmented research efforts, especially considering the limited pool of researchers engaged in PNG at present, to promote collaboration and provide more research opportunities for upcoming geoscientists and provide important experience for PNG geologists. As the network grows it is anticipated the development of workshop and conference proceedings will follow, as well as prospects for consortium funding.

Creation of the Papua New Guinea Geoscience Network aims to develop an innovative and sustainable geoscience agenda that will foster knowledge sharing and support the development aspirations of PNG. In collaboration with PNG geoscientists there is a real opportunity to contribute to building the institutional capacity in PNG and address contemporary challenges as well as achieving advances in the global geoscience field. This is an emerging initiative; any enthusiastic input and contributions would be greatly appreciated.

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Is coal seam gas dead in SE Asia? Opportunities and impediments

Moore T[1,2,3]

[1]School of Resources and Geosciences, China University of Mining and Technology, [2]School of Earth, Environmental and Biological Sciences, Queensland University of Technology, [3]Cipher Consulting Pty Ltd

TS6 - 3.2.2 Energy from coal, Room R2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:

Since 2010 Tim has been the Managing Director of Cipher Consulting, specialising in the understanding of, and exploration for, organic-rich sediments, including coal, coalbed methane and shale gas. He holds the positions of Adjunct Associate Professor at the School of Earth, Environmental and Biological Sciences, Queensland University of Technology, Australia (since March 2016) and as Distinguished Visiting Professor at China University of Mining and Technology. Long-term roles while at Cipher have also been Principal Advisor – Subsurface for Sinopec Oil & Gas Australia Pty Ltd., Chief Geologist for Ephindo Energy Ltd. and Senior Advisor for Dart Energy Ltd.

Coal seam gas (CSG) reservoirs are abundant in SE Asia. The geology, however, is complex, making exploration and engineering a non-trivial challenge. In part, this accounts for a lack CSG development in the region. The other factor impeding momentum is regulatory and, in some ways, this poses the greatest challenge.

Technically and commercially successful CSG basins usually have several of the following attributes: large aerial extent, simple geological structures and thick net coal reservoirs that have good permeability and high gas saturation.

Basins in SE Asia are challenged to meet most of the above attributes, but there are notable exceptions such as the South Sumatra and Kutai basins. Like most basins in the region they are Cenozoic in age and generally of subbituminous rank. Initial exploration and pilot projects have shown potential but follow up production pilots and optimisation studies have been lacking. Other SE Asian basins, for example in the Philippines, Myanmar and Thailand also show promise but are woefully under explored.

Recognising that oil price plays a major role in the economies of CSG, a significant impediment to further exploration and development is regulatory. In almost all cases in SE Asia, CSG is regulated similar to conventional oil and gas permits. In all but exceptional cases profit margins for CSG are more like mining (10-20%) and cannot sustain a heavy burden of improper exploration and development requirements. Until such time that regulations are matched to CSG-type industry, development will likely flounder.

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How much? Commonalities and differences in resource calculations in the water, minerals and petroleum sectors

Baker P[1]

[1]*Office of Water Science, Department of Environment and Energy*

TS3 - 3.4 Resources sustainability – responsible investment and management, Room R2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:

Peter has over 35 years experience working across the petroleum, mining and water sectors as well as academia. He is currently Director and Senior Principal Research Scientist of the Office of Water Science within the Australian Government Department of Environment and Energy. In this role he leads a dedicated group of scientists that support the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, the Supervising Scientist and the broader department in regards to the impacts of developments on water resources.

Water 'reserves' are used to determine the 'sustainable' extraction of water from the surface and groundwater systems, which includes an allocation for the environment. This is most commonly done through a water balance developed in water sharing plans which determines the amount of water available for use.

Due to the 'fluid' nature of many components of the water balance the 'reserve' can vary seasonally, yearly, and on longer decadal timescales. Further complicating calculating a water balance is the inclusion of external water sources such recycled water and seawater desalination.

This makes calculating a ‘water reserve' quite different to calculating a ‘mineral reserve’ or ‘energy reserve’ in the resources sector where the orebody or petroleum accumulation was formed millions of years ago and hence can be considered a 'static' resource.

Despite this there are certain commonalities in how reserves are calculated. For example in the petroleum sector Darcy’s Law underpins quantitative analyses and permeability, storativity and flow rates need to be known in order to calculate how much oil and gas can be extracted. Similar parameters are required to know how much groundwater can be extracted.

Not all the groundwater stored in an aquifer can be extracted. Similarly an orebody is contained within a host rock and the amount of ore than can be extracted is limited by grade and distribution through the host rock.

This keynote will explore the commonalities and differences in methods and language in calculating the size of a resource across the water, minerals and petroleum sectors.

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Active tectonics and mass transport deposits on the North West Shelf of Australia

Keep M[1], Lindhorst K[2], Gallagher S[3]
[1]University Of Western Australia, [2]Kiel University, [3]University of Melbourne

TS6 - 1.3 Marine geoscience - The evolving oceans, Hall E1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Dr. Myra Keep is a professor of structural geology and tectonics at The University of Western Australia, specialising in basement reactivation and inheritance, neotectonics, fault inversion and reactivation, seismic structural interpretation and basin evolution, both onshore and offshore along the northern Australian margin. She also has considerable research interests in East Timor.

The RV Sonne expedition SO257 (May-June 2017) collected continuous bathymetry and sub-bottom profiling data and also shot 30 high-resolution seismic profiles. The cruise included deep- and shallow water areas, areas of known surface-breaching faults and mass transport deposits (MTDs). Initial imaging indicates that MTDs are more extensive than previously known. High quality multichannel seismic acquired from SO257 exceeds comparable industry seismic in quality, so, for the first time a high resolution data set for MTD and fault mapping in the shallow subsurface is available. The location of documented offshore landslides, downslope from known surface-breaching faults (e.g. the Shark Bay, Bonaventure, Gorgon and Picard slides), and in close proximity to modern earthquake epicentres, suggests that there may be a tectonic cause for these landslides. Modern earthquake activity has already been implicated in the formation of large mass-transport deposits (with volumes ~17 to >162 km3) in the Carnarvon and Browse basins. Age estimates for these slides range from Miocene to Recent (Gorgon MTD), late Pliocene to Recent (Thebe/Bonaventure MTDs) and Pleistocene to Recent. Data from IODP Sites U1461 and U1463 suggest that some of these slides are relatively young (<1 Ma) and occur 50 to 500 m beneath the seabed. Evidence of ongoing earthquake activity shaping the present-day coastline of Northwest Australia identifies a number of new surface-breaching faults, that cause significant surface offset, capture drainage and alter landscapes. Many recent earthquakes have strike-slip focal mechanisms indicating that the present-day stress on the North West Shelf is causing highly oblique fault reactivations.

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Fieldwork in the machine learning era: GSWA's WAROX field observation and rock database

Riganti A[1], Farrell T[1], Johnson S[1]
[1]*Geological Survey of Western Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Angela Riganti is the Content Manager at the Geological Survey of Western Australia, focussing on design and management of geoscience databases, and innovations in geoscience data delivery. Her recent work has focused on the delivery of the Explanatory Notes System (ENS), a digital repository of detailed unit descriptions that integrates stratigraphic relationships with links to all tectonic units and events recognized in Western Australia — ENS underpins the delivery of all maps and digital geology at GSWA.

As increased computational power, machine learning and AI are advancing the way geological data is acquired and interrogated, mapping skills are in danger of being unheeded at best and not being taught at worst. Reliable field observations by geologists trained first and foremost to do fieldwork are — and will become more so — an invaluable resource for the exploration and mining industry.

Fieldwork has been fundamental to mapping at the Geological Survey of Western Australia (GSWA) for well over 100 years. Since 2007, field observations have been recorded directly in the field into the WAROX (for WA Rocks) database using Motion computing tablet PCs; these are synchronized into a centralized system once back in the office. In addition, from 2003 a program to capture legacy field observations from GSWA field notebooks has greatly increased the number of sites and related observations available from fieldwork conducted since the advent of aerial photography in the 1960s.

WAROX data have been routinely added as part of data packages for individual project areas since 2010, and a statewide compilation has been made available annually from 2017. The '2018 Compilation of WAROX Data' includes over 240,000 field observation points and nearly 130,000 linear and planar structural measurements, with related field photographs and site sketches, sample information and petrography reports. Customized reports allow easy viewing of information for each site, both through the in-house GeoMap.WA viewing software and in ArcMap. The dataset is available on a USB flash-drive, and online delivery is being considered.

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Western Australia's 100k bedrock geology — live and kicking

Riganti A[1], Johnson S[1], Wallace D[1], McDonald T[1], Backhouse P[1]
[1]*Geological Survey of Western Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Angela Riganti is the Content Manager at the Geological Survey of Western Australia, focussing on design and management of geoscience databases, and innovations in geoscience data delivery. Her recent work has focused on the delivery of the Explanatory Notes System (ENS), a digital repository of detailed unit descriptions that integrates stratigraphic relationships with links to all tectonic units and events recognized in Western Australia — ENS underpins the delivery of all maps and digital geology at GSWA.

GeoVIEW.WA has been the online delivery mechanism for Western Australian geology since 2001. A new digital dataset — the 1:100 000 Interpreted Bedrock Geology (IBG) — is finally available, covering those areas of the State where IBG exists at this scale (about 30% of the State, with a focus on areas of exposed Archean and Proterozoic bedrock). The new dataset includes geology polygons, geology lines, and largely pre-Cenozoic linear structures, with a regolith layer being assembled. Viewed simultaneously, the four layers will effectively represent a surface geology map of the State; IBG is being compiled for other areas where surface geology at 1:100 000 already exists, ensuring coverage's expansion.

The 1:100 000 IBG dataset incorporates significant new functionality. The link to the Explanatory Notes System (ENS) underpinning the layer is based on Lithostratigraphic Number (the ENS unique identifier) rather than geological code, avoiding breakdown of the unit report's link when a code is modified in ENS. More radically, geological attributes of lithostratigraphic units are sourced dynamically from ENS rather than from a static lookup table — this ensures that geological information (e.g. new geochronology) is updated weekly rather than annually or longer. A procedure is in place to automatically transfer updates to the Data & Software Centre, from which this dataset can be downloaded for offline viewing. This functionality will be rolled out as geological layers at other scales are updated, ensuring all State geology datasets provide a seamless, truly current summary of the geology of Western Australia.

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Discovery through the ages – a journey of coal resource discovery in Queensland's Bowen Basin from the 1960's to the 2000's

Walker D[1]
[1]U&d Coal Ltd

Biography:
Mr Darren Walker is currently a Senior Executive with U&D Coal Pty Ltd, a coal mine developer and explorer. Darren is also Deputy Chair of the Queensland Exploration Council (QEC) and a Non Executive Director of the Association of Mining and Exploration Companies (AMEC). He has over 18 years' experience in exploration, mining operations, marketing and corporate management in coal, iron ore, gold and other metals as well as petroleum and gas and is passionate about exploration and the exploration industry.

Exploration, technology and equipment may have changed greatly over the last few decades but still does not replace sound geological principles in new coal resource discoveries. Starting with a case history of the big discoveries in the Bowen Basin, Central Queensland, author and co presenter Mr Lex Hansen will provide an overview of the methods, techniques, equipment and successes of exploration during the early 1960's in the Bowen Basin.

Mr Hansen was a member of the team of 3 geologists working for Utah development Company (purchased by BHP Ltd in the 19080's) that made the first big coking coal discoveries in the Bowen Basin extending from Blackwater in the south along the western side of the Basin to Goonyella in the north. The majority of these discoveries are still in production today, some 50 years later.

These will then be contrasted with a more recent case study involving greenfields discovery's at the Meteor Downs and Rockwood Projects as well as the world class brownfields coking coal discovery at Saraji East, located also in the Bowen Basin Central Queensland. This will provide a unique opportunity as to recent coal exploration methodology, technology and successes. Co author and co presenter Mr Darren Walker lead the teams responsible for these discoveries.

The authors will then contrast and compare exploration from the 'then' and 'now' and discuss the importance of 'grass roots' geological field work, data analysis and principles in successful exploration regardless of the perceived exploration or resource maturity of a mineral province.

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Reducing Mineral Exploration risk in the Yukon Plateau

Parker N[1]
[1]Geosoft, [2]International Geoscience Services

TS4 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Nick is a Solutions Consultant with Geosoft, based in Perth. Nick has worked at Geosoft for 12 years spanning various technical roles, but for the last 8 years focused on driving technical data services projects and data management implementations for exploration and government groups in the Australasia region. In his previous role with Geosoft, Nick was a Technical Analyst, based in South Africa, providing technical and business support for Geosoft's suite of earth science applications software. Before joining Geosoft, Nick worked in mineral exploration projects including platinum, base metals and gold in Southern Africa.

Reducing Mineral Exploration risk in the Yukon Plateau

Public domain regional data provided by the Geological Survey of Yukon, was used to reduce exploration risk using Machine Learning algorithms.

The interpretation process combined datasets and models from across the geosciences with the application of different algorithms to different types of data:
- Self Organising Maps (SOM) analysis of Magnetization Vector Inversion (MVI).
- Principal Component Analysis (PCA) of stream sediment geochemical data.
- Prospectivity maps showing the permissive, favourable and highly favourable areas using as input geology maps, geochemistry, geophysics and mineral system model.

MVI recovers the total effective magnetization vector and can provide additional insight. The cartesian components of the MVI results and the cartesian coordinates were used to classify the magnetization domains using a 3D SOM algorithm.

The stream sediment data was normalized, levelled, and then used as input for a PCA. Considering the 18 elements analysed, the Varimax analysis reduced the number to 6 factors and factors 1 to 4 were used for targeting purpose.

Prospectivity Analysis with Semantic Technology (ST) basically allows computers to "understand" the data they store, reason about information and easily share information across different systems.
Reducing large areas of regional data into more manageable targets, the methods applied are scalable.

The team used the integrated data to confirm known epithermal gold, porphyry copper targets and then proposed 22 new drill targets.

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The Australian Society of Exploration Geophysicists:Diversity of thought, Diversity through Membership

Costelloe M[2], Nightingale M[2], Burns D[2], Tyne T[2], Rutley A[2], McKenna K[2], Frankcombe K[2], Annetts D[2], Pervukhina M[2], Robertson K[2], Atkinson L[2], Squelch A[2]
[1]Geoscience Australia, [2]Australian Society of Exploration Geophysicists

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Marina Costelloe is the current President of the Australian Society of Exploration Geophysics, the third woman in 30 years, and the first Public Sector Leader to hold this office. Marina is passionate about STEM and diversity matters. Marina has made significant contributions new diversity APS policies including; flexible working and domestic violence leave. Marina mentors many people in all stages of their career. Since joining Geoscience Australia about 12 years ago, she has worked in mineral exploration, groundwater, critical infrastructure, earthquakes, and contributed to international nuclear monitoring and space weather, she has worked in STEM for over 25 years.

Founded in 1970, the Australian Society of Exploration Geophysicists (ASEG) is a learned society of professional earth scientists specialising in the practical application of the principles of physics and mathematics to the discovery of new mineral and energy resources and the solution of problems in a broad range of geological situations. The ASEG Mission is to provide an environment for the science of applied geophysics to grow for the benefit of its members and the wider community. The ASEG is a non-profit company incorporated under and regulated by the provisions of the Corporations Act (2001).
As a Society we are committed to diversity, inclusion and anti-discrimination through respect and appreciation of what makes our membership so varied in terms of age, gender, ethnicity, disability, education and national origin. The ASEG from foundation, 1970, quickly became an inclusive and diverse society which has been a real strength over the past 49 years, bringing new ideas, new thinking and innovation into our member forums and conventions. Members live and work across the world. One of the Society's strengths is in engaging and connecting professionals from geographically remote and isolated areas, which is shown in our membership figures, publication statistics, as well as our social media and online presence statistics. The Society is exceptionally good at linking technology, people and resources. The conferences the Society organises and runs strive to be free from prejudice of any kind and are places where great innovations are uncovered.

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Automated geological map publishing in the Queensland Department of Natural Resources, Mines and Energy (DNRME)

Withnall I[1], McWhirter C[2], Browning G[3], Estrim K[2], Lane R[2], Bastow J[4]

[1]Geological Survey Of Queensland (GSQ), [2]Spatial and Graphics Services, Statewide Services, Dept of Natural Resources, Mines & Energy (DNRME), [3]Freelance ArcGIS Specialist, [4]Spatial Systems Support, Department of Agriculture & Fisheries

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:

Ian Withnall has had more than 40 years experience with the Geological Survey of Queensland in regional geological mapping and metallogenic studies throughout Queensland. He was principal compiler and editor of the Queensland Geology 1:2M-scale map published in 2012, and a major contributor to the 2013 Geology of Queensland volume. He officially retired from GSQ in 2014 as Geoscience Manager (Minerals), but remains there on a voluntary basis working on NW Queensland geology, mentoring and database development. In 2016-17, he was re-employed to help develop automatic output of geological maps from the GSQ's state-wide digital geological mapping and observation databases.

In spite of the ability to display and analyse geological data in GIS, demand remains for traditional maps, where symbolised geological units and structures (boundaries, folds and faults) are displayed with structural measurements and mineral occurrences, supported by legends displaying units in a geologically meaningful order.

The DNRME Statewide Compilation Mapping system produces standard 1:100K-scale geological and mineral occurrence compilation maps in pdf and tiff formats as well as ESRI geodatabase files used to generate them. It also produces ad hoc maps from 1:10K to 1:500K at user-defined map centres. The system takes about 6 minutes to generate a compilation map for any area of Queensland. Standard maps can be downloaded via the QDEX Data System.

The system was developed in ArcGIS Pro using a contract GIS programmer and a GSQ geoscientist with database expertise, supported by Departmental Spatial Officers.

The map legends display units within defined groupings in chronological/stratigraphic order. The GSQ rock unit database was modified and populated with parent–child relationships so that all units can be correctly ordered using SQL scripts.

The maps show a topographic base and graticule, main mines and prospects, and structural measurements, isotopic dates and fossil localities derived from GSQ's Observation database. The database contains all field observations collected since 1986 and data from older notebooks or digitised from published map sheets. To avoid overwriting, point data are filtered on order of importance and a grid-based conflict detection algorithm. Maps showing all mineral occurrences have a 'semitransparent' geological background omitting other point data.

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The world-class Gruyere Au deposit in the Yamarna Terrane, Western Australia: Significance of interface sampling for its discovery

Salama W[1], Anand R[1], Bath A[1], Walshe J[1], Miller S[2]
[1]CSIRO, [2]Gold Road Resources

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Walid Salama graduated from Faculty of Science, Cairo University, Egypt. He got his PhD degree from Cairo University in Egypt in collaboration with Friedrich-Schiller University, Jena, Germany. He joined CSIRO since 2012 as a post-doc fellow in the regolith geoscience team and was involved in 11 research projects about mineral exploration in areas of transported cover in Western Australia, Queensland and Botswana.

The world-class Gruyere gold deposit is hosted within quartz-monzonite porphyry in the Dorothy Hills Greenstone Belt in the Yamarna Terrane, Western Australia. The host Gruyere porphyry varies from 5 to 10 m wide at the northern and southern extremities, to a maximum width of 190 m at its widest point in the centre of the deposit. The Gruyere higher-grade (> 2ppm) gold mineralization occurs within an alteration zone of albite-pyrrhotite-pyrite± arsenopyrite. The distribution of Au and As in the mineralisation are highly variable with mineralised zones rich in Au and poor in As and others rich in As and poor in Au reflecting the localised zones of arsenopyrite in the mineralisation.
The regolith stratigraphy over the Gruyere Au deposit was studied from 32 drill holes arranged along three, east-west cross-sections over the Gruyere porphyry to the background areas. The Gruyere porphyry is deeply weathered to saprolite and is covered, from the base, by Tertiary paleochannel filled mottled and red clays, silicified colluvium and alluvium and ferruginous aeolian sands. The cover varies in thickness from 2 m over the southern end to 40 m over the northern end of the deposit.
Interface sampling (a composite of 1 m above and 1 m below the unconformity between mottled clays and saprolite) along the three traverses was successful in delineating Au, As and Ag anomaly over the Gruyere Au deposits compared to the background areas that are dominated by intermediate-mafic volcaniclastics. The interface Au anomaly is much stronger when the cover is thin.

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The Continent of Zealandia: Implications for the mineral exploration potential of New Zealand

Smillie R[1], Hill M[1], Martin A[1], Mortimer N[1], Rattenbury M[1], Tulloch A[1], Turnbull R[1]
[1]GNS Science

TS3 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Rob is Head of Department for Regional Geology at GNS Science. He is a geologist with over 25 years experience in mineral exploration and mining throughout SE Asia, Australia and New Zealand. He has worked with a number of companies including WMC Resources, and Oceana Gold, and most recently was Exploration Manager for Ok Tedi Mining in Papua New Guinea.

The recent recognition of New Zealand as the world's 8th continent, Zealandia, has important implications for the country's mineral potential. The new knowledge that New Zealand is a not a small, South Pacific island, but rather a continental landmass that has been subjected to episodic convergent and extensional plate margin geological processes for more than 500 million years casts a whole new light on New Zealand as a mineral exploration destination. Continental settings, including the Cordillera of North and South America, are host to significant precious and base metal deposits, and until recently New Zealand was not seen in this context - now it is. As a result, New Zealand's perceived and real mineral potential – a key driver for mineral exploration investment – has been considerably enhanced.
With this new context and "geological assurance", mineral explorers can consider New Zealand in more familiar and favourable terms in both space and time. Zealandia provides the big-picture framework and roadmap for helping guide future exploration, superseding previous fragmented, complex and less-coherent frameworks. The clear delineation for example, of different lithostratigraphic terranes, including the continental-scale Median Batholith, and the Western Province with its Eastern Australian orogenic gold connections, allows for improved conceptual exploration strategies and targeting, based on appropriate mineralisation processes and geological models.

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Geomorphodynamics

Asadiyan Falahiyeh M[1]
[1]*Payame Noor Univercity*

Biography:
I born in 1953 in Abadan/Iran. I am a retained member of Payan-e Noor University (assistant prof.). I have a new concept in global tectonic, named Spiral Tectonics.

The goal of this paper is to understand geodynamics from viewpoint of geomorphology. All geomorphic evidences indicate the Earth's crust twists from top and down spirally around two hinges: Aleutian and Scotia. Due to asymmetrical position of the Earth in the space, interaction of N-source and S-source produce mountainous spot (Himalaya) in the east and hollowware spot (Bermuda) in the west. Deformation in the Earth originates from the central bar of Mecca-Spiral (MS). Rotation differentiation between the North Pole (NP) and the South Pole (SP) beside Coriolis Effect is the main reasons for Spiral Tectonics.
Excess rotation of NP collected continents in the N. Hemisphere and abandons Antarctica in the S. Hemisphere, in the other hand excess rotation of MS collects continents in one side and abandons Pacific in the other side. Crust deformation has developed within two periods: in the first period, the Red Sea, and in the second period, Pacific Ocean have formed due to the inverse rolling of Earth's wings named a/b and A/B: the Red Sea from a/b-wing and the Pacific Ocean from A/B-wing. A and B is two loops of Global Mobius (GM). GM is overturns the whole Earth. This dynamic accompanied by rifting occurring in the points where the sense of spiral is changes. These points are called catastrophic zone (CZ), e.g. Aleutian Trench and Scotia Ridge. The Helical rolling of Eurasia around Africa has caused N. America spliting from Eurasia and pulling in the reverse direction, and therefore producing Atlantic Ocean in-between.

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Potential of remote sensing tools for groundwater resource assessment, monitoring and management - Case studies from India

Chinnasamy P[1]
[1]Indian Institute Of Technology

Biography:
Pennan Chinnasamy obtained his doctoral degree, with focus on hydrology, from Missouri University, USA. After his post doc with ATREE, he joined the International Water Management Institute where he focused on climate change impacts on under developed and developing nations. He recently joined as an Assistant Professor with Indian Institute of Technology-Bombay,where his focus is on water resources in rural regions.Over the past eight
years,Pennan has experience working in NGOs, national and regional government agencies and academic institutions, focusing on sustainable surface and groundwater management plans, climate change impacts and hydrological simulation models.

Formulation of water management indices and performance indices for adaptation plans (e.g. drought index, flood index, unmet demand index) requires good observation data. In developing and under developed countries, such as India, holistic approaches are limited due to low quantity/quality observation data and lack of cooperation between surfacewater and groundwater management agencies (including trans-boundary, inter-government and intra-government agencies). In such scenarios, big-data from remote sensing tools (e.g. Gravity Recovery and Climate Experiment–GRACE) can be used to assess research gaps. In this presentation, results from using GRACE data, for estimation of groundwater recharge and extraction, in various study regions of India, including states of Gujarat, Tamil Nadu, Madhya Pradesh, West Bengal, Bihar and Uttar Pradesh will be discussed. Study results have successfully identified reasons for large scale groundwater depletion in India, potential of underground storage for floods, impact of water distribution systems, impact of crop-diversification and on-going climate and human induced stresses on water resources. These studies also discuss and recommend a framework for upscaling the use of remote sensing data along with observation data from government agencies, to formulate management plans, especially for groundwater management. These include, developing conceptual and hydrological models for which the base data is a combination of observation and remote sensing data, establishing new indices and developing management scenarios. Such models will also aid sharing of data between nations that use the same groundwater pool for water resources.

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A fifteen-year longitudinal AGC survey of Australian earth science departments: Results and predictions

Cohen D[1]
[1]University of New South Wales

TS2 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
David Cohen is President of the UNSW Academic Board and former Head of the School of Biological, Earth and Environmental Sciences. He is a former president of the Association of Applied Geochemists and recent recipient of the AAG silver medal. He is the President-elect of the AGC.

The Australian Geoscience Council has completed the third of its pentannual surveys of Australian university earth science departments and schools. The fifteen years spanned by the surveys encompass annual enrolments at undergraduate and postgraduate levels, staffing, degrees offered and the spread of earth science disciplines in which research is undertaken or specialist subjects taught. Further data has been compiled from high school enrolments in E&ES subjects, along with the various national or international university and disciplinary rankings provided by QS, THE, ARC ERA, QILT and other endless acronyms.

And the major factor controlling earth science student numbers is.... (you will have to attend the talk).

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Unleashing thermal infrared spectroscopy on the carbonate mineralogy of drill holes

Green D[1]
[1]Mineral Resources Tasmania

TS1 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
David Green collects and analyses hyperspectral mineralogy datasets produced by the HyLogger-3 to characterise ore-related hydrothermal alteration for a range of geological and metallurgical outcomes. David also has expertise in geoinformatics (GIS), geochemistry and structural geology.

The characterisation of carbonate mineralogy in drill core is an important consideration for interpreting regional geology and hydrothermal alteration. Hyperspectral reflectance scanning has the potential to provide remarkably detailed information, which can now be fully realised with the more definitive mineralogy offered by thermal infrared (TIR) spectroscopy.

The major infrared active features of carbonates that can be exploited to discriminate mineral species lie in the short wave infrared at 2340nm and in the thermal region at 6500 nm, 11300 nm and 14000 nm. Combined consideration of these separate features enables confident identification of carbonates, including the composition of dolomite-ankerite mixtures or solid solutions.

The comprehensive spatial and compositional resolution offered by HyLogger-3 TIR data allows downhole trends in carbonate mineralogy to be examined in detail. Well characterised carbonates can be used to guide interpretation of less definitive spectra, providing more complete coverage and much improved statistical certainty of compositional populations and trends. As a result, individual carbonate species can be tracked downhole, trends in mixtures of carbonates quantified and variation in matrix and vein mineralogy studied separately. It is also possible to use spectral features to map variation in carbonate grain size. Examples from New Caledonia, Georgina Basin (NT) and the Mt Read Volcanics and Smithton Basin (Tasmania) are presented.

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Zoned pyroxenes in magmatic sulphide deposits around the world

Schoneveld L[1], Barnes S[1], Le Vaillant M[1], Paterson D[2], Mao Y[3], Taranovic V[1], Makkonen H[4]
[1]Mineral Resources, Australian Resources Research Centre, CSIRO, [2]Australian Synchrotron, ANSTO, [3]Key Laboratory of Mineral Resources, Institute of Geology and Geophysics Chinese Academy of Sciences, [4]Boliden FinnEx Oy

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Louise graduated with honours from James Cook University in Townsville, then received her Ph.D. from the Australian National University in 2018. She is currently a postdoctoral fellow at CSIRO in Perth, where she is working on chemical prospectivity indicators for magmatic sulfide deposits. This includes LA-ICP-MS analysis and X-ray fluorescence mapping.

Magmatic sulphide Ni-Cu-(PGE) deposits occur in small, usually differentiated, mafic or mafic-ultramafic intrusions. Such intrusions are common in a variety of settings around the world, but only a very small proportion contain economically exploitable sulfides. If mineralised and barren intrusions could be discriminated from sparse sampling at early exploration stages, then exploration for deposits of this type could be streamlined.
To this end, a number of pyroxene-bearing samples from small intrusions containing magmatic sulphide deposits have been investigated using X-ray fluorescence microscopy (XFM) carried out at the Australian Synchrotron. The mineralised intrusions represent the Noril'sk-Talnakh camp, Siberia; the Kotalahti nickel belt in Finland; Ntaka in Tanzania, and the east Tianshan Ni province in NW China.
Using this fine scale (<5 µm/pixel) chemical imaging, complex zonations were found in cumulate and poikilitic pyroxene. Both clinopyroxene and orthopyroxene display complex oscillatory and sector zoning of chromium in all samples from economic deposits. Steeply-bounded marginal Cr depletion zones reflect distinct cumulus and post-cumulus growth stages. These zoning patterns are likely an indication of the high flux of magma and fluctuating cooling rate that accompanies wall rock assimilation in the dynamic conduits where sulphide liquid forms and accumulates.
A number of barren intrusions from Kotalahti, and from the Savannah camp in Australia, have also been imaged but evidently lack such zonation. This suggests that this distinctive style of chemical zonation in pyroxene, coupled with other features such as semi-dendritic olivines and intermittent chromite saturation, is a prospectivity indicator for magmatic sulphide deposits.

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Caught in the act: Incipient metal extraction during melting of metasomatically oxidised mantle

Tomkins A[1], Rielli A, Nebel O, Brugger J, Etschmann B, Evans K, Vasilyev P, Wykes J, Paterson D
[1]*Monash University*

TS3 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Andy Tomkins is an Associate Professor of Geology at Monash University. His research focuses on applying principles of metamorphic and igneous petrology to problems in economic geology and meteoritics.

A relationship between subduction, production of oxidised arc magmas and genesis of porphyry Cu-(Au-Mo) deposits has been long recognised, but the link between these processes still unresolved. Here, we show that this relationship arises from the control that elevated oxygen fugacity (fO2) exerts on enrichment of basaltic melt in sulfur and chalcophile elements at the mantle source. We have found in situ evidence for this relationship in peridotite xenoliths from Victoria (Australia), where melt generated by the breakdown of metasomatic phlogopite and hornblende is preserved as glass due to rapid volcanic extraction. Oxidised glass with fO2 of 1.2 to 1.8 log units above the fayalite-magnetite-quartz buffer (FMQ), contains an exceptionally high abundance of quenched sulfide droplets, whereas more reduced glass (fO2 < FMQ) has low sulfide content. Textural evidence shows that the oxidised melt was able to dissolve interstitial sulfides, whilst percolating along grain boundaries, collecting sulfur and chalcophile elements. Our finding proves, counter to some previous arguments, that oxidised, metal and sulfur-rich magmas are generated by melting of mantle modified by oxidative fluids derived from a subducting slab, providing the missing link in understanding the genesis of some of our most important ore deposits.

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Engineering Geology in Australian Infrastructure's Projects

Rotariu C[1]
[1]*FSG GEOTECHNICS + FOUNDATIONS*

Biography:
Cristian Rotariu is an 20+ Engineering Geologist working on high profile projects from North Africa (GMMR Project) to New Zealand, Papua New Guinea, Mongolia and across Australia, manly in Queensland.

The $1.6 billion Toowoomba Second Range Crossing (TSRC) is a 41 km heavy vehicle route jointly funded by the Australian and Queensland Government. The route is designed to increase freight efficiency and significantly improve driver safety and community amenity by removing heavy vehicles from Toowoomba's CBD.

The TSRC Engineering Geologist role was to:

- Manage, distribute and/or release earthworks hold points raised by the TSRC Construction Team
- Asses and confirm the encountered ground conditions versus the designed predictions
- Review and assess the predicted cut batter treatments vs. the encountered ground conditions as exposed
- Review, propose and tailor batter treatments based on the encountered ground conditions
- Review and assess design solutions for temporary working platforms
- Construction materials mapping and assessing for fill/pavements usage
- Founding materials assessment
- Assisting QA Team in adopting ways to identify better earthworks construction control
- Slope risk assessments and analysis
- Asses ground conditions for the designed bored piles based on project specialised field personnel recommendations
- Assist upper management with earthworks progress, testing and future site investigations
- Assist, propose and negotiate with the construction team, possible safe construction approach

During this project, the input of an Engineering Geologist commenced from the site investigation stage through to the design and construction phase.

It should be noted that the project comprised more than thirty cuts.
Each bench of the any of the cuts has to be mapped, assessed and treated in agreement with the approved stakeholder.

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The variations of compounds distribution and d34S values of organic sulfur compounds in biodegraded oils from Alberta Basin, Canada

He N[1]

[1]*Department of Earth and Planetary Sciences, Curtin University*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I am interested in applying the recently invented compound specific sulfur isotope analysis (CSSIA) technology to petroleum exploration. To do this I am studying the subsurface chemicophysical impacts on organic sulfur compounds (OSCs) formation and alteration processes to more holistically understand the S cycle of petroleum systems.

To investigate the biodegradation behaviour of organic sulfur, we have measured the distribution and δ34S of oil sulfur compounds (OSCs) in Alberta Basin (Canada) oil sand samples from two oil-legs (PR1 and PR2) reflecting different biodegrdation gradients. The PR1 oils were estimated to have biodegradation levels (BLs) of 3-4 and the PR2 oils have BLs of 5-7, although this was not always reflected by traditional biodegradation parameters due to the fluctuating contributions of different source inputs and varied thermal maturity - typical of the mutiple controls and high complexity of Alberta Basin petroleum systems. Nevertheless, the OSCs concentrations and δ34S data suggested several potential biodegradation trends. The concentrations of alkylated benzothiophene (BT) and dibenzothiophene (DBT) declined sharply through each oil leg, and varied rates of decline between several isomers (e.g., 4&3-mBT >> 2-mBT; 4-mDBT >> 1-mDBT/2&3-mDBT; 4-EtDBT >> 1,3-dmDBT) may indicate their different vulnerabilites to biodegradation. A general 34S enrichment in the δ34S values of alkyl BTs was observed in the more biodegraded PR2 oils (Nb. PR1 oil conecentrations were too low for δ34S measurement), which is consistent with the microbial utilisation of the lighter 32S. However, a similar trend was not evident in the δ34S values of alkyl DBTs measured in both two oil-legs, suggesting these higher molecular weight OSCs are not susceptible to biodegradation.

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Assessing the microbial contribution to the development of terrace iron formations

Shuster J[1,2], Rea M[1,2], Reith F[1,2]
[1]School of Biological Sciences, The University Of Adelaide, [2]CSIRO Land and Water, Contaminant Chemistry and Ecotoxicology

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Jeremiah Shuster is a postdoctoral researcher fellow at The University of Adelaide. His primary research focuses on understanding how bacteria contribute to gold solubilisation and precipitation processes, i.e., the gold biogeochemical cycle, and how gold is mobile within natural environments. Jeremiah's research in microbe-mineral interactions involves an integration of fieldwork, laboratory- and field-scale experiments, molecular and high-resolution microanalysis. In addition to the geomicrobiology of precious metals, he is interested in understanding how the lithosphere is able to support life from both modern and ancient environments. As such, his research interests include: biomineralisation, microfossil preservation and the formation of biogenic rock.

Terrace iron formations (TIFs) are travertine-like structures composed of alternating laminations of schwertmannite/goethite and gypsum. These structures are typically found within acid mine drainage environments where water is present and can cover large areas. In this study, a TIF that developed on the surface of a tailings pile was sampled from a non-operational, open pit mine located in Mount Morgan, Queensland. The TIF was analysed using molecular and micro-analytical techniques to assess how microbes contribute to the overall development of these structures. The microbial community of the TIF was more diverse in comparison to the tailings. The detection of both Acidithiobacillus ferrooxidans and Acidobacterium capsulatum suggests that iron oxidation and reduction were continuous processes that occur within TIFs. Calculations estimated that it would took ca. 119 days to form one lamination of schwertmannite/goethite. This number of days corresponds with the season when monthly rainfall exceeds 60 mm. Therefore, the formation of these laminations was attributed in part to the active metabolism of Mariprofundus ferrooxydans and A. ferrooxidans, when enough water was present to support life. Gypsum laminations intuitively represented the drier season during the year since gypsum crystals likely precipitated as standing water within terraces gradually evaporated. Interestingly, gypsum acted as a substrate for the attachment of cells and growth of biofilms that eventually became mineralised within schwertmannite/goethite. In summary, this study highlights the relationship between various microbes and provides an interpretation of the biogeochemical processes that contributes to the development of TIF on mine tailings.

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Socio-Geolology and Socio-Hydrogeology: New Challenge to Geoscientists for Taking Geoscience to the Society

Limaye S[1]

[1]Director, Ground Water Institute; Honorary Life Member International Association of Hydrogeologists; International Association for Promoting Geoethics (Vice President)

Biography:

Dr. Shrikant Daji Limaye, B.Engg, M.Tech (Geophysics) and PhD (Hydrogeology), is in the field of ground water exploration and development for the past over 55 years for promoting small scale irrigation by farmers. He specializes in promoting conjunctive use of surface water and ground water, recharge augmentation and watershed development. Dr. Limaye is Project Leader of UNESCO-IUGS-IGCP Project 523: "Ground water network for best practices in ground water management in low-income countries". Website: www. igcp-grownet.org. This is one of the most successful project under IUGS-IGCP umbrella and its website received over 35,000 visits so far.

Socio-Geology (SG) and its branch Socio-Hydrogeology (SHG) are recent topics in Geosciences and aim at taking our beloved science to the society, especially to the rural society. Because it is the rural society which is connected to mining activity for employment and to ground water development for irrigation and drinking water supply. Eco-friendly and Socio-friendly development of earth-resources should be the aim for all Geoscientists. Geoscientists working in mining companies should concentrate upon sustainable mining practices and interact with the society to understand its expectation from the mining company. Hydrogeologists should orientate their field work and research towards solving practical problems of the villagers residing in the research area. Such cooperation between the Geoscientists and rural society is the foundation of SG and SHG, which aims at broader dissemination of technical information in easy language. Geologists should occasionally attend village meetings to enlighten the villagers regarding mining activity, efforts by mining industry to reduce its impact on the environment, the nature of local aquifer, need to improve its recharge, quality of local ground water and prudent use of groundwater pumped from the aquifer. SG and SHG should be included in University Curricula of Geosciences, so that after graduation the young geoscientists would put SG and SHG into practice.

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Monitoring of unstable rock volumes for rockfall hazard assessment

Giacomini A[1], McCallum R[1], Thoeni K[1], Santise M[1,2], Roncella R[2], Fityus S[1]
[1]*The Uiversity of Newcastle,* [2]*University of Parma*

TS3 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Associate Professor Giacomini is committed to the deployment of innovative procedures to promote and improve safety in civil and mining environments. Dr Giacomini received her PhD in 2003 from the University of Parma, Italy, and joined the University of Newcastle in 2005. She has worked in the area of Rock Mechanics for more than 15 years. Adapting to the new Australian Environment, she has extended her rich background and extensive research experience in rockfall analysis and rock mechanics from civil engineering to mining.

Rockfall represents a significant hazard in surface mining to personnel and machinery located at the base of highwalls. Close range photogrammetry for the continuous monitoring of the rock surfaces, combined with a thoughtful geostructural characterization, is fundamental to assess the potential rockfall hazard, improve the prediction capabilities and design appropriate mitigation measures to reduce the risk in the areas potentially affected. These techniques allow for the continuous monitoring of the slope and provide information on the three-dimensional (3D) terrain geometry and displacements, contributing to an early recognition of potential impacts on human activity and production.
This work focuses on the analysis of the images of a mine highwall acquired over a two months period by a new fixed-base low-cost stereo pair photogrammetry system. The system is an extension of the stereo-photogrammetric system proposed by Roncella and Forlani (2015) and developed to detect changes in Digital Surface Models (DSM) with a scheduled frequency. The images are captured by a high-sensitivity DLSR camera at different times during the day, automatically uploaded to a server for further processing, and used to produce accurate DSM for change detection. The analysis is conducted taking into account weather variations recorded during the period. Change detection of the rock surface, volumes and frequency of the rocks dislodging from the highwall are measured during the observation period. Results show the capability of the 24h/day fixed-base monitoring system to provide valuable rockfall return period information, detect potential rock instabilities and correlate them to environmental effects at very reasonable costs.

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Drilling and Sampling with RoXplorer®: Coiled Tubing Drilling for Mineral Exploration

Soe S[1,2,3], **Giles D[1,2,3]**
[1]Future Industries Institute, University of South Australia, [2]MinEx CRC, [3]Previously at Deep Exploration Technologies CRC

TS5 - 3.4 Resources sustainability – responsible investment and management & 3.5 Technology integration, Room R2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Prof David Giles is Strand Leader and John Ralston Chair of Minerals and Resources Engineering at the Future Industries Institute, University of South Australia. At the Future Industries Institute we partner with resource sector companies to deliver innovative solutions underpinning productivity and sustainability across the resources industry value chain. Prof Giles has over 20 years' experience in minerals exploration spanning the boundaries of industry and academia. He is Chief Scientific Officer of MinEx CRC where he manages a portfolio of projects in collaboration with resource companies, METS companies, government organisations and research providers.

In November 2016 the Deep Exploration Technologies Cooperative Research Centre (DET CRC) launched the RoXplorer®, a coiled tubing (CT) drilling rig for greenfields mineral exploration, delivering a platform for low-cost, rapid, safe and environmentally-friendly drilling. The major advantage of CT drilling is the replacement of drill rods with a continuous 'coiled' drill string, thus eliminating the work, health and safety overhead associated with manual handling of drill rods and avoiding the time cost of making drill rod connections and disconnections. This has the potential to produce substantial improvements in bottom-hole time and hole-averaged rates-of-penetration. Further, in the absence of making rod connections the driller is able continuously maintain in-hole pressures with the promise of improved hole stability. The main challenges for CT drilling in mineral exploration are three fold: i) maximizing the fatigue life of the coiled drill string; ii) drilling hard rocks with low weight-on-bit and iii) ensuring a high-quality sample representative of the depth being drilled. In this talk we will outline DET CRC's approach to addressing these challenges, we will illustrate key aspects of the RoXplorer® design and report on the results of field trials conducted in diverse geological environments.

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Platinum Group Elements to identify sulphide saturation in evolving magmas: application to the Río Blanco Cu-Porphyry Deposit, central Chile

Cajal Contreras Y[1], Campbell I[1]
[1]*The Australian National University*

TS8 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
I did my bachelor in Geology at the Universidad de Concepcion, Chile. Since then, I have been working in Cu and Au mining and mineral exploration, both at the industry and at the academia. I am currently undertaking my PhD at the Australian National University, where I am working in the PGE geochemistry applied to the mineral exploration of Cu-Porphyry deposits.

Recent studies [e.g. 1,2] show that the Platinum Group Elements (PGE) can provide new insights into granitic magma fertility by determining the timing of sulphide saturation. The aim of this study is to test the hypothesis that timing of sulphide saturation, relative to volatile exsolution, controls magma fertility in the Andes of central Chile.
To address this aim, samples from Río Blanco-Cu-Porphyry Deposit are being studied. This deposit is part of the Rio Blanco-Los Bronces District, the world's biggest copper reservoir, which was formed in the Miocene to early Pliocene magmatic arc of central Chile.
The samples include different lithologies from the San Francisco Batholith and porphyritic intrusions, which range from diorite to granodiorite. They have been analysed by major elements using XRF; for trace elements by ICP-MS; and for Re, Au and PGE by the NiS extraction-isotope dilution method.
Preliminary results suggest that sulphide saturation occurred ca. 2.2-1.8 wt.% MgO, slightly before than volatile saturation at ˜1.2 wt.% MgO. This is similar to El Abra Cu-Porphyry Deposit [1], where it has been suggested that the amount of sulphide separated from the melt was small, enough to lower the PGE and Au contents, but not enough to have a significant effect on Cu due to its lower partition coefficient, resulting in a Cu-only porphyry rather than a Cu–Au deposit.

[1] Cocker, H., Valente, D., Park, J., and Campbell, I. 2015. Journal of Petrology. Vol. 56: 2491-2514.
[2] Park, J.; Campbell; Kim, J. 2016. Geochimica et Cosmochimica Acta. Vol. 174: 236–246.

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THE STAGGERING COST OF LOW LEVEL LEAD POISONING TO THE NATIONAL ECONOMY – AN UNDER ESTIMATED GEOHAZARD

Keet B[1]

[1]*Geo & Hydro - K8 Ltd*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:

Ben's background ranges from medical physics and isotope hydro-chemistry to oil exploration and production. In 1988 Ben started the first NZ company specialised in soil and groundwater remediation. This was expanded to 4 states in Australia from 1990 and in 1994 he also started a bioremediation Research & Development company in Holland. He has worked on over 5000 projects in 10 different countries and is still very active in R&D projects focussing on chemicals in our environment. In 2016 he completed an MBA thesis on the economic impact of lead in our environment. He holds several patents in environmental technology.

Lead in house dust are detrimental to human health, especially to the health of young children. Until recently the international literature and research focussed on serious lead poisoning leading to dramatic decrease in IQ. In modern research the focus has shifted to average nationwide low-level lead poisoning, leading to small but far more significant lowering of the nation's population IQ level.

The main source of the lead in the living environment is from anthropogenic sources accumulating in the geologic substrate of our living environment: the garden soil. From there it is transported into our homes and from there into our bodies through various mechanisms and pathways.

The costs of this lead exposure are staggering. Several studies in the US found the annual cost to exceed $US 50 billion, while a study in France estimates the cost for that country at Euro 20 billion, annually! This means the cost to society due to low level lead poisoning is 6-10 times that of Asthma.

Phasing out of lead-based paint and leaded fuel 'down-under' occurred much later than it did in the US or EU. Therefore, our mitigation efforts have to be more intense and are more urgent. However the contrary is current reality. Mitigation only incurs a one-off cost, while it benefits many generations of house dwellers.

In the cost benefit analysis presented the similarities and differences with overseas studies will be highlighted and a case made for shifting our focus from home insulation to dealing with this re-emerging environmental geohazard.

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Insights into the structural architecture and tectonic evolution of the Batten Fault Zone (southern McArthur Basin) from geophysical modelling

Blaikie T[1]

[1]CSIRO

TS7 - 1.1.6 Proterozoic tectonics, Hall C, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Dr Teagan Blaikie completed her BSc and PhD at Monash University, Melbourne, Australia. She specialised in the geophysical interpretation and modelling of potential field data for understanding the subsurface architecture of volcanoes. Currently, Teagan is working as a postdoc for CSIRO Mineral Resources, but is embedded at the Northern Territory Geological Survey. Her current work focusses on geologically constrained interpretation and modelling of geophysical data to understand the structural architecture of the McArthur Basin.

The Batten Fault Zone (BFZ) is a 50-80 km wide fault zone located within the southern McArthur Basin. The BFZ exposes Paleo-Mesoproterozoic sedimentary and volcanic sequences from the Tawallah, McArthur, Nathan and Roper groups, which can be correlated to basin sequences in Mt Isa. The McArthur Group is economically important as it is host to major Pb-Zn-Ag deposits in the region (e.g., McArthur River).

This study integrates geophysical interpretation and modelling with detailed sedimentology to understand the 3D structural architecture and spatial distribution of sedimentary sequences within the BFZ. This allows for a detailed reconstruction of the tectonic evolution of the region, particularly during deposition of the McArthur Group. A solid structural and geological map of the BFZ and seven forward models of geological cross sections were produced and highlight the nature of major fault systems, regional scale folding and broad scale variations in the preserved thickness of stratigraphy. Results suggests N-S to NE-SW directed extension during deposition of the McArthur Group caused significant sub-basin deepening in some areas, and uplift and erosion in others. Sub-basins developed in north-south trending transtensional segments of the Emu Fault, and adjacent to E-W trending cross-faults between the Hot Spring and Emu faults. Uplift and erosion occurred along transpressional segments of the Emu Fault.

Forward modelling also suggests the presence of a thick mafic volcanic pile within the Tawallah Group, which underlies the major Pb-Zn-Ag deposits in the region. This may represent the source region for base metals.

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Preliminary archaeological investigations into the submerged continental shelf of South Australia: geomorphology, context and significance.

Fowke A[1]

[1]*Flinders University*

TS6 - 5.2 Prediction, process, place: Geomorphology, Room R8, October 18, 2018, 9:30 AM - 11:00 AM

Biography:

Adeena Fowke is a graduate archaeology student from Flinders University. Her current postgraduate (Masters) research is aimed at understanding the physical changes to the submerged continental shelf of South Australia in regards to archaeological investigations concerning the Indigenous past. Her research interest include palaeoenvironmental reconstructions, GIS applications in underwater archaeology, landscape changes, and human/landscape interactions. She is particularly interested in discussions focused on the significance and progression of submerged landscape research in Australian archaeology, and the integration of geoscience to archaeological research.

Over the last 50,000 years, changes in sea levels due to Quaternary glacial processes had seen the Australian continent vary in the configuration of its extent and topography. During this time, the continent was a featured backdrop to the arrival and subsequent occupation of its terrestrial landscape by Indigenous people. Evidently, through the process of this colonisation in relation to lowered sea levels, the Indigenous people may have interacted with the then terrestrial landscape of the now submerged continental shelf. Numerous archaeological investigations around the world have demonstrated the potential for material evidence relating to this interaction to exist underwater on shelf areas and the knowledge with which they hold concerning past human activity. Simultaneously, a great deal of information is known about the submerged continental shelves of Australia from a multitude of disciplines. However, the combining of these two areas of research has been explored limitedly in the Australian context. This paper will present the research conducted into understanding the geomorphological history of South Australia, within the context of Australian Indigenous archaeological discourse. Specifically it will focus on the results of bathymetric based, palaeoenvironmental reconstructions of South Australia for the last 50,000 years, and the significance of archaeological investigations into the submerged continental shelf.

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Applying geoscience to Australia's most important challenges

Johnson J[1]
[1]Geoscience Australia

Opening Ceremony (GeoEXPO), Halls E & Foyer E, October 15, 2018, 8:30 AM - 9:30 AM

Biography:
Dr Johnson has been the Chief Executive Officer of Geoscience Australia since April 2017. Dr Johnson is a geologist with over 30 years' experience, including private sector mining and mineral exploration. He has led teams of geoscientists for over 20 years with a range of diverse achievements. These range from discovery of over 2 million ounces of gold reserves in industry, to national scale pre-competitive geoscience programs that have attracted exploration investment to Australia.
Dr Johnson first joined Geoscience Australia in 2006 and in that time has been head of various divisions with diverse duties including carriage of energy and mineral programs. He has also been a member of the Board of the CO2CRC (CRC for Greenhouse Gas Technologies) since 2014 and the National Computational Infrastructure (NCI) at the Australian National University since 2017.
Dr Johnson has a Bachelor of Science majoring in Geology from the University of Sydney and a PhD from the Australian National University.
Dr Johnson's vision for Geoscience Australia is one of unity in deploying geoscience for the economic, social and environmental benefit of Australians. He is driving a strong agenda of inclusiveness, particularly new programs to engage with aboriginal Australia.

We live in a connected world that is in a state of profound transformation. Increased information, data, technology and communication allows for significant advances in science and innovation, creating a landscape in which the role and responsibility of scientists is greatly increased.

The value that geoscience provides to Australians cannot be underestimated. Geoscience is the study of the Earth, providing valuable knowledge and tools to understand and adapt to Australia's changing environmental, economic and social environment, and the related needs of Australian citizens.

As modern geoscientists, we are increasingly being called to integrate across diverse fields of geoscience including groundwater, mineral and energy resources, geography, geodesy and geohazards. By integrating our understanding of the Earth's landscape, what lies beneath the Earth's surface, and what we can observe from space, we can connect these geoscience disciplines and harness the power of big data and high performance computing to understand the Australian continent as a whole.

Applying this integrated thinking to better understand how Earth systems interconnect, and change over time, leads to innovative applications and solutions to Australia's most important challenges. It is the responsibility of geoscientists to raise awareness of geoscience with Australians so that they understand the full value of this science. With the pace of technology change it is not possible to predict all of the applications of geoscience into the future, but the future of geoscience will be defined by how well we recognise and seize the opportunity that connectivity and integration provides.

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New indicators of and methods to assess magmatic fertility in the Northparkes district

Wells T[1], Meffre S[1], Cooke D[1], Steadman J[1], Hoye J[2]
[1]CODES - University Of Tasmania, [2]Northparkes Mines

TS2 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Tristan Wells is currently undertaking his PhD at CODES - University of Tasmania as part of the Australian Research Council Linkage Project on the Lachlan Fold Belt. Tristan is researching magmatic fertility in the Macquarie Arc using whole rock and mineral chemistry.

The Northparkes district in central western NSW hosts economic Cu-Au mineralisation associated with discrete pencil porphyries emplaced in the Late Ordovician (444 - 439 Ma). Exploration in the Northparkes district is complicated by the limited lateral alteration haloes (<200 m) associated with mineralising intrusions, and the depth of weathering and post-mineralization cover in the district. This research aims to refine the geochemical indicators of magmatic fertility at Northparkes.

Mineralising intrusions in the Northparkes district are transitional from high-K calc-alkaline to silica-oversaturated alkalic in composition and exhibit a distinct arc signature. Northparkes porphyries are interpreted to have crystallised from hydrous melts based on geochemical indicators (Sr/Y ratios, listric shaped REE curves). Wholerock geochemistry at Northparkes indicates the suppression of plagioclase crystallisation in favour of hydrous mineral phases. The presence of primary hornblende phenocrysts in mineralising intrusions supports the interpretation of the geochemistry.

A key finding of this research is the association of mineralising intrusions with a low Zr fractionation trend. Both Sr/Y and the low Zr fractionation trend can be assessed using pXRF on wholerock or drill cutting samples. The availability of near real time data comparable to wet chemical assay allows for rapid assessment of drillhole success and increases the potential flexibility of exploration drilling campaigns. Use of pXRF technologies has the potential to significantly reduce exploration costs, which may lead to an increase in exploration and enhanced probabilities for future discoveries in the Northparkes district and broader Macquarie Arc.

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Optimizing agricultural benefits of partial and complete lining using Indus Basin Model Revised : case for Greater Thal Canal, Pakistan

Sanaullah M[1], Rehman A[2], Iman S[3]
[1]Institute of Geology, University Of The Punjab, [2]Planning and Design, Water and Power Development Authority (WAPDA), [3]College of Earth and Environmental Sciences, University of the Punjab

Biography:
Muhammad Sanaullah is the lecturer of geosciences at institute of Geology, university of the Punjab. His professional career is dedicated for research and teaching of Hydrogeology and has conducted significant number of investigations in the fields of Engineering Geology, water resource management and Geo-hazards. His doctorate research is on numerical modeling for ground water flow dynamics. He has published over 25 papers in Journals and conference proceedings. He is member editorial of the journals; Bulletin of Environmental studies and Geological Bulletin of the Punjab University. He is working on various national and international research projects.

The agriculture system in the Greater Thal Canal command area is rainfed and crop water requirements are accomplished by rainfall as well as the ground water pumpage. Cropping intensity in Kharif (The summer crop season) is about 6% and the crop yields are quite low in the study area. Indus Basin Model Revised (IBMR) has been adopted and a separate canal command was built to the model for assessing the prospective agricultural benefits of the canal.The results for non-perennial system at 80% canal efficiency under partial lining scenario posed net water requirements at canal head as 2.368 MAF with 45% Kharif cropping intensity, which are 0.128 MAF less than canal water availability of 2.496 MAF. Under the complete lining option at 85% canal efficiency and Kharif cropping intensity of 48%, the net water requirement at canal head is estimated as 2.46 MAF which is near to the canal water availability of 2.496 MAF. The annual net recharge to the ground water system has been estimated as 1.226 MAF, which is higher than partial lining option (1.026 MAF). The increased annual recharge is an attribute of increase in seepage from watercourses and farm fields by 4%, increase in crop area and a decrease in groundwater pumpage by 30%. This rapid rise of groundwater table in complete lining system may result in creating water-logging conditions while partial lining system can be adopted under increased cropping intensity.

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Application of a "Best Practices" Approach to the Leigh Creek Energy Insitu Gasification Demonstration Project

Haines J[1]
[1]*Leigh Creek Energy Limited*

TS6 - 3.2.2 Energy from coal, Room R2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Justin has postgraduate qualifications in geology and mining engineering and broad experience across engineering and geological services for multiple commodities including coal, iron ore and uranium. Most recently, he worked as Technical Manager for Carbon Energy Ltd, an In Situ Gasification (ISG) technology developer who successfully operated a demonstration facility in Queensland under the direction of the Queensland Government's UCG Trial Policy.

In the General Manager Technical role at Leigh Creek Energy, Justin is responsible for all technical and operational aspects of the development of the Leigh Creek Energy Project through to commercial production.

Leigh Creek Energy (LCK) is an emerging energy company focused on developing its Leigh Creek Energy Project (LCEP), located in South Australia, to produce high value products such as electricity, methane (synthetic natural gas) and ammonium nitrate products (fertiliser and industrial explosives) from the remnant coal resources at Leigh Creek utilising in situ gasification (ISG) technologies. LCK is committed to the long-term stability and economic development opportunities to the communities of the Upper Spencer Gulf, northern Flinders Ranges and South Australia.

Currently in the Demonstration Phase of the project, this stage will assist in proving the application of ISG at Leigh Creek, provide clearer commercial pathways and give confidence to the South Australian Government and community that LCK can operate safely and with minimal impact to the environment. Key to achieving these aims are site selection, operational controls and monitoring within a sound regulatory environment.

Key learnings from the large body of historical research and application of ISG around the world has enabled LCK to develop the Leigh Creek Energy Project using a risk based "best practices" approach.

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Overview of Geo-science Development in Papua New Guinea - The Challenges and Way Forward

Saroa D[1]

[1]*Mineral Resources Authority - Geological Survey Division*

TS3 - 5.5 Planning the future of Geoscience & 5.1 Geology in society: geotourism and geoheritage, Room R8, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Dulcie Saroa obtained her Masters in Geoscience Exploration in 2008 from Department of Applied Geology at the Curtin University of Technology, Western Australia. Her prior engagements were her Bachelor of Science honours degree attainment at the University of Papua New Guinea in 2006 and contract roles as exploration geologist at Barrick's Porgera gold mine and Wafi-Golpu project. Recruited as Senior Exploration Geologist within the Geological Survey Division of the Mineral Resources Authority in late 2009 and promoted to a managerial role in 2013, her 15 years of industry-government experience have given her much insights into development issues.

Unlike Australia where geoscience programs are highly recognized and pertinently integrated into sustainable development planning, Papua New Guinea (PNG) is still to realize the maximum benefit of geoscience contribution at the national development front. Endowed with vast geo-resources, the significance of geoscience in unearthing the earth resources through various geoscience applications for inclusive growth is however, missing in PNG's governance structure and policy development initiatives. The prominence of geoscience growth in mining and petroleum sector is associated with the prospective geological potential strengthened through the academically aligned courses. The success of the mining and petroleum industry in PNG owes generally to global industry players and foreign aid programs.

This paper presents the history of geoscience development in PNG inclusive of the regional mapping programs prior to and after independence and the challenges faced within the various external aid programs. Lessons learnt are also discussed and recommendations proposed as a way forward to enhance geoscience engagement in PNG through the mining and petroleum development experience and the academia while largely promoting geoscience principles to achieve inclusive growth.

The paper further demonstrates that intergovernmental regulations fall short of geoscience expertise and its contribution to the national and global goals of sustainable development. The author therefore propose views to improve geoscience policy coordination with regional alignment within the Asia-Pacific region through external and intergovernmental geoscience accords which would see integration of sustainable geoscience in rural communities.

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Lower-grade coals as a means to ensure Australia's Energy Security

C Clarke M[1]
[1]M.E.T.T.S. Pty Ltd

Biography:
Dr Mike Clarke, CPEng, FIEAust, FAusIMM, RPEQ (mining & chemical). Mike is a consulting engineer who has qualifications in mining, chemical and environmental engineering. Mike's areas of expertise are in Infrastructure Development and Resource Management as applied to fuels (coal, gas, liquid transport fuels), energy, electricity, wastes and helium.

Energy Security means that we have, dispatchible electricity for Industry, Commerce and the Community, ample transport fuel for travel (air, sea and land), plus liquid and gaseous fuel for industry, commerce and the community, leading to the populace being protected from unplanned energy supply failures and outages.
The Commonwealth Government has come up with the idea of legislating and/or regulating uninterruptable energy supply (e.g. gas and electricity) through the National Energy Guarantee (NEG):- the NEG however does not supply cash for new base-load power generation, energy transport and/or distribution. Will a government promise be enough to turn around our parlous national energy situation?
Natural gas (NG) as LNG and quality coal have an international demand. What is required is a source of non-export fuel that can meet both the future electricity and fluid fuel needs. That fuel should be non-export coal, washery middlings, colliery wastes, fine coal rejects and coaly mine inter-burden. The process to turn this unloved coal into usable fuel is gasification, with the utilisation of the product gas (syn-gas) in power generation, plus liquid fuels production.
The understanding of what 'coal fuels' are suitable for each gasification technology will determine the syn-gas specific energy and composition, and thence the most suitable down-stream system for syn-gas conversion.
The inputs of coal professionals, including coal geologists, mining engineers, washery engineers, processing and logistics experts will be required to make these dual energy scenario a reality.

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Helium and Australia

Clarke M[1]
[1]*M.E.T.T.S. Pty Ltd*

TS2 - 3.2.3 Petroleum and its co-products & 3.2.5 Geoscience aspects of the storage of energy related waste, Room R2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Mike Clarke, CPEng, FIEAust, FAusIMM, RPEQ (mining & chemical). Mike is a consulting engineer who has qualifications in mining, chemical and environmental engineering. Mike's areas of expertise are in Infrastructure Development and Resource Management as applied to fuels (coal, gas, liquid transport fuels), energy, electricity, wastes and helium

Helium (He) is a very valuable natural substance. Its uses include; being a lifting gas for balloons and dirigibles, as a source of extreme cold for super-conductors as found in MRI machines and future advanced nuclear reactors, as a flooding and purging gas, a welding shield, in fibre optics and as a nitrogen replacement in breathing gas.

Most He is produced as an alpha particle (α) formed through the decay of Thorium and Uranium. He is found in geological traps formed by evaporates that slow the progression of He atoms through the earth and form commercial/recoverable He 'concentrations' in some natural gas (NG) occurrences. Geological structures that concentrate He do exist in Australia.

He occurs in concentrations of over 10%, in others recoverable reserves are only 0·04% He; why the huge difference?

Australia currently produces around 2·5 tonnes/day of A grade liquid He (LHe) from one source, the Bayu-Undan gas-field off Darwin. The production out of Darwin is around 3% of the World's production, and which roughly matches Australia's use of He. The Bayu-Undan gasfield is however rapidly depleting such that new He resources/reserves are required to meet future demand and ensure 'Helium Security'.

The process of producing He from NG is to separate and collect most constituents of NG and leave an off-gas that contains recoverable He.

Q: Can the production of He lead to riches? A: In some instances Yes; this will be explored in the talk.

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Assessing magma fertility through platinum group geochemistry from Polo Sur and Penacho Blanco porphyry copper deposits, Centinela District, Northern Chile.

Carrasco Godoy C[1], Campbell I[1]
[1]*The Australian National University*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Carlos Carrasco is a Chilean Geologist doing a Master by research at the Australian National University. His previous working experience is related to mineral exploration, mainly blind porphyritic systems in northern Chile as well as strata-bound copper deposits and exotic copper ores.

Polo Sur and Penacho Blanco are Cu-Mo-(Au) porphyry copper deposits from Centinela District, Northern Chile, and part of the middle Eocene-early Oligocene metallogenic belt. The objective of this work is to assess the fertility of Cu and Au of magmas that are related to their formation using platinum group elements (PGE) under the hypothesis that the timing between sulfide saturation, relative to volatile saturation, is a main factor controlling the type and fertility of porphyritic systems.
If a parent magma reaches early sulphide saturation, an immiscible sulfide melt will form, that will extract chalcophile metals (as Cu and Au) and trap them at the bottom of the chamber so that they cannot enter the volatile ore-forming phase. In contrast, if the sulfide saturation occurs close to the time of volatile saturation, most of the metals will be available to enter the fluid phase and form an economic Cu or Cu-Au deposit.
Thirty samples related to the magmatism and mineralization at Polo Sur and Penacho Blanco have been analysed for major and trace elements. A subset of samples, selected according to their composition are being analysed for PGE geochemistry to identify the onset of sulphide saturation.
This study seeks to contribute to the understanding of how Cu and Au behave during the magmatic evolution and which factors control the formation of economic porphyry copper deposits. This might help to distinguish between fertile and barren system at an early stage of exploration.

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"Linking Northern Australia to PNG's southern coast through geotourism"

Lunge M[1], Saroa D[1]
[1]*Mineral Resources Authority*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Moira Lunge is a geologist with 10 years industry experience and currently works as a Senior Exploration Geologist at the Papua New Guinea Geological Survey (a division of the Mineral Resources Authority). She holds an MSc from the University of PNG and has considerable skills in Regional Geological Mapping, Mineral Systems Studies, and Geothermal Exploration including Geographic Information Systems Applications. She is passionate about promoting sustainable geoscience initiatives in PNG and she is part of the 'Geotourism' development initiative in PNG.

Separated by the Arafura and Coral Seas, the geological linkage of northern Australia and Papua New Guinea's (PNG) southern coast is widely known. This commonality has seen progressive developments in PNG's mining and petroleum sector with continuous exploration efforts and oilfields development in the offshore and onshore petroleum basins as well as the prospective central mineral fields. Yet an untapped geoscience potential to merge further connectivity and sustain inclusive economic growth remains to be realised.
Geotourism being a niche tourism product has emerged as a global sustainable development and conservation approach to promote sustainable tourism.Known as the tourism of geology and landscape, the initiative is to promote the rich geological heritage of PNG through an initial collaborative agreement between the PNG Tourism Promotion Authority (PNGTPA) and the Mineral Resources Authority's Geological Survey Division (MRA-GSD).
We present PNG's southernmost coastal village of Boera as the collaborative pilot project.With Boera's geological heritage link to northern Australia, its striking landscapes and coral islands rifted basins coupled with its vivid history and unique cultural experience presents an ideal opportunity for geoscience research and conservation; thus promoting visitors' engagement while contributing to the local and national economy.

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Keynote: Emerging technologies for characterisation of slope stability - managing misinterpretation, misuse and over-confidence

Elmouttie M[1]

[1]*CSIRO Energy*

TS5 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Dr Marc Elmouttie studied physics and mathematics at the University of Queensland. Marc leads the Mining Geoscience Team in CSIRO Energy, who develop rock mass characterisation and monitoring technologies for geological and geotechnical applications for the mining and civil engineering industries. Current R&D is focussed on 3D vision, structural mapping and modelling, uncertainty quantification and representation, borehole geophysical logging and imaging while drilling, microseismic monitoring and seismic tomography and multi-criteria analysis of geological and environmental factors effecting mining. Marc's current research focusses on numerical simulation, 2D and 3D image processing, 3D structural analysis and modelling, uncertainty quantification and risk analysis.

The ever-present challenges of geological and geotechnical uncertainty differentiate rock-mass engineering from other engineering disciplines. New and emerging technologies are supporting improved estimation of surface and sub-surface characteristics associated with potential slope instability, such as discontinuity delineation and rock mass deformation.
However, it is well recognised that there are several challenges associated with the arrival and uptake of new tools, both in the civil and mining engineering domains. These include preventing misinterpretation of technology outputs (especially semi-automated or fully automated analytics), misuse of new technologies (such as operating sensors outside of their specifications) and over-confidence (such as inferring more knowledge of the critical state of the slope is present or neglecting factors such as environmental impacts)
In this presentation, I will discuss some of the exciting sensing and monitoring technologies at our disposal but with an emphasis on how the aforementioned challenges apply to each. I will also discuss methods to manage these challenges.

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Magmatic plumbing styles within rift basins – insights from the Bass and Gippsland Basin, Australia

Meeuws F[1], Holford S[2], Foden J[1]
[1]School of Earth Sciences, the University Of Adelaide, [2]Australian School of Petroleum, the University of Adelaide

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Ms. Meeuws is a PhD student at the School of Earth Sciences, University of Adelaide. Ms. Meeuws completed a Master degree at Ghent University, Belgium and started her PhD after moving to Australia.

The cause of magmatic activity in continental rift basins is still not fully understood. Several of the rift basins along the southern Australian margin contain remnants of syn- and post-rift volcanism. Here we focus on the Bass and Gippsland basins, which despite having similar rifting histories, with two pulses of NNE-SSW to NE-SW directed rifting related to Tasman Sea extension in the Late Cretaceous, contain quite different magmatic plumbing systems.

Preliminary interpretations of seismic reflection data indicate that within the Gippsland Basin, late Cretaceous magmatism involved significant lateral transport (<40 km) through intrusions, from the centre of the basin towards the basin-bounding faults, to finally extrude as lava flows on top of the Upper Cretaceous sediments. A second pulse of post-rift magmatism is evidenced as a single Mid-Eocene volcanic mound in the centre of the basin. The Bass Basin in contrast, saw mainly dyke-fed magmatism during the Middle and Late Cretaceous and Miocene which is expressed as vents and sills. Magmatism in the Bass Basin is therefore more laterally confined and has not travelled significant lateral distances.

Magmatism in rift basins is often perceived negatively with regards to hydrocarbon plays, however several examples exist within the Bass and Gippsland basins proving otherwise (e.g. lava flow sealing the Kipper Field, volcanic complex overlying reservoir units of Yolla Field). A better understanding of magmatic plumbing systems in rift basins will aid in exploration and mitigation of associated risks in these often petroliferous areas.

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Evidence of multiple fluid events at Angularli uranium prospect, Alligator Rivers Uranium Field, Northern Territory from mapping HyLogger mineralogy.

Smith B[1]

[1]Northern Territory Geological Survey

TS2 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Belinda Smith graduated with Honours in Geology from the University of Western Australia. Since 1995, Belinda has been working through her company Rocksearch Australia for various exploration companies and the Northern Territory Geological Survey. Belinda entered the colourful world of spectral lines and HyLogger imagery in 2010 at NTGS but also still works as a consultant geologist.

Angularli prospect is an unconformity-style uranium resource comprising 26 Mlbs U3O8 (with 0.15% U3O8 cutoff; Vimy Resources, 2018). This resource is located within the Alligator Rivers Uranium Field, which also hosts Ranger 1 and 3, Koongarra, Nabarlek and Jabiluka 1 deposits, with a combined estimated uranium endowment of 360 000 t U3O8 (Lally and Bajwah 2006). Uranium mineralisation at Angularli prospect is hosted in a NNW-trending deformed fault zone which offsets the unconformity between the Paleoproterozoic Cahill Formation metasedimentary rocks and the overlying Mesoproterozoic Mamadawerre Sandstone. The Angularli fault zone shows evidence of multiple episodes of deformation, with variations in white mica and silica that may be related to uranium mineralisation. HyLogging data shows the logged 'silica flooded breccia' in the Angularli fault zone to also have silica-poor zones, which may indicate desilicification. White mica is the most common HyLogged mineral. Spatial variations in white mica composition and crystallinity are observed at different scales, ranging from composition changes within the Angularli fault zone, to white mica changes at a prospect scale. Other mineral changes are observed: diaspore (which can form from kaolinite desilicification) is found spatially associated with the Angularli fault zone. Tourmaline is found in breccias and along fractures within the Mamadawerre Sandstone proximal to uranium mineralisation. Magnesian chlorite is also observed in the Mamadawerre Sandstone associated with structures or Oenpelli Dolerite alteration zones. The chemistry and spatial distribution of these minerals is evidence of multiple fluid events that are not observed away from the uranium mineralisation at Angularli.

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A new era of biogeoscience- Life at the limits

Grice K[1]
[1]Curtin University

TS2 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Professor Grice was awarded a PhD in Organic Geochemistry at the University of Bristol. At Curtin University she has held two ARC QEII fellowships and a DORA. She is the Director of the WA-OIGC. She has received a number of research awards- The Premier's Inaugural Science Award for Early Career Achievement in Science, WA, International Pieter Schenck Award and the Gibbs Maitland Medal. She is a Fellow of, Geochemical Society and European Association of Geochemistry, Royal Australian Chemical Institute and a Fellow of the Australian Academy of Science. She has advised > 25 PhD students and published >160 papers.

Biogeoscience brings together molecular biology, environmental science, genomics, paleontology, palynology, sedimentology, geology, organic geochemistry and paleoclimate studies of the geological record to research the evolutionary synergies of life and the inorganic elements of Earth in the atmosphere, biosphere, geosphere and even beyond (Mars). Geobiology is one of the most quickly growing fields of science because of search for, and exploration of, planets both within and outside our solar system. As Earth-like planets are revealed in the next 20 years, we can only assess new life forms if we fully comprehend geosphere-biosphere interactions on our own planet Earth. Discerning the boundary conditions for life requires scientific investigations in Earth's most hostile or extreme environments. These include the deep subsurface such as thermal springs to the deep mantle. Geoscientists admit one of the major grand challenges we face in Earth Sciences is to anticipate the future state of our own planet- due to population growth, to sustaining resources to addressing major climate change issues. The importance of the rapidly growing field of geobiology will be discussed in view of the major challenges we face on our planet. Finally the importance of Earth Science research applied to major health issues will also be presented in the relatively new field of geomedical research.

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Geoenvironmental Assessments of Heavy Metals in Surface Sediments From Coastal Plain Sediments, Arabian Gulf, Kuwait

Elhabab A[1]

[1]*College Of Technological Studies*

Biography:

An assistant professor at the college of technological in kuwait and a faculty member of petroleum eng department. Hold a PhD in petroleum geology from university of Niigata Japan.

Pollution is problem that many countries around the world are facing. Pollution in Kuwait is Due to the rapid expansion of its industrial sector which has mainly occurred around its coasts, which resulted in the discharge of a variety of contaminants directly into the marine environment. The released harmful contaminants such as petroleum hydrocarbons, trace metals, nutrients, and contaminated brine from desalination plants, which are essential for freshwater production in the Arabian Gulf region.
In this study, sediment samples were collected from 12 different sites from two locations, located north and south of Arabian Gulf, Kuwait. The carried out analysis focused on the distribution of seven heavy metals. The study reveals that the order of the mean concentrations of the tested heavy metals in the north coastal plain sediment area is different than the south coastal plain sediment area.
The contamination factor (CF) and degree of contamination (Cd) were calculated and the obtained results from both showed that all the measured heavy metals, excluding Pb, Zn and Cd, exhibits low contamination status in the sediments. Also, the calculated Geo-accumulation Index (Igeo) showed that the sediments are generally classified as unpolluted (grade 0) with regards to the measured heavy metals, except that Pb from north coastal samples was slightly polluted. Results of Pollution Load Index (PLI) conclude that sediments are generally unpolluted.
This work aimed at assessing the concentration levels of some heavy metals in sediment to provide information that might be useful to Government agency other stakeholders for remediation purposes.

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Technologies for change: how magnetotellurics, geochronology and drilling have revitalised our view of South Australian geology

Reid A[1]

[1]*Geological Survey of South Australia*

TS8 - 1.6 Advances in structural, igneous metamorphic and sedimentary geology, Room R1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Anthony is a geoscientist with the Geological Survey of South Australia. His primary goal at present is to facilitate the geoscience team within the Geological Survey to achieve high quality applied geoscience that covers the spectrum of geological and geophysical techniques, in order to benefit South Australians.

This talk highlights three technologies at the forefront of advances in the last decade of geoscience in South Australia.

The new wave of magnetotelluric (MT) measurements being carried out across Australia as part of AusLAMP are a disruptive innovation. The ease with which passive recording, long-period MT instruments can be deployed and collect data means the UNCOVER aim of surveying the entire continent with MT methods is achievable. South Australia is now covered in half degree-spaced stations. The three dimensionality of the data being recorded provides unprecedented insight into the architecture and potential fluid pathways within the lithosphere.

Geochronology has undergone evolutionary innovation in the past few decades, with ever more sensitive instrumentation giving greater clarity over the timing of geological events. In SA, Multiple geochronology methods undertaken through collaborating laboratories including Geoscience Australia, have discovered the most ancient rocks in South Australia, completely re-defined the map of the western Gawler Craton, and have shown that eruption of a large igneous province associated with economic copper-gold mineralisation took just 8 million years.

Drilling remains the truth machine for geological interpretation of the subsurface. Recent diamond drilling in the Coompana Province has sampled mafic rocks within one of the state’s most intriguing geophysical domains. However, coiled tubing drilling developed in the DET CRC and tested in the field near Port Augusta, is an emerging technology with potential for disruption to mineral exploration practice.

Integrating these technologies in the MinEx CRC will facilitate the next wave of scientific and mineral discoveries.

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Bursting Bubbles: Can experiments and analogues help stakeholders and the public visualise risks?

Stalker L[1], Roberts J[2], Mabon L[3]
[1]CSIRO, [2]Department of Civil and Environmental Engineering, University of Strathclyde, [3]School of Applied Social Studies, Robert Gordon University

TS3 - 3.2.4 Sustainable energy sources & 3.2.6 Using geoscience to address social licence concerns for energy projects, Room R5, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Linda Stalker is Group Leader in Exploration Geosciences and Science Director for the National Geosequestration Laboratory at CSIRO. An Applied Geologist and Petroleum Geochemist, Linda has worked at Statoil, Norway before joining CSIRO in 2000. Research in gas geochemistry and stable isotopes led to carbon capture and storage research in monitoring and verification. Science communication has become increasingly important to working in pilot scale and demonstration projects, and Linda has sought better approaches to open science dialogue.
She obtained a BSc. (Hons) in Applied Geology from Strathclyde University, and PhD in Petroleum Geochemistry and CO2 Generation at Newcastle University.

Laboratory experiments, natural analogues and pilot projects have been fundamental in developing scientific understanding of risk and uncertainty for a range of geological and subsurface activities. But the value of these experiments as a communication tool for collaborators, regulators, policy makers, other stakeholders and the public is often overlooked. To quote Reiner (2015) "…it is difficult to engage in a serious public debate over risks or to develop an effective risk communications strategy if there is no actual project on which to present information."
International research into CO2 and CH4 leakage provides scientific understanding of potential leakage styles, rates and environmental impacts. Quantifiable lab experiments, measurement of CO2 at natural springs or CH4 emissions at abandoned wells, or monitoring controlled gas release all raise awareness and commitment to understanding the geological complexities. Related images from lab- and field-based activities, showing bubbles of seeping gas, or showcasing monitoring methods and capabilities, contextualise risks and geoscientific concepts, shaping opinions. These materials aid dialogue between the wider scientific community, public and stakeholders, whose opinions are critical to the conduct of subsurface activities.
We show a range of examples and how to bring together scientific results in context with images, and show how visual information can greatly facilitate communication. Research into public understanding of the subsurface demonstrates that quality, scale and dimension of schematics can all affect perceived risk. Here, we consider how public perception of subsurface activities could be shaped by relevant and applicable research that shares accessible and visually engaging information.

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COMPLEX EVOLUTION OF VOLCANIC ARCS AND ACCRETING PLATES: CASE-STUDY OF THE CAMBRIAN MOUNT STAVELY VOLCANIC COMPLEX

Bowman N[1], Van Otterloo J[1], Cairns C[2], Cas R[1]
[1]School of Earth, Atmosphere and Environment, Monash University, [2]Geological Survey of Victoria, Department of Economic Development, Jobs, Transport and Resources

TS7 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Nathan is a geology graduate from Monash University, specializing volcanology/igneous petrology.
In 2017 he completed his Honours degree at Monash. His project: Complex Evolution of Volcanic Arcs and Accreting Plates: Case study of the Cambrian Mount Stavely Volcanic Complex, focused on the paleovolcanology of the Mount Stavely Volcanic Complex. This involved combining drill core, field mapping, petrological and geochemical data to reconstruct the the tectonic environment the complex emplaced in.

The Mount Stavely Volcanic Complex (MSVC) is a prominent greenstone belt in western Victoria, which formed as a continental arc during subduction of the proto-Pacific plate under Gondwana.
While the MSVC has been broadly described in literature, its paleogeography and the geodynamic setting in which it emplaced remains unconstrained. The lithofacies that occur throughout the MSVC were characterized using drill core from the Geological Survey of Victoria, along with field work. Geochemical data was used to constrain the tectonic environment, and compare the MSVC to two analogous environment: The Honshu Arc and the Andean volcanics. The majority of the MSVC form fragmental facies, which were deposited in a deep, marine environment. The coherent facies can be divided into three suites: a High Ti Basalt suite, which emplaced in an extensional, Japanese style arc, and a Low Ti Mafic and High Ti Felsic suite, which emplaced in a compressional, Andean style arc. These findings help to not only constrain the environment in which the MSVC emplaced, but the tectonic setting, which provides important constraints for the tectonic reconstruction of Gondwana.

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Detrital zircons and the distribution of S-type granites through time

Zhu Z[1], Campbell I[1]
[1]*Australian National University*

TS2 - 1.1.1 Decoding Earth's supercycles: from the core to the crust, Hall C, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
2017 - Present: PhD student (Geochemistry) from Australian National University;
2013 - 2017: BSc (Earth Science) from China University of Geosciences (Wuhan).

A global database for approximately 7000 detrital zircon U/Pb ages and P concentrations from 52 worldwide major rivers show secular variations in the relative contributions of igneous (I-type) and sedimentary (S-type) components to source magmas through time. The U-Pb isotopic data show age peaks at 0.15-0.35, 0.40-0.65, 1.00-1.20, 1.65-1.95 and 2.40-2.75 Ga. These intervals correlate with the timing of supercontinents assembly and represent periods of enhanced granites production during supercontinents formation. Furthermore, the distinction of zircon P data distribution between characteristic I- and S-type granites from Lachlan Fold Belt (LFB) makes P-in-zircon a discriminant to identify them. We then compared the P data distribution for typical I- and S-type granites with that for detrital zircons from the 5 selected time intervals based on peaks in the U/Pb age histogram. Additionally, we plot all P data as moving point average as a function of time, which allows a more detailed assessment of the distribution of S-type granites through time. Our results show the proportion of S-type granitic source increases at times of supercontinent amalgamation, which could be explained by rapid erosion of mountains by continent-continent collisions that formed the supercontinents. We also found the highest proportion of S-type granitic source during 400-650 Ma. This could be attributed to the formation of supercontinent Gondwana as well as some possible biota that promoted chemical weathering, resulting in extreme erosion and sedimentation rates arguably the highest in the geological record.

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Using a Convolutional Neural Network to Classify Downhole Imagery

Rodger A[1]
[1]*CSIRO*

TS4 - 4.6 Mathematics, modelling, AI, robotics and machine learning applied to the acquisition and interpretation of large or complex geoscience data sets, Room R6, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Andrew Rodger is a research scientist with the CSIRO. His research has ranged from the development of atmospheric compensation routines for remotely sensed data, algorithm development for minerals research and the application of machine learning to minerals and geological applications.

He is also the project manager for the CSIRO developed The Spectral Geologist (TSG) software. His current research work is primarily focused on the machine learning realm and its application to aid and assist the work of geologists.

In an active drilling environment producing a large volume of drillcore field geologists need to allocate a large proportion of time to drillcore logging. This can be an expensive exercise and one that is prone to subjective results if multiple geologists are required for the task. With the advent of convolutional neural networks (CNN) for image recognition an opportunity exists to build and test the ability of such networks to assist the geologist in the automated identification of drillcore imagery. The result will be a reduction in time and subjectivity of core logging.
Using a 13 drillcore dataset that was both scanned with the HyLogger and independently logged by field geologists, a training, validation and testing dataset was constructed such that camera imagery collected by the HyLogger and the field geologists classification could be associated. This allowed the assessment of a CNN for automated drillcore logging. It was found that with suitable class representations and drill core imagery a reasonable downhole log could be automatically formulated that can assist the field geologist. While the use of a CNN does not ensure a perfect downhole log it does provide a means of rapidly assessing major changes in rock geology. Additionally, the creation of separate classes for cracks or fractures, empty tray sections and rubble will allow those classes to be identified and discarded.

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Geothermal energy for heating and cooling projects: Hydrogeology determines viability and design.

Taylor M[1]
[1]*Rockwater Pty Ltd*

TS3 - 3.2.4 Sustainable energy sources & 3.2.6 Using geoscience to address social licence concerns for energy projects, Room R5, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Miranda Taylor, Senior Hydrogeologist, joined Rockwater in 2002 following the completion of a Bachelor of Science (Hons) in Geology and Environmental Geoscience at the UWA. She is highly experienced in the fields of aquifer assessments, numerical modelling, groundwater chemistry, geothermal projects, and MAR. Miranda routinely undertakes feasibility studies, system design, management, supervision, commissioning, monitoring and performance assessments for shallow MAR, geothermal, and WWTP re-use projects in the Western Australia. She regularly prepares reports for local councils, mining executives and regulatory body representatives to consider.

Geothermal energy is a reliable sustainable energy source that can be harnessed continually, year round, with low operating costs. Initially determining whether geothermal is viable requires an understanding of the scale and seasonality of your energy need. Assessing a potential site's hydrogeology determines whether this could potentially be delivered. A geothermal aquifer assessment includes defining aquifer productivity and temperature, and evaluating an aquifer's propensity for thermal break-through, geochemical reactions and clogging. Potential impacts on other users and groundwater dependent ecosystems are assessed. Concept designs for geothermal systems are prepared by geothermal hydrogeologists and engineers to meet a project's energy requirements. The designs are then compared with other potential energy sources with respect to costs (capital and operational), environmental benefit, and risk.

In Western Australia, the aquifers in major geological basins are viable heat sources, and the technology of geothermal energy is well-developed. Direct-use geothermal heating of large swimming pools has been successfully completed at over a dozen sites where groundwater of about 45°C can be accessed at around 1 km depth. Heat-pump and direct-use systems have also utilised groundwater of 20-26°C from 20 to 160 m depth to heat and cool buildings, heat swimming pools, and to cool the Pawsey Supercomputer at Kensington.

A number of direct-use and geothermal heat-pump case studies are presented to illustrate potential geothermal applications in Australia. As energy prices increase and carbon emission targets are implemented, geothermal energy utilisation in Australia is expected to move toward electricity generation using groundwater temperatures of 70-150°C.

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Seismic Surveys and Marine Life: A Plea for Evidence-based debate, assessments and Regulation

Hughes J[1]
[1]*The Norwood Resource*

TS4 - 3.2.1 Future energy mix & 3.2.6 Using geoscience to address social licence concerns for energy projects, Room R5, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
John Hughes graduated from UCW Aberystwyth in 1969 with a BSc (Hons) in geology and, as a contractor, client and now consultant, has become a highly experienced operations geophysicist with an excellent command of environmental issues. He is an honorary member of ASEG, and a member of SEG and EAGE. He is also a founding member and the public officer of The Norwood Resource (TNR), a not-for-profit organization with a mission to "assemble and disseminate factual, scientific and verifiable information" and "actively challenge and counter misinformation" about the impacts of oil and gas exploration and production on the environment.

This presentation recommends that the debate surrounding seismic surveys and marine life, along with environmental assessments and regulations governing the conduct of seismic surveys, be based on the wealth of information we know rather than focus on perceived unknowns.
Cetacean populations actually do recover at close to biological maximum in areas exposed to considerable seismic activity. The Group IV humpback population in Western Australia exemplifies this.
This is not surprising given:

- The calls of many marine organisms have been measured at levels almost as high or higher than seismic pulses. For example, blue whales, sperm whales and shrimps;
- Natural sounds in the ocean have intensities similar to or higher than seismic pulses: Lightning strikes, calving/colliding icebergs, earthquakes and undersea volcanoes. The sounds from calving/colliding icebergs have similar levels, frequencies and periodicities to seismic sounds yet numerous species of whales spend summer months in polar waters;
- The activities of many marine creatures create very significant sound signals: A breaching humpback whale has a similar signature to a single element in a seismic array; and
- The continued occupation of marine animals in an area or even entry into the "exclusion" or "power/shut down zones", while a seismic survey is proceeding.

These basic facts and observations, along with the scientific principles of attenuation of sound in water, support a more pragmatic, evidence-based approach to the environmental assessment and regulation of marine seismic surveys. This model can be applied to other social licence issues faced by the petroleum industry.

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Identification of basement density heterogeneities through using stratigraphic modelling

Chopping R[1], Crombez V[1], Peeters L[2]
[1]CSIRO Deep Earth Imaging Future Science Platform, [2]CSIRO Deep Earth Imaging Future Science Platform

TS4 - 3.1.5 Technology metals and minerals – the importance of non-traditional commodities in the evolving economy & 3.1.6 New frontiers in ore system research, Room R2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Vincent Crombez received in 2012 a MSc in Petroleum geology from UniLaSalle (France) and a PhD in 2016 from the Université Pierre et Marie Curie in Paris (France). He was previously working for IFP Energies Nouvelles before moving to Australia and joining CSIRO as a postdoctoral fellow in November 2017. His background is in geology and geophysics, mostly sedimentology, stratigraphy and numerical modelling. His research mainly focuses on applied projects, linked with both the Mineral and the Oil and Gas industry.

Basement density heterogeneities are difficult to infer from gravity data as they are covered by thick sedimentary deposits. As a large fraction of Australia's mineral resources is likely hosted in rocks buried beneath extensive and stacked sedimentary basins, this cover presents a major limitation for mineral resources exploration. Common gravity forward modelling of sedimentary basins integrates density gradients to reflect the evolution of the porosity with depth linked to compaction and diagenesis. Our project aims at computing a range of probable gravity response of basins integrating density heterogeneities related to sedimentary processes and stratigraphic architecture. Using stratigraphic and gravity modelling we separate gravity anomalies due to heterogeneities in the cover from anomalies located in the basement. Once the cover's response computed, its effect on regional gravity data is removed to unravel density anomalies which we can more accurately attribute to the basement.
We will present the first phase of this project: (1) the development of a workflow that computes the gravity response of sedimentary cover, and (2) the understanding of the workflow sensitivity. The sensitivity analysis provides a ranking of the main stratigraphic and sedimentological controls on the gravity response of sedimentary basin. Over long periods (~10Ma), sediment supply and subsidence are the two main controls on the gravity response but over short periods (~1Ma), variations in the gravity response are controlled by the sediment supply, the type of sediments and their transport parameters. We are currently actively deploying this workflow to demonstrate its applicability on Australian case studies.

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The MAIA Mapper: a powerful new tool for investigation of magmatic ores by microbeam XRF imaging of drill core

Barnes S[1], Ryan C[2], Le Vaillant M[1], Yudovskaya M[3], Kirkham R[2], Moorhead G[2]
[1]CSIRO Mineral Resources, [2]CSIRO, [3]University of the Witwatersrand

TS5 - 3.1.6 New frontiers in ore system research, Hall E2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Steve Barnes is an economic geologist with a background in igneous petrology, geochemistry and volcanology and is CSIRO's expert in magmatic ore deposits. He is widely recognised as a world leader in the field of ore deposits associated with mafic and ultramafic igneous rocks, including deposits of nickel, chromium and the platinum group elements. He has published over 150 peer reviewed journal papers and book chapters over a 40 year career, covering ore deposits on six continents.

The CSIRO-designed Maia Mapper is a lab-based microbeam XRF scanning instrument that generates 30 micron resolution chemical maps of unprepared cut drill core using the Maia multi-detector array used on several synchrotron-based XFM beamlines. We report the result of Maia Mapper investigations of magmatic sulfide Ni-Cu-PGE and chromite ores from the Norilsk Ni-Cu-PGE camp and the Bushveld Complex. Samples from Norilsk intrusion reveal complex relationships among cumulus silicates, amygdales (former gas bubbles) and schlieren of chromitite within the PGE-rich, sulfide poor taxites. For the first time the technique allows us to directly image the location of platinum group minerals at cm to dm (0.5 m) scale in drill core. Pt-rich phases are clearly associated with the margins of original sulfide-vapour bubble pairs where sulfide has degassed, providing new evidence for the origin of this ore type.
Images from the UG2 PGE-chromitite interval of the Bushveld Complex reveal relationships between chromite and pyroxene crystal size and large poikilitic grains, giving clues to crystallisation processes. Scanned samples from the Platreef, and also from mineralised Ni-Cu bearing small intrusions, reveal distinctive patterns of trace element zoning in pyroxenes that may be diagnostic of ore-hosting intrusions. Results can be used to measure Ni, Cu and Co concentrations in the sulfide fraction.
The technique is rapid, non-destructive and involves minimal sample preparation beyond a clean, flat diamond-saw cut surface. We anticipate wide applications in ore genesis research, mineral exploration and geometallurgy for magmatic ores as well as in many other ore types.

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OneGeology; a global platform for interoperable subsurface data

Kemp C[1], Harrison M[3], Robida F[4], Broderic B[2]
[1]Geoscience Australia, [2]Geological Survey of Canada, [3]British Geological Survey, [4]French Geological Survey (BRGM)

Biography:
Dr Kemp is currently the acting CIO at Geoscience Australia, with responsibility for providing strategic leadership for enabling Digital Science across the organisation.

Dr Kemp has spent the last 6 years at Geoscience Australia leading the development of virtual laboratories and high performance computing to enable geophysical applications for pre-competitive dataset delivery. Her 20-year career has focused on the application of innovative technologies for mineral and petroleum exploration.

Dr Kemp holds a Doctor of Philosophy from the University of Sydney and a Bachelor of Science (Geology and Geophysics) from the University of New South Wales.

The OneGeology initiative began in 2007 with a goal of developing a globally consistent and accessible framework for geology. It has improved the web availability and usefulness of global geoscience data to address sustainability goals. Initially focus was on 2D spatial data challenges where management ended at national boundaries or hadn't previously existed. These parochial issues were addressed through the adoption and promotion of international data standards, the establishment of an accreditation scheme and data portal (http://portal.onegeology.org), with workshops and buddy system.

Today one of the shared challenges currently facing the global community is undoubtedly sharing 3D understanding of underground space. These challenges are slowly becoming resolved nationally but lacking interoperability due to an absence of agreed conventions for describing data, accepted standards data access, the lack of shared platforms for integrating this data and generating models that enable the analysis and interpretation of the associated information.

OneGeology is looking to expand the group of participants in efforts to address this challenge of 3D subsurface data, particularly those already active in this space. The desired availability and interoperability of subsurface geology and environmental data will provide an important mechanism supporting Sustainable Development and evidence-based decisions for the international community.

703

Midwave infrared functional groups of rock forming minerals

Laukamp C[1], LeGras M[1], Lau I[1], Pejcic B[2]
[1]CSIRO Mineral Resources, [2]CSIRO Energy

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Carsten Laukamp is a senior research geoscientist at CSIRO Mineral Resources, leading the Mineral Footprints Team and the National Virtual Core Library Project. Carsten explores the potential for combined use of lab, field and remote visible and infrared reflectance spectroscopy, geochemistry and geophysics for tracing hydrothermal alteration signatures through cover and to advance ore body knowledge.

The fast development of handheld spectrometers and hyperspectral drill core scanning systems opens up new wavelength regions of the electromagnetic spectrum for cost-effective and precise characterisation of rock forming minerals by means of reflectance spectroscopy. This includes the mid-infrared (MIR) region from 2500 – 6000 nm, which contains additional absorption features not perceivable in the commonly collected shortwave (SWIR) or thermal infrared (TIR) wavelengths. To support the interpretation of mineralogy from MIR spectral signatures, SWIR, MIR and TIR reflectance spectra were collected for a variety of nominally anhydrous silicates, dioctahedral and trioctahedral sheet silicates, carbonates, sulphates and carbon-bearing compounds using portable and lab-based Fourier Transform Infrared spectrometers (FTIRs), and their MIR functional groups examined. The results suggest that the additional wavelength range has the potential to 1) improve the characterisation of common minerals already interpreted from other wavelength regions (especially hydroxyl-bearing silicates and carbonates but also quartz), and 2) provide information about additional compounds that were not readily identifiable in the SWIR or TIR. Furthermore, the MIR potentially provides a solution to the problem of un-mixing minerals from samples that contain carbon black, manganese, magnetite or sulphides, as the impact of the listed materials on the reflectance spectrum is decreased when compared to the SWIR. This paper presents a summary of already published functional groups and assignments for newly identified absorption features of rock forming minerals and vector minerals applicable to a range of mineral deposit styles.

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THE CONCEPT OF ECON AS A NEW ANALYTIC UNIT FOR THE STUDY OF BIODIVERSITY EVOLUTION AT THE MACROEVOLUTIONARY LEVEL

Vislobokova I[1]
[1]*Paleontological Institute, Russian Academy of Sciences*

Biography:
Paleontologist, graduated from the M.V. Lomonosov Moscow State University.
Doctor of Geological and Mineralogical Sciences, 1974
Doctor of Biological Sciences, 1990
Main current researches are connected with two areas:(1) evolution of Cenozoic mammals (mainly artiodactyls) and mammalian faunas and (2) some aspects of theory of evolution.

Today, the further progress in our knowledge of the origin, evolution and distribution of life on Earth, in the past, present, and future, can be based on the global and systemic approaches. A huge array of new information requires a revision of existing evolutionary concepts and an enlargement of ecological basics for macroevolutionary and paleoenvironmental reconstructions. The fundamental law of unity of type and the conditions of existence introduced by Charles Darwin in 1859 can obtain a new analytic paleoecological key. The term “econe” was proposed by an Australian ecologist Harold Heatwole in 1989 as a fundamental ecological unit for recent species and their subgroups which occupied the different ecological niches. I suggested using the econ (taxon and its ecological niche) as a basic ecological unit that evolved in space and time at the macroevolutionary level. The new concept of econ better highlights the unity of evolution of a taxon and its environment, the evolutionary wholeness of taxon and space (s.l.) of its habitats (including organic entity and all its possible interactions within the multidimensional stratoreticular network, e.g. the adaptation, behavior, interactions with other animals, competition, tolerance gradients, etc.). The econ, as integrity of a taxon and its environments, will help to better understanding the processes of evolution and distribution of taxa and well suits for systemic analyses, when the evolution of paleobiodiversity is regarded as the evolution of biosystems in the frame of a global ecological approach.

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Geoscience-based discussion making in our governments and society towards an ongoing value of geological surveys

Hill S[1]
[1]*Geological Survey Of South Australia*

Biography:
Steve is South Australia's Chief Government Geologist and Director of the Geological Survey of South Australia. Like all of us he enjoys short biographies.

Government geological surveys have had an impressive and honorable history, with valuable contributions to nations, states and society - Well done. What will the role of geological surveys look like into our futures? One thing that is certain is change, and as such geological surveys will need to move beyond "more of the same" or "better of the same" and therefore become more engaged with and offer value propositions in new ways for new and different geographical and conceptual frontiers. An important cornerstone here will be the importance of trusted geoscience-based decision making for governments that are in the best interests of the greater community. This will take geological surveys into frontiers of people's hearts and minds.
Besides highlighting an awareness of this challenge and the dangers of ignoring it, this presentation will look at solutions and ways that some geological surveys in South Australia, Australia and the world are starting to change and adapt to these challenges. In the Geological Survey of South Australia, UNCOVER has provided a fundamental framework and structure for how it's geoscience has been directed towards mineral resources discoveries. Of course the value of geoscience and government geological surveys extends beyond mineral resources, but the challenge becomes greater as we then look at ways to build trust and capacity while support becomes more lean. A key here will be collaboration and for geological surveys to effectively broker and champion the best teams from outside of their own organizational structure.

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Plug in and play: Cyberinfrastructure for Magnetotellurics (MT) practitioners

Rees N[1], Heinson G[2], Evans B[1], Wyborn L[1], **Rawling T[3]**, Wang J[1], Druken K[1], Conway D[2]
[1]The Australian National University (NCI), [2]The University of Adelaide, [3]AuScope Limited

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Dr Tim Rawling is the CEO of AuScope. Prior to this role he was Director Infrastructure Development of AuScope's Australian Geophysical Observing System (AGOS). His recent research has involved the development of regional/crustal-scale 3D and 4D geological models as well as new exploration methodologies involving 3D modeling and finite element simulation. Tim has previously worked as a consultant exploration geologist, as the manager of the 3D modelling and simulation programs at GeoScience Victoria (DPI), as the MCA funded lecturer at the University of Melbourne, a commercial programmer and as a researcher at Monash University and the University of Arizona.

As part of the 2017-2018 AuScope-Australian Research Data Commons funded Geoscience Data Enhanced Virtual Laboratory (DeVL) project, the University of Adelaide MT data collection has been made accessible online, along with software and workflows in a High Performance Computing (HPC) environment. This development by the National Computational Infrastructure (NCI) has significantly benefited MT practitioners by providing them with:
- The ability to store and publish raw time-series data using open self-describing data formats (e.g., netCDF), thus enabling easier sharing of MT data through OPeNDAP services.
- The ability to publish MT transfer functions, as well as modeling outputs (e.g., lithospheric conductivity models).
- Access to HPC and cloud resources enabling a move to server-side discovery, data subsetting and then faster processing and modeling.
- An assortment of MT processing and modeling tools available on the NCI Raijin Supercomputer and Virtual Desktop Environment (VDI).
- Access to non-MT specific software for data visualisation.
- Technical staff to help with MT and HPC related issues.

NCI, in partnership with the University of Adelaide, has also been working with the international MT community in adopting Findable, Accessible, Interoperable and Reusable (FAIR) data principles to allow easier sharing of MT data and workflows within and across disciplines. This work has been presented at the 24th EM Induction Workshop [1], to help ensure that the data capture, publishing, curation and processing being undertaken at NCI is in line with best practice internationally.

1. The 24th EM Induction Workshop (EMIW2018: https://emiw2018.emiw.org/, accessed 3 July 2018).

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Building realistic fracture networks for tunnel design in Sydney, Australia

Weir F[1]

[1]*PSM*

Biography:

Dr Felicia Weir is a Principal Engineering Geologist of Pells Sullivan Meynink Pty Ltd, with 12 years' experience in her field. In 2006 Felicia completed her PhD in Geomorphology before starting at PSM. In 2010 she completed her Postgraduate Certificate in Geotechnical Engineering at the University of New South Wales, where she currently lectures post graduate levels part time. Felicia's primary areas of practice include engineering geology, 3D geotechnical models, fracture network modelling and stability assessments for open cut mining. Felicia enjoys a spectrum of projects from short life operations to large scale pits in complex risk settings.

The city of Sydney (Australia) is currently undergoing a major infrastructure construction boom, with numerous rail and road tunnels currently under construction. This paper presents fracture network modelling undertaken as part of the design process for the Parramatta and Wattle (PW) Caverns of the M4East project.

The PW caverns are expected to be excavated in fresh Hawkesbury Sandstone. At the study site the primary discontinuities controlling block formation are expected to be joints, bedding planes and bedding plane shears. The discrete fracture network (DFN) modelling of this study has been built to be representative of these types of structures. This paper presents the necessary input parameters for the modelling, derivation of these parameters along with the model generation process. Of particular importance for engineering applications is the development of realistic DFN models and validation of the simulated fracture network. The simulated fracture networks were shown in this instance to be a good fit to the measured field data.

Multiple realizations of the model were generated, with a stability analysis carried out on each. The stability analyses were used to develop the unstable block volume distribution and identify the maximum likely block volume for the crown and sidewalls of the cavern. Large stable blocks were found to occur between the parallel caverns, where the tunnel sidewalls form two boundaries.
Excavation of the caverns is now complete and has provided field verification of the modelling, with the shape and dimensions of the blocks within the predicted range.

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Tasmania in 3D: Insights from a Comparison of Passive Seismic and Geoelectric Images

Ostersen T[1], Reading A[1], Cracknell M[1], Roach M[1], McNeill A[2], Duffett M[2], Bombardieri D[2], Rawlinson N[3], Pilia S[3], Thiel S[4], Robertson K[4], Duan J[5], Heinson G[6]
[1]University of Tasmania, [2]Mineral Resources Tasmania, Department of State Growth, [3]University of Cambridge, [4]Geological Survey of South Australia, [5]Geoscience Australia, [6]University of Adelaide

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Thomas is a PhD student from the University of Tasmania working on the geoelectric structure of Tasmania and interpretation of integrated geophysics datasets toward geological understanding. Thomas returned to study following three years in industry where he developed skills in potential field data acquisition and geophysical project management.

Tasmania has a complex and enigmatic tectonic history, with much of the geological basement being hidden by cover sequences in the east, and thick vegetation in the west. Beginning in 2003, passive seismic campaigns have been carried out which have revealed the seismic structure of the crust and upper mantle architecture through the north and east of Tasmania through various tomographic studies. In 2016, these were complemented by a long period magnetotelluric field campaign covering the whole state. In this contribution we present, as a 'first' for Tasmania, a comparison of images derived from seismic and geoelectric methods.

The 3D passive seismic tomography images show the block structure of units that have been brought together in a sequence of orogenic events with fast wavespeeds in the northwest and northeast. At upper mantle and lower crustal depths, the geoelectric structure suggests that fluid, or other conductive, pathways through these continental blocks exist: i.e. there is no strong suggestion of fluids being confined to the block edges. In the mid-crust, there are a number of discrete geoelectric anomalies some of which have a candidate geological explanation although others have no surface expression. The upper crust is dominated by the slow seismic wavespeeds of the Tasmania Basin, which extends across the Midland Valley and corresponds to a significant geoelectric anomaly. Within the basin, the details of the 3D geoelectric images suggest that fluid pathways are focussed in the Tamar Valley and in central eastern Tasmania which are less evident in the seismic images.

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Modelling gold solubility in alkaline and ammonia-rich hydrothermal fluids

Mei Y[1,2], Liu W[1], Brugger J[2]
[1]CSIRO, [2]Monash University

Biography:
Dr. Yuan Mei obtained her PhD degree in geochemistry in 2014 from the University of Adelaide. After submitted thesis in September 2013, she started her postdoc in University of Adelaide and moved to Monash University in July 2014. Now she is working at CSIRO
Minerals as an OCE Research Fellow. Yuan's research focuses on understanding mineral solubility and metal mobility in ore-forming fluids using molecular simulation, reaction modeling and synchrotron spectroscopy.

Gold is transported as aqueous complexes in chloride and sulfur rich hydrothermal fluids in its reduced oxidation state (Au(I)) with major ligands (Cl- and HS-), which has been investigated by considerable theoretical and experimental studies (see reviews by Williams-Jones et al., 2009; Brugger et al., 2016). However, alkaline hydrothermal fluids (e.g., ammonia-rich) may play an important role in the formation of gold deposits, yet the solubility of gold and complexation of Au(I) with hydroxyl and ammine ligands in sulfur- and chloride-poor fluids received limited attention so far.
In this study, we use ab initio molecular dynamics (MD) simulations to calculate the coordination structures of Au(I)–OH and Au(I)-NH3 complexes, and use thermodynamic integration to determine the formation constants of these species at temperatures up to 350 ºC and at water-saturated pressures. Our simulations showed linear structures of Au(I) complexes with two bonded ligands (OH-/NH3/H2O), consistent with previous experimental and theoretical studies of Au(I) complexation (e.g., Liu et al., 2014). The derived formation constants show that the stability of Au(I)–OH and Au(I)-NH3 complexes decreases progressively with increasing temperature. These new data enable better understanding and quantative modelling of gold mobility in alkline and amonia-rich hydrothermal fluids.

References:
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Liu, W., Etschmann, B., Testemale, D., Hazemann, J.-L., Rempel, K., Müller, H. and Brugger, J. (2014) Chem. Geol. 376, 11-19.
Williams-Jones, A.E., Bowell, R.J. and Migdisov, A.A. (2009). Elements 5, 281-287.

710

Ground movement changes due to climate effects on roads and infrastructure founded on shallow expansive clays.

Lopes D[3]
[1]USL Group Pty Ltd, [2]Australian Geomechanics Society, [3]Housing Engineering, Design & Research Asociation

TS7 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
PROFESSIONAL GEOLOGICAL AND GEOTECHNICAL EXPERIENCE
- Mineralogical, geophysical and geochemical exploration.
- Foundation Engineering.
- Slope Stability Investigations.
- Civil Works.
- Piling
- Building forensic investigations.
- Geotechnical Research.

QUALIFICATIONS
- 1971 - Qualified in Applied Geology at RMIT.
- 2000 – Master of Engineering at Swinburne University of Technology.
- 2017 – PhD of Engineering at Swinburne University of Technology.

AWARDS
- 1990 – Award in recognition of establishing the FFSV
- 1997 – Co-Award for Engineering Excellence in Timber design (Timber Promotion Council Aus)
- 2016 – Award in appreciation of 25 year service to the FFSV

Ground movement changes due to climate effects on roads and infrastructure founded on shallow expansive clays.

D. Lopes1, Xi Sun2 and Jie2
1 USLGroup, Melbourne.
2 School of Engineering, RMIT University, Melbourne.

Abstract:
Soil moisture change is a critical component of a wide range of human activities. Its decline correlates well with climate change. This study extends the examination for soil moisture and Thornthwaite Moisture Index (TMI) in the State of Victoria, Australia, pioneered by the C.S.I.R.O in 1965 and by Aitchison and Richards and several other researchers since. It examines trends in soil moisture in three 20 year periods from 1948 to 2007 and presents 3 TMI maps which show a continual drying trend in Victoria. A further 3 TMI maps are included which predict future changes by using the latest 23 climate models from the Coupled Model Inter-comparison Project 3 for 2030, 2050 and 2070.
The data is used to construct the 'Predictor models' for ground movements that may be expected for roads and other infrastructure with shallow foundations in different climates. These models are a refinement of

existing models that have been used by Australian geotechnical engineers for 3 decades and supported by global predictions of TMI and climate change.

Researchers have estimated that the costs of repairs to infrastructure world-wide due to soil moisture changes are annually very high. Li and Cameron noted in 2014 that it was >$30 billion in China and U.S.A. alone. An improved modelling of surficial ground movement will reduce such costs.

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Using a risk framework to guide groundwater modelling and data collection to analyze future environmental impacts from extractive industries

Walker G[1]
[1]*Grounded In Water*

TS1 - 3.3.1 Groundwater challenges and opportunities & 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Bio TBC

Groundwater modelling to predict future impacts of a given action is an important component of environmental assessments. There has been a long-standing tension about the complexity with which processes are represented in groundwater models as increased complexity can lead to greater predictive uncertainty and computational difficulties in modelling and uncertainty analysis. The conventional approach is to use a single groundwater model, calibrated with historical piezometric data and conducted without uncertainty analysis. Improved geophysical, geochemical and geological techniques for obtaining better information on underground hydraulic properties and the large improvements in computing power and software means that greater complexity can be incorporated into groundwater models in ways that may reduce predictive uncertainty, but in doing so, does not resolve the computational issues. Risk frameworks provide a basis for managing complexity through principles, such as using a tiered approach to match complexity with risk. Matching data collection with the requirements of modelling and risk assessments is problematic, as the time required to collect these may be inconsistent with that of modelling and the changing nature of decisions which may relate to several developments in the one region. Also, there may be a range of institutions, responsible for data collection. The development and application of best practices for data collection may better justify appropriate data collection and enhance both modelling and risk assessments.

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Tectonic Provenance Of The Palaeoproterozoic Plum Tree Volcanics

Higgie D[1], Foden J[1], Cox G[1], Blades M[1], Collins A[1]
[1]Centre for Tectonics, Resources and Exploration (TRaX), Department of Earth Sciences, The University of Adelaide

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Dion Higgie is an honours student at The University of Adelaide where he is currently undertaking a project that is constraining the tectonic provenance of the Palaeoproterozoic Plum Tree Volcanics within the McArthur Basin, Northern Terriotory, Australia.

Forming part of the fluvial conglomerate-sandstone sequence of the upper Edith River Group, the Palaeoproterozoic (1825 ±4Ma) Plum Tree Volcanics are a bimodal suite of basalt and rhyolite lavas. They are preserved in remnant outliers unconformably overlying the Pine Creek Orogen north of Katherine (Edith River, Mt Callanan & Birdie Creek). These sequences directly postdate the convergent orogenesis of the Pine Creek and mark the prelude to the extensional or sag regime that initiated the McArthur basin. The tectonic setting of the Plum Tree volcanism; whether divergent intraplate rift, or mantle hotspot, may suggest how the formation of the McArthur Basin began and provide some insight to how the Pine Creek Orogen ceased.

Rhyolites may be formed by; fractional crystallisation of parental mafic melts, by crustal melting, or by coupled crustal assimilation and fractional crystallisation (AFC). Although an anticipated key to the tectonic setting these tholeiitic basalt's origin is ambiguous identified by preliminary geochemical discrimination as variously; calc-alkali arc (subduction), within plate tholeiite or transitional MORB (rift or hotspot).

Initial conclusions suggest that the discrimination as a subduction suite is spurious, driven by crustal assimilation. Crust-mantle melt disentanglement using radiogenic isotopes will allow the more probable rift versus hot-spot origin for the Plum Tree Volcanics to be identified. This resolution will have important implications for the understanding of the tectonic evolution of Australia during the Palaeoproterozoic.

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The dependency of Proterozoic stromatolite abundance on trace elements and temperature

Corkrey R[2], **Mukherjee I[1]**, Large R[1], Danyushevsky L[1]

[1]Center for Ore Deposits and Earth Sciences (CODES), University of Tasmania, [2]Tasmanian Institute of Agriculture (TIA), University of tasmania

TS4 - 2.6 Geobiology, Room R1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:

Indrani Mukherjee is a postdoctoral researcher at CODES, University of Tasmania. Her research focuses on understanding pyrite trace element and sulphur isotope geochemistry in black shales and its implications on ore deposit cycles and evolution of early life.

The occurrence of stromatolites date from 3.485 Ga and display varying diversity and abundance over time, with both rising to peaks at ~1.35-1.0 Ga, followed by declines. From the Cambrian onwards their distribution has been limited to refugia associated with intertidal-supratidal zones, saline regions, and high energy environments, thought to exclude metazoan grazers and burrowers. Metazoa are classified within the Eukarya Domain.

We have recently shown that critical biological evolutionary events, including the appearance of eukaryotes, occurred during a period of low nutrient element availability (e.g., Ni, Co, Se, Zn, Mo, Cd), followed by diversification associated with relatively high nutrient trace element concentration. We investigated whether the variation in trace elements might also be associated with stromatolite abundance variation.

We modeled the proportion of stromatolite bearing geological units between 2.5Ga to 540Ma using as predictors the variation in trace elements and in ocean temperature. The modeling procedure made use of recursive partitioning within R. Using just trace element predictors we were able to explain 51% of the variation in stromatolite abundance. When we also allowed for variation in temperature, we could explain up to 89%.

Linkages between variation of trace elements and temperature consistent with metabolic function are likely to support a biogenic origin for Proterozoic stromatolites. They may also shine light on whether their decline was due to the rise of metazoa or from other factors. They further support the importance of temperature on biological growth rates and their variation in geological time.

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Rock Assemblage Library

Moltzen J[1], Bottrill R[1]
[1]Mineral Resources Tasmania

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Jake Moltzen graduated from the University of Tasmania in 2015 after completing his Honours thesis entitled "Integrated techniques for rapid drill core characterisation". Prior to completing his thesis Jake studied Mining Geology at Curtin University and the Western Australian School of Mines. Since then, he has worked for Mineral Resources Tasmania with a focus on HyLogger-3 operation and the interpretation of hyperspectral data using The Spectral Geologist program. Jake has specific interests in mineralogical identification techniques with a focus on emerging technologies.

Understanding mineral assemblages is imperative for accurate and routine characterisation of drill core. The Spectral Geologist (TSG) program is used for the interpretation of hyperspectral data acquired by HyLogger-3 instruments and is frequently used by the Australian State and Territory Geological Surveys. The identification of minerals and their modal proportions is undertaken through unmixing algorithms incorporated into TSG and processes spectra in the VNIR-SWIR (400 – 2500 nm) and TIR (6000 – 14000 nm) regions. Typically, TSG reports results with either a singleton or mixture of minerals by matching the measured spectra against a built-in Spectral Reference Library. The reliability of the library is dependent upon both the purity of samples and how representative the library is of the rocks and minerals that are being tested. Difficulties with unmixing common mineral mixtures (e.g., chlorite + carbonate SWIR response) had led to the use of analytical instruments such as XRD for validation.

The Rock Assemblage Library aims to evaluate the performance of TSG unmixing algorithms for both mineral identification and modal mineralogy. Test work has been undertaken on a sample suite from the Mount Read Volcanics in Western Tasmania with rocks analysed at each Geological Survey HyLogger-3 machine to provide a detailed comparison between instruments. Unmixing results are validated using several advanced analytical techniques (e.g., XRD, EPMA and XRF) to assess the overall accuracy and performance.

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A world-class Rock Kit for teaching in middle school

McNamara G[2]
[1]Australian Science Innovations, [2]Teacher Earth Science Education Programme

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Greg is a consultant geologist with interests in geoscience education and outreach as well as the sedimentology, stratigraphy and geochronology of Australian vertebrate fossils.
He has taught undergraduate geoscience, helped run a CSIRO science education centre, managed an interactive science museum and established the education centre at Geoscience Australia.
In 2007 he helped create the award-winning Teacher Earth Science Education Programme. Greg also authors e-newsletters GEOZ for the Geological Society of Australia and GeoEdLink for the Australian Geoscience Council.
In 2014 Greg was appointed as the inaugural Program Director of the Australian Earth and Environmental Science Olympiad.

One of the best rock kits available for schools anywhere in the world has been assembled by a dedicated team of TESEP geoscientists.

For too long schools, teachers and students have put up with poor quality, inappropriate and often dangerous specimens that were simply not suited to teaching in middle school.

In many schools, even these specimens were under-utilised because the teachers and their support staff were ill equipped to identify them, label them correctly and use them effectively in the classroom to engage and inspire student interest in Earth Science.

Anecdotally, it is partly these poor-quality support materials that have contributed to a significant level of under-teaching this component of the science KLA in the K-10 curriculum.

To address these issues TESEP has assembled set rocks that are all:

- Guaranteed to be what we say they are.
- Well labelled
- Hold in your hand size
- Nicely boxed, one box for each rock type
- Free from distracting features not relevant to yr8-9 students
- Collected from reliable sources for ease of replacement

In addition the kit comes with:
- Stories about each rock, where they come from, how they formed
- Question and Answer materials to support student inquiry
- Extension materials including:
  - Virtual 3D versions online
  - Virtual thin sections to see what they are like on the inside

The rocks and support materials are also provided with a professional development workshop that gives teachers the knowledge they need to use it effectively.

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Ground zero: The return of the deep biosphere at the Chicxulub Impact crater

Schaefer B[1], Coolen M[1], Grice K[1], Cockell C[2], IODP 364 Science Party
[1]Western Australian Organic and Isotope Geochemistry Centre (WA-OIGC), School of Earth and Planetary Sciences, Curtin University, [2]Centre of Astrobiology, School of Physics and Astronomy, University of Edinburgh

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
PhD student with Kliti Grice and Marco Coolen at Curtin University working on the end-Cretaceous mass extinction event.

The Chicxulub crater, Mexico, is the site of the asteroid impact that led to the end-Cretaceous mass extinction. Deep ocean drilling into the peak ring of the impact structure allowed us to investigate the modern deep biosphere within the (a) high-porosity melt-bearing impact breccia or suevite (617-740 mbsf) emplaced within a day or so of the Cenozoic, (b) the overlying low porosity post-impact marine Cenozoic carbonates (504-617 mbsf), and the impacted and fractured granitic basement (740-1334 mbsf). The microbial biomass (~106 cells/g wet weight) was highest in the upper suevite, in underlying non-granitic strongly serpentinized and ultramafic, subvolcanic pre-impact basanite and at the intercalation of suevite and impact melt rock. Enrichments at in situ 50-60 °C show the presence of heterotrophic lifestyles in the suevite and bacterial sulfate reduction extending into the top of the granitic basement. Cultivation-independent 16S diversity profiling revealed the presence of heterotrophic (fermentative) as well as autotrophic C-fixing thermophilic bacteria in the organic-rich Cenozoic sediments. The organic-lean suevite showed the unique presence of sequences related to thermophilic Synechococcus (cyanobacteria) and S-oxidizing green sulfur bacteria (chlorobi), and Chloroflexi often associated with organic-poor deep-sea sediments. Alphaproteobacteria, predominated in the upper part of the granitic basement (<1000 mbsf), while putative manganese-oxidising Bacilli (Firmicutes) predominated in the melt-rich granitic basement (>1200 mbsf). Our data suggest that the catastrophe that led to the end-Cretaceous mass extinction caused geological disruption and recolonisation of microbial life in the deep subsurface biosphere at the Chicxulub impact site

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Insights into changes in crust formation processes at the Archean-Proterozoic Transition from receiver functions: Capricorn Orogen, Western Australia

Yuan H[1,2,3], **Lu Y[1]**, Murdie R[1], Dentith M[3], Johnson S[1], Gessner K[1]
[1]Geological Survey of Western Australia, [2]CCFS, Macquarie University, [3]Centre for Exploration Targeting, University of Western Australia

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Yongjun is a Senior Geochronologist in Isotope Acquisition at the Geological Survey of Western Australia

Between 3.0 and 2.0 Ga in Earth history, the major crust-forming mechanisms may have switched from plume tectonics to modern-style-like plate tectonics. From a seismic perspective this regime change may have left systematic imprints in the stable cratonic crust; however, due to sparse sampling, a global consensus is not evident whether a secular change can be inferred. We investigate the Capricorn Orogen in the West Australian Craton using a four-year passive-source seismic array and available permanent and temporary deployments in the area. Over 110 stations cover a 500 x 1000 km area that spans nearly two billion years Earth history. Teleseismic receiver functions were analyzed to target specifically the geophysical characteristics of the crust, which are then compared with the Nd model age of surficial rocks. Our results show that there is a progressive thinning of the crust through the mid- to late Archean, during which the rocks evolve from more felsic to more intermediate compositions, and the Moho to upper mantle transition remains sharp in general. Significant crustal thickening and increasingly mafic rock compositions are observed along the major crustal boundaries, which are accompanied by weak Moho amplitudes and a consistent one-sided dipping Moho. Considering the spatial proximity of the two major orogenies, the 2.2 Ga Ophthalmia and 2.0 Ga Glenburgh Orogenies with the thickened mafic crust and dipping Moho, we speculate that this change in the crustal characteristics may reflect that the dominant crust-forming mechanism may have already switched to plate-tectonic-style subductions by the Paleoproterozoic.

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Measuring Lithium-Bearing Minerals with Infrared Reflectance Spectroscopy

Legras M[1], Laukamp C[1], Otto A[1], Verrall M[1], Francis N[1], Narbey M[2], Schoneveld L[1]
[1]CSIRO Mineral Resources, [2]AXT

TS4 - 3.1.5 Technology metals and minerals – the importance of non-traditional commodities in the evolving economy & 3.1.6 New frontiers in ore system research, Room R2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Monica LeGras has worked with CSIRO since 2011 after completing a Bachelor of Science (Geology Hons) at the University of New South Wales.

Li-bearing pyroxene and mica minerals have unique signatures in the infrared region of the electromagnetic spectrum, which contain information about their chemical composition and abundance. The spectral signatures are comprised of absorption features arising from molecular bond vibrations. These include Si-O bonds in Li pyroxene (spodumene), and both Si-O and hydroxylated cation (e.g. Al, Mg, Fe2+, Fe3+ and Li) bonds in Li micas (such as lepidolite, polylithionite and zinnwaldite). The wavelength, intensity and shape of the absorption features are related to the abundance of that bond within the crystal structure and, by extension, to the abundance of the mineral containing those bonds within the rock.

This study analyses a variety of Li-bearing minerals with infrared reflectance spectroscopy in the 1200 - 14500 nm wavelength range (short-wave, mid and thermal infrared). The Spectral Geologist (TSG™) software is used to extract and interpret the spectral features, and comparisons are made with X-ray diffraction, inductively coupled plasma mass spectrometry and electron probe microanalysis data to quantify mineral composition and abundance. The influence of co-occurring mineralogical phases is also assessed. The results improve our understanding of infrared reflectance spectroscopy as a tool for Li deposit exploration and characterisation.

719

Towards an understanding of boninite genesis and their role in probing the sub-arc mantle, Cape Vogel, Papua New Guinea

Nebel O[1], Benard A[2], LeLosq C[3], Arculus R[3]
[1]School Of Earth, Atmosphere And Environment, Monash University, [2]Institute of Earth Sciences, University of Lausanne, [3]Research School of Earth Sciences, The Australian National University

TS8 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
2006-2008 PostDoc Vrije Universiteit Amsterdam, NL
2009-2011 PostDoc RSES, ANU
2012-2014 ARC DECRA Fellow, RSES, ANU
Since 2015 ARC Future Fellow at Monash University

Primitive, non-evolved island arc lavas (IAL) have a considerably larger spectrum in element chemistry than their mid ocean ridge counterparts. This diversity is the result of heterogeneous mantle sources, the addition of slab-derived components and complex sub-arc mixing and mingling of melts, all of which contributing to the chemistry of IAL. Isolation of factors that add to the spectrum in melt chemistry is thus crucial for a detailed understanding of melt genesis in subduction zones. Boninites, named after lavas at Bonin Island, are melts with unusually high MgO content that are commonly associated with high-degree, fluxed mantle melting in fore-arc regions, yet other types and sources have been recognised. Cape Vogel (Papua New Guinea) high-MgO melts cover a range in MgO-CaO content that identify a dichotomy of fertile (high-Ca boninites, HCB) vs more depleted (low-Ca boninites, LCB) mantle sources. The melts are water-rich, oxidised and sulphur-undersaturated. Whilst HCB appear to be probes of a moderately depleted mantle with lower MgO for a given SiO2 and MORB-mantle like Fe isotope signatures, LCB are low-degree melts of highly depleted sources, likely harzburgite. The LCB can further be subdivided into (i) a suite depleted in incompatible trace elements and with iron isotope values lower than depleted MORB mantle, and (ii) a second suite re-enriched in selected trace elements and slightly heavier Fe isotopes. The latter group is likely the result of re-fertilisation by a Si-Fe rich melt, which may be the parent to high-Mg andesites.

720

The emerging energy revolution

McCabe P[1]

[1]*Australian School of Petroleum, University of Adelaide*

TS4 - 3.2.1 Future energy mix & 3.2.6 Using geoscience to address social licence concerns for energy projects, Room R5, October 17, 2018, 11:30 AM - 1:00 PM

Biography:

Pete McCabe obtained his PhD in Geology at the University of Keele in the UK. After graduating he moved to North America where he worked for various organizations including Exxon Production Research Company and the Alberta Research Council. He worked for 20 years with the US Geological Survey and heading up the Asia Pacific part of their World Energy Assessment. He then worked as Theme Leader for oil and gas in CSIRO. He joined the Australian School of Petroleum in 2014 and became Head of School in 2016. His research interests are in unconventional petroleum resources, stratigraphy and resource assessments.

Events such as the development of the steam locomotive, the invention of electric light bulbs and the first manufacture of motor vehicles with internal combustion engines heralded radical changes in the world's energy mix in ways that were largely not anticipated at the time. Although the world's demand for energy has risen tenfold in the last 70 years the percentage of primary energy sources used in the energy mix has remained relatively constant, with the exception of the introduction of nuclear energy into the mix. However, recent developments, including the reduction in cost of renewable energies and the development of better batteries, electrical cars, driverless vehicles, and the internet of things, suggest we are at the beginning of a new energy revolution that will radically alter how we produce, transport and use energy. The global energy mix will undoubtedly evolve in response to these changes. Renewable energy (excluding hydro) currently comprise <4% of the global energy production. That percentage will likely rise substantially over the next 30 years but an anticipated rise in global energy demand by over 50% by 2050 suggests that the demand for oil and gas will remain relatively high for decades to come. Although there was a substantial percentage rise in global renewable energy production from 2014 to 2017 there was also a 6% rise in oil and gas production over that time period – an amount of energy that was equivalent to more than two and a half times the increase from renewables.

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Reappraisal of MORB redox state using both Fe and S speciation

Alard O[1,2], Baudoin C[2], Chassé M[3], Parat F[2], Muñoz M[2]
[1]CCFS GEMOC-Macquarie University, [2]Géosciences Montpellier, CNRS UMR5243, [3]IMPMC UMR7590, Paris 6

TS8 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
My expertise is about in-situ Geochemistry (and petrology) of terrestrial and extra-terrestrial mafic and ultramafic rocks.

The oxidation state of MORB (fO_2) has been vividly debated these recent years and several studies have yielded distinct values ranging from FMQ-1.2 to +1 and conclusions regarding the (lack of) variability and/or correlation with other geochemical indexes [1-3]. Historically, the oxidation state of Fe ($Fe^{3+}/\sum Fe$) in glasses has been used to assess fO_2 of magma. While less abundant than Fe, S oxidation shifts sharply from S^{2-} to S^{6+} at FMQ+1.0±0.5 [4], thus ideal to constrain MORB fO_2. $Fe^{3+}/\sum Fe$ and $S^{6+}/\sum S$ were determined by micro X-ray absorption near edge structure (ID21 ESRF) on the same shard of fresh MORB glasses (N=38) along with other trace lithophile and chalcophile trace elements by LA-ICP-MS.
The average $Fe^{3+}/\sum Fe$ = 0.137±0.006 yielding an average fO_2Fe ca. FMQ-0.10±0.16. fO_2Fe is positively correlated with V/Sc and S content. No other significant correlation with trace element fractionation (e.g., La/Sm, Nb/Zr) or radiogenic isotopes composition (e.g. $^{206}Pb/^{204}Pb$, $^{143}Nd/^{144}Nd$) have been found. $S^{6+}/\sum S$ ranges between 0.03 and 0.17 average is 0.09±0.02 yielding fO_2S ca. FMQ+0.01±0.05 within error of the Fe based estimate.
[1] Christie DM, Carmichael ISE, Langmuir CH, 1986 Earth Planet Sci Lett. 79: 397; [2] Bézos A Humler E, 2005 Geochim Cosmochim Acta 69: 711; [3] Cottrell E, Kelley KA, 2013. Science 340: 1314; [4] Jugo PJ, Wilke M, Botcharnikov RE, 2010 Geochim Cosmochim Acta. 74:5926.

722

Unifying global satellite measurements of vertical ground displacements using radio telescopes

Parker A[1], McCallum L[2], McCallum J[2], Haas R[3], Featherstone W[1]
[1]Curtin University, [2]University of Tasmania, [3]Onsala Space Observatory, Chalmers University of Technology

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Amy specialises in the use of satellite radar imagery (InSAR/SAR) to monitor, measure, and understand natural and man-made hazards. Her research has included the 2010 M 7 Haiti earthquake, atmospheric corrections of InSAR data, the Cascades Volcanic Arc, volcano monitoring in Papua New Guinea, and urban subsidence in Australian cities caused by groundwater extraction. Amy completed her PhD at the University of Bristol, UK, in 2015. She sits on the steering committee of Earth Observation Australia and is an Australasia Outreach Coordinator for Women in Earth & Environmental Science Australasia.

The coverage of satellite-based synthetic aperture radar (SAR) imagery has expanded to a reliable, global basis. This presents new opportunities to measure ground displacements on inter-continental-scales. Potential applications include a complete global assessment of the land contribution to relative sea-level rise. However, this first requires unification of SAR measurements with other geodetic methods to convert relative observations to absolute values in a globally consistent reference frame. The network of Very Long Baseline Interferometry radio telescopes provides an existing, yet unexploited, solution. Proof-positive of concept experiments reveal the suitability of these instruments as both bright artificial reflectors in SAR imagery and direct connections to an absolute geocentric reference frame. Automated tracking of radar satellites is easily implemented into telescope operations in parallel to other schedules for geodesy and astronomy, and has been operational across the Australian VLBI network since 2017. Using existing telescopes avoids the need for additional co-located infrastructure or ground surveys, and is ready to implement immediately across the global telescope network.

723

Application of 3D hotspot analysis method to mineral resource estimation

Kim S[1], Park H[1], Choi Y[2]
[1]Seoul National University, [2]Pukyong National University

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Assoc. Prof. Dr. Yosoon Choi
Affiliation: Department of Energy Resources Engineering, Pukyong National University, Busan 608-737, South Korea
Email: energy@pknu.ac.kr
Website: https://sites.google.com/site/yspower7/
Research Interests: Mine Planning and Design; Open Pit Mining Operation; Mine Safety; Geographic Information Systems; 3D Geo-modeling and Geostatistics; Hydrological Analysis; Energy Analysis and Simulation; Design of Solar Energy Conversion Systems; Renewable Energy Systems

Conventional hotspot analysis methods have been used in the field of humanities such as disease, crime, and population distribution analyses, however little attention has been made to the 3-D hotspot analysis for mineral resource estimation. In this study, a 3-D hotspot analysis method using the Getis-Ord Gi * statistic was developed and applied to the analysis of drilling data in the gold mine area. The 3-D hotspot analysis method was used to calculate the z score representing statistically significant hotspots of 52 boreholes and 1365 Au contents data from lode gold deposits. A top-cut operation of the Au content data was performed using the calculated z score to remove statistically meaningless anomalies before applying the kriging technique. As a result, we could compensate the disadvantages of the existing top-cut operations in the process of mineral resource estimation.

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Interpreting community structure and dynamics of petroleum-degrading microbes in subsurface petroleum environments

Cheah D[1], Wuchter C[1], Grice K[1], Scarlett A[1], Coolen M[1]
[1]Western Australian Organic & Isotope Geochemistry Centre, Curtin University

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
I have a background in geology and organic & isotope geochemistry, having obtained my B.Sc. and M.Sc. in Earth Sciences from the University of Minnesota (USA) and University of Notre Dame (USA) respectively. I am currently a 2nd year PhD candidate at Curtin University, where I am incorporating methods in molecular biology and microbiology with organic geochemistry to exploring the microbial ecology of subsurface settings and other extreme environments.

Petroleum reserves in subsurface environments, which include deposits of crude oil, natural gas, and unconventional gas resources, are indigenous habitats for anaerobic microbial communities that degrade petroleum compounds for metabolic activities. Biodegraded crude oils are denser and more viscous than undegraded and slightly degraded oils, which reduces extraction and purification efficiency. The North West Shelf (NWS) of Western Australia comprises considerable deposits of biodegraded petroleum, of which there are substantial geochemical data, but scant ecological data on indigenous microbial communities. Notable depletions of natural gas in shale gas formations, such as the Antrim Shale in the Michigan basin, have been attributed to methanotrophic activity. Environmental genomics analysis identify microbial communities residing in subsurface environments, as well as the metabolic functions that are utilised for degrading petroleum compounds. These methods is correlated with biomarker and compound-specific isotope analyses to ascertain metabolites associated with microbial degradation pathways. Anaerobic incubation experiments characterise nutrient and substrate variables that influence microbial growth and metabolism at ambient subsurface temperatures. An understanding of subsurface microbial community structure and dynamics, especially in petroleum reserves influenced by microbial metabolic activity, may be developed for secondary production of crude oil or its conversion to extractable natural gas.

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The origin of Cuyania revealed by Hf isotopes of zircon

Martin E[1], Collins W[1], Spencer C[1]
[1]*Earth Dynamics Research Group, The Institute for Geoscience Research (TIGeR), School of Earth and Planetary Sciences, Curtin University*

Biography:
Erin Martin currently works at the School of Earth and Planetary Sciences, Curtin University. Erin is carrying out her Ph.D. research in Geology focusing on isotope geochemistry and global plate tectonics during the Rodinia-Gondwana period.

The proto-Andean margin of South America is scattered with Mesoproterozoic basement inliers, the sources of which are disputed. For the source of one such terrane, Cuyania, in western Argentina, there are two prevailing models: (1) the Laurentian microcontinent model, in which Cuyania rifted from the Ouachita Embayment in the late Cambrian and collided with Gondwana in the middle Ordovician; and (2), the parautochthonous Gondwanan model, in which Cuyania rifted from the Kalahari craton in the Ordovician, and was transported laterally before accreting to the Gondwanan margin during the Silurian-Devonian period. We present new U-Pb-Hf data of zircon from Paleozoic Cuyanian strata and Mesoproterozoic basement rocks of Central Argentina, to compare with published data from the Grenville margin of Laurentia and the Namaqua-Natal belts of Kalahari. Detrital zircon εHf data of Grenville terranes show Mesoproterozoic populations with characteristic depleted values, whereas Namaqua data show clear crustal reworking of the Kalahari craton with exclusively sub-chondritic values.
Detrital zircon from Cuyanian strata shows a variation in provenance up-sequence. Cambrian strata record zircon εHf values close to that of the Granite-Rhyolite province as well as a Cambrian population that correlates with rift-related rocks of the Ouachita Embayment. In contrast, zircons in Ordovician strata record a larger range of Mesoproterozoic εHf values which correlates with values from inboard proto-Andean Mesoproterozoic inliers reflecting provenance from the margin of Gondwana. These data not only obviate the parautochthonous Gondwana model but verifies the Laurentian microcontinent model as the origin of Cuyania.

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COLLABORATIVE RESEARCH: How to drive your exploration dollar further?

Hall G[1]

[1]*Golden Phoenix International Pty Ltd*

TS5 - 3.4 Resources sustainability – responsible investment and management & 3.5 Technology integration, Room R2, October 17, 2018, 3:30 PM - 5:30 PM

Biography:

Greg Hall was Chief Geologist in Placer Dome Group and responsible for exploration research in Australia throughout this period. Greg Hall graduated from University of New South Wales in 1973 with First Class Honours in Applied Geology. He has worked continuously in mineral exploration throughout the world.

Collaborative research is the only feasible means by which mid-tier and junior exploration and mining companies can begin to address solving the large science questions that inhibit exploration success. There are four ways of collaboration that have been used effectively in the past twenty years. They are (i) proof-of-concept studies, (ii) one-on-one studies, (iii) one-on-one plus service providers and (iv) multi-client studies.

Proof-of-concept studies were internally funded and involved a single researcher. One-on-One studies would involve another company and may need an external research capacity. Ultimately the really big long term projects require large research organisations like AMIRA to succeed. These studies were often nested proceeding from proof-of-concept to large multi-client studies.

The big research questions that inhibit exploration success in the gold sector are in our understanding of non-linear dynamics especially its application to the mathematics of ore grade distribution and geochemical processes of ore deposition.

This presentation is based on the experience of Placer Dome Group's exploration research efforts in the period 1988 to 2006. The presentation will include actual research programs and their outcomes across numerous fields of geoscience and present many different approaches to collaboration.

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An Australian source for Pacific-Gondwanan zircons: Implications for the assembly of northeastern Gondwana

Martin E[1], Collins W[1,3], Kirkland C[1,2]
[1]Earth Dynamics Research Group, ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS) and The Institute for Geoscience Research (TIGeR), School of Earth and Planetary Sciences, Curtin University, [2]Centre for Exploration Targeting–Curtin Node, ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS) and The Institute for Geoscience Research (TIGeR), School of Earth and Planetary Sciences, Curtin University, [3]NSW Institute for Frontiers Geoscience, University of Newcastle

Biography:
Erin Martin currently works at the School of Earth and Planetary Sciences, Curtin University. Erin is carrying out her Ph.D. research focusing on isotope geochemistry and global plate tectonics during the Rodinia-Gondwana period. The title of her thesis is 'Understanding Neoproterozoic geodynamics through Hafnium isotope arrays.'

Detrital zircons in Neoproterozoic–Paleozoic basins of the Pacific-Gondwana (PG) region contain a distinctive 700–500 Ma population conventionally considered to be derived from Antarctica. However, the 700–600 Ma age component of the population predates major peripheral orogenesis (Terra Australis orogen), which began at ca. 580 Ma and the highly evolved εHf(t)-in-zircon values (to −40) require an Archean source, which is not proximal to the Terra Australis active margin. Based on similar εHf(t) arrays defined by Neoproterozoic granites in Western Australia and detrital zircon populations from the surrounding basins, we suggest that PG zircon grains were derived from the >2000-km-long, late Neoproterozoic Paterson-Petermann orogen, which sutured northern and southern Australia at 550–530 Ma. This Himalayan-style orogen was responsible for amalgamating Southeast Asian terranes into northeast Gondwana, thereby constraining the paleogeography of the northern Gondwanan margin at the Precambrian-Cambrian boundary. The remarkable isotopic similarity of zircon grains with the Lhasa terrane of Tibet suggests that the Paterson-Petermann orogen was the eastern sector of the developing circum-Gondwana subduction system from ca. 700 Ma.

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Surface heat flow measurements: a new window on the subsurface

Beardsmore G[1], Sandiford M[1], Egan S[1]
[1]*School of Earth Sciences, University of Melbourne*

TS8 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Dr Beardsmore earned his PhD in Geophysics from Monash University in 1996 and has spent much of the subsequent 22 years testing and developing tools and processes for measuring and modelling heat flow from the Earth. He is a casual Senior Research Fellow in the School of Earth Sciences at the University of Melbourne, lead author of Crustal Heat Flow: A Guide to Measurement and Modelling (Cambridge Uni Press, 2001) and a member of the International Heat Flow Commission.

Many subsurface phenomena of economic or scientific interest theoretically affect the flow of heat through the Earth's surface. These include uranium-rich ore bodies, hydrothermal circulation systems, groundwater motion, strong thermal conductivity contrasts, underground coal fires, and others. Measuring heat flow through the Earth's surface, however, was previously considered of limited value for investigating the subsurface due to the overprinting of subsurface thermal signals by the dominant diurnal and annual atmospheric temperature cycles. Boreholes on the order of 100 m deep or more have historically been required to obtain measurements of thermal gradient and thermal conductivity from beneath the thermally disturbed zone. We demonstrate a new approach to detect the geothermal component of surface heat flow from within the heavily disturbed surface heat flow signal. The method requires an accurate and precise measurement of the thermal diffusivity of the ground, and a reconstruction of the surface temperature signal over the past decade or more. We numerically predict the diffusion of the surface signal into the top metre of ground and subtract the prediction from precise temperature observations. The 'reduced temperature gradient' multiplied by thermal conductivity measured in situ gives a value of heat flow that can be attributed to subsurface causes. The method relies on precise and accurate temperature measurements, correlations with satellite earth observations, Fourier analysis and some subjective interpretation. A case study from Victoria suggests heat flow measurement with a precision on the order of ±20 mW/m2 is possible.

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Formation and multiple impact events on the IIE iron parent body as recorded by the Miles meteorite

Kirby R[1], King P[1], Forster M[1], Henley R[1], Ireland T[1], Norman M[1], Pelton A[2], Tamura N[3], Troitzsch U[1], Turner M[1]
[1]*The Australian National University,* [2]*Ecole Polytechnique de Montréal,* [3]*Advanced Light Source*

TS8 - 1.5 The solar system and beyond, Hall C, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Rachel Kirby is a PhD student at the Australian National University studying high temperature and low temperature processes during the formation of the solar system. Her research integrates geochemical and petrological studies of meteorites with physical and geochemical modelling and experimental petrology to help understand the processes that formed our solar system.

Rachel Kirby graduated from the ANU in 2014 with First Class Honours in a Bachelor of Science (Advanced), receiving the University Medal and the Janet Elspeth Crawford Prize for the female science student who received the highest Honours result.

This research aims to model the formation of IIE iron meteorites by studying the Miles meteorite. Miles contains Na-K-Ca-Si-rich silicate + phosphate inclusions (20 vol.%) within a granular iron-nickel mass. Some IIE iron meteorites contain K-feldspar + tridymite + albite (like Miles), whereas others contain chondrules. Previous work shows the meteorites formed at 4.5 Ga or 3.6 Ga; this has required a repeatable process to form these enigmatic phase assemblages.
Pb-Pb SHRIMP dating of srilankite and zirconolite indicate the Miles meteorite formed at 4.542 Ga and Ar-Ar dating suggests that it continued cooling slowly to 4.303 Ga, with a later impact event >3.5Ga. This new finding demonstrates that the younger age is related to impact, not formation.
At 4.542 Ga, petrography, mineralogy and geochemistry demonstrate that the Miles meteorite was >1491 °C. Such high temperatures are only possible at this time if Miles formed in an impact crater. Geochemical models using an H chondrite composition show that reduction occurred to form Fe-Ni metal, decreasing Fe in the remaining silicates. Cosmochemically volatile elements were enriched in the silicate melt via partial melting of the parent body. Schreibersite, $(Fe,Ni)_3P$, formed along the metal grain boundaries and around silicate inclusions via reactions with phosphates from the silicate melt and reduced gases. In summary, IIE iron meteorites likely formed through impact melting on an H chondrite-like body. In the case of Miles, impact occurred at 4.542 Ga with a later impact event during the Late Heavy Bombardment at >3.5 Ga.

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MICROBIALLY MEDIATED BLACK SLUDGE FOLLOWING A CYCLONIC EVENT IN SHARK BAY, WESTERN AUSTRALIA AND ITS LINK WITH COBBLE FORMATION

Campbell M[1], Grice K[1], Coolen M[1], Visscher P[2], Morris T[1], Burns B[3]
[1]Curtin University, [2]University of Connecticut , [3]University of New South Wales

TS4 - 2.6 Geobiology, Room R1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Education: Curtin University

Research interests: Microbial ecology, sulfur cycle, lipidomics, isotope geochemistry, metatranscriptomics, Extracellular Polymeric Substances

Thesis title: Sulfur Cycling in Modern Microbial Systems and Advancing the Interpretations of Early Life with Modern Analogues

Supervisors: Prof. Kliti Grice and Assoc. Prof. Marco Coolen

Conferences: 2016-07 Astrobiology Australasia Meeting (Incorporation of Sulfur into Extant Microbialites with Ancient Geological Analogues), 2016-12 19th Australian Organic Geochemistry Conference and 2017-09 28th International Meeting on Organic Geochemistry (Occurrence of microbially mediated black sludge and cobble formations after a cyclonic event in Shark Bay, Western Australia)

On the 13th of March 2015 Shark Bay, Western Australia was hit by a category 3 cyclone, “cyclone Olywn”, causing destructive wind gusts of up to 140 kilometers per hour and a record total of 122 mm of rainfall in just 24 hours. This event caused significant structural changes to a microbial ecosystem found in Hamelin Pool. Immediately after the cyclone, the formation of a black sludge was observed in the impacted area, this black sludge is currently assumed to be a mixture of reconstituted extracellular polymeric substances from impacted microbial mats, anoxic sediments containing iron sulfide minerals, marine debris and terrestrial-derived organic matter. Upon returning to the site on the 7th of July 2016 it was found that the black sludge had turned into cobbles. These cobbles could represent modern analogues of carbonate concretions found throughout the geological record and provide insight into concretion formation. A multidisciplinary approach using organic geochemical and genomic techniques has been applied to allow for a greater understanding of how these formations developed and if they exhibit the necessary conditions and microbial communities for calcium carbonate precipitation. Additionally, sulfurisation is recognised as one of the most important diagenetic pathways; Raney nickel desulfurisation of the polar fraction from the cobble extract has confirmed that the biomolecules had been sulfurised during early diagenesis. Further, identical stable isotopic signals of individual biomarkers from the sludge and mud cobble were obtained pointing to the same source material.

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EXOPOLYMERIC SUBSTANCES OF HYPERSALINE MICROBIAL MATS FROM SHARK BAY, WESTERN AUSTRALIA

Campbell M[1], Grice K[1], Coolen M[1], Visscher P[2]
[1]Curtin University, [2]University of Connecticut

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Education: Curtin University

Research interests: Microbial ecology, sulfur cycle, lipidomics, isotope geochemistry, metatranscriptomics, Extracellular Polymeric Substances

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Microbial mats are organosedimentary biofilm communities and analogues of the earliest life on Earth that accumulate as a consequence of microbial communities producing exopolymeric substances (EPS) that trap and bind sediments and minerals. By producing EPS, microorganisms engineer their immediate environment with respect to many physicochemical characteristics. EPSs are most commonly composed of polysaccharides and proteins but also include lipids. Shark Bay offers a large diversity of modern microbial mats that are affected by a range of different physicochemical factors; as an example, research has shown that microbes will excrete variable amounts and types of EPSs depending on the salinity of the environment in which their living in. In order to investigate the chemical composition of EPS from 3 contrasting Shark Bay microbial mats, in this study, we chemically characterised EPS by a variety of non-destructive (i.e. Fourier-transform infrared (FT-IR) and Nuclear magnetic resonance (NMR) spectroscopy) and destructive (i.e. chemical degradation of EPS for Gas chromatography mass spectrometry (GCMS) and hydropyrolysis (HyPy) methodologies.

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Shark Bay microbial mat community responses to oil contamination: a lab-controlled time series experiment

Jiménez Y[1], Grice K[1], Coolen M[1]
[1]*Western Australian Organic & Isotope Geochemistry Centre, The Institute for Geoscience Research, School of Earth and Planetary Science, Curtin University, Bentley, WA 6102, Australia*

TS4 - 2.6 Geobiology, Room R1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Yalimay is a Geochemist with a Bachelor and Master in Science. She worked on Geochemical Mapping for mineral exploration and environmental purposes for nearly 10 years, covering urban and remote areas, such a Guiana Shield in Venezuela (South America). In 2015, she moved to Australia to study, obtaining a Graduate Certificate in Hydrogeology at UWA, and now, she is on her 2nd year of her PhD at Curtin University. She is also a mother of two children, coffee lover and amateur photographer.

Microbial Mats (MM) consist of millimetric layers of microorganisms embedded in a matrix of exopolysaccharides and sedimentary material. It has been demonstrated in previous studies that MM have the capacity to respond to petroleum contamination. In our study, two different types of MM were collected from a hypersaline benthic environment, Nilemah embayment in Shark Bay, Western Australia. These MM have been maintained in microcosms at 25°C with sterile hypersaline water, constant sterile air flux and diel regime (16h light:8 h darkness) by artificial light. The effect of oils that have been degraded to different extents have been subjected to smooth and pustular MM communities. The incubation experiments have been sampled before and after 1, 5, 10 and 16 days of oil pollution. Samples of MM and oil traces in the water column were taken for organic geochemical analysis. DNA and RNA were extracted in parallel for paired bacterial 16S rDNA vs.16S rRNA profiling, to reveal those taxa that are present vs. metabolically active. This project provides relevant information for environmental agencies and oil companies due to the anticipated sea level rise for the next decades might introduce oil into the Shark Bay region because of increased transportation activities.

733

A geomorphological maze: Martian valley networks and impact craters.

Caprarelli G[1]
[1]*Hypatia Scientifica Pty Ltd*

TS6 - 5.2 Prediction, process, place: Geomorphology, Room R8, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Graziella Caprarelli obtained her MSc and PhD from University La Sapienza of Rome, Italy, before moving to Japan and then to Australia. Prior to founding Hypatia Scientifica, she has been Senior Lecturer and Associate Professor at UTS and UniSA. She is Research Professor (Adj.) at the International Research School of Planetary Sciences in Pescara, Italy, and member of the scientific team for Mars Express - MARSIS. She has been Chair of the NSW and SA Divisions of the Geological Society of Australia, and Inaugural President of the Japan Society for the Promotion of Science Alumni Association in Australia.

Studies of extra-terrestrial planetary surfaces carried out by remote observation may not lead to unique interpretations: a km-scale two-dimensional circular feature on the surface of a terrestrial-type planet, observed in imagery captured by satellite, can be interpreted either as an impact crater or a volcanic vent; linear networks can be fluvial valleys, lava channels or tectonic structures. If the surface is geologically young and fresh (e.g., Olympus Mons on Mars), identification may be clear, facilitated also by associated geomorphological indicators enabling unique interpretations. This is rarely the case, however: extra-terrestrial planetary surfaces are usually aged, with many different types of morphologies overprinting each other. Furthermore, what is observed (by imagery) or measured (e.g., by altimetry) depends strongly on the resolving capacity of the instruments that acquire the data, complicating or rendering earlier interpretations obsolete when new high-resolution data are obtained. One way to support interpretations is to apply quantitative geomorphology principles and techniques. These rely on systematic measurements and their scaling, have proved extremely powerful to interpret evolving landscapes on Earth, and have been applied to investigations of other planets. In this work, I summarise and discuss the insights gained by my studies (with colleagues) aimed at deciphering the Martian geological history of ancient surfaces characterised by a maze of valley networks and impact craters. I conclude that quantitative analysis of morphologies using scaling and stochastic approaches is useful when coupled with deep understanding of the geological processes that sculpt planetary surfaces.

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The water budget myth and a resource condition limit approach

Cranswick R[1]
[1]*Department For Water And Environment*

TS8 - 3.3.5 Groundwater science for policy development and decision making, Room R5, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
A hydrogeologist with 13 years experience in private, government and research industries, loves rivers and environmental tracers. Enjoys the challenge of communicating technical information to a range of audiences.

Is it really true that there is some “safe yield” that can be withdrawn from an aquifer forever without any impact to groundwater users or the environment? Certainly not. But that doesn’t mean that we don’t currently manage groundwater systems under more or less this same assumption. The “water budget myth” was dispelled by a now famous Hydrogeologist, C.V. Theis, in late 1930’s and the key messages from his early career are still relevant today for water managers all around the world. In South Australia, we are now shifting away from basing groundwater management and licensed allocations on recharge estimates, which allows us to focus more clearly on the condition of the resource and potential impacts that are likely to be observed in the future. This is fundamental to the resource condition limit approach, whereby a series of unacceptable conditions for the economic, social and environmental values of the groundwater resource are agreed upon through stakeholder engagement and informed by the best available scientific evidence and understanding. Preliminary examples from a range of developing water allocation plans led by the Department for Water and Environment will illustrate how groundwater management may soon evolve in South Australia.

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Extent and Significance of Gondwanan stromatolites following the Permian-Triassic mass extinction

Cunneen J[1], **Olden L[1]**, Olierook H[1], Smith G[1], Suosaari E[2,3]
[1]Curtin University, [2]Smithsonian Museum of Natural History, [3]Bush Heritage

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Liam Olden is a student currently completing his honours at Curtin University, Western Australia. He graduated with distinction and has been awarded numerous accolades for both academic and extracurricular achievements.

The northern Perth Basin, Western Australia, records one of the few well-preserved stromatolite occurrences at high palaeolatitudes following the Permian-Triassic (P-Tr) mass extinction. Sedentary microbial communities are known to proliferate in the aftermath of mass extinctions when there is less predatory ecological competition. The peak of microbial activity in the Phanerozoic is recorded as stromatolite and other microbialite beds in the Early Triassic as a direct consequence of the mass extinction at the P-Tr boundary. The stromatolites were abundant in the low-latitude Tethyan Ocean but rare at high palaeolatitudes and in continental interiors. Only three intracontinental occurrences are known: Greenland, Madagascar and Western Australia. In Western Australia, the main stromatolite locality (Blue Hills) is furthest from the Siberian Traps (the presumed cause of the extinction) and occurs at the highest palaeolatitude (~60 °S), yet it remains poorly characterized in terms of spatial and vertical extent. Here, we use field mapping and satellite imagery to show that the Blue Hills stromatolites cover a wide lateral extent and display considerable vertical complexity. Detailed sedimentary logs and thin section observations reveal numerous discrete stromatolite growth intervals separated by minor breaks in deposition. The punctuated spatial and temporal variations in deposition show that the biotic system after the P-Tr event was sensitive to localised changes in sea level, sediment supply and depositional environments. The depositional model developed here provides a detailed interpretation of these local changes and a basis to understand the biological rebound at high southern latitudes following this major ecological crisis.

736

Reducing the Complexity of Dense Drillcore Spectral Datasets with Spectral Feature Extraction and Clustering

Rodger A[1]
[1]*CSIRO*

TS1 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Andrew Rodger is a research scientist with the CSIRO. His research has ranged from the development of atmospheric compensation routines for remotely sensed data, algorithm development for minerals research and the application of machine learning to minerals and geological applications.

He is also the project manager for the CSIRO developed The Spectral Geologist (TSG) software. His current research work is primarily focused on the machine learning realm and its application to aid and assist the work of geologists.

Collecting spectral datasets from drillcore via instruments such as the HyLogger can potentially provide prohibitive constraints of the spectral geologist tasked with the analysis. For the purposes of downhole assemblage logging it is desirable to reduce the complexity of the dataset to a much simpler representation. To this end a feature extraction methodology was developed and tested. Firstly each spectrum is reduced to a representation of its principle absorptions as defined by depth. Plotting the wavelengths corresponding to the deepest extracted feature against the second deepest extracted feature reveals that like assemblages are clustered.
Using a clustering method such as density based clustering, DBScan was used in this case, it is possible to assign a cluster ID to each spectrum and to calculate the mean and standard deviation of each cluster so that a single cluster is represented by only those two spectra. Further, the clustering in two dimensions can be extended to higher dimensions to allow for possible overlap of clusters.
In this manner a spectral dataset consisting of thousands of spectra can be effectively reduced to tens of spectra. This representation in turn can be used by the analyst to assign assemblage names to a given cluster and plot said assemblages down hole. Further, the clusters work well with machine learning techniques such as random forest classifiers so the analysis can be repeated on further drill cores without the need for clustering.

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The porphyry mineral system - key targeting criteria for exploration across all scales

Cooke D[1]
[1]*CODES, University Of Tasmania*

TS2 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
David Cooke and his research team have been researching porphyry copper and epithermal gold deposits of the circum-Pacific region for over 30 years. They have investigated the geodynamic environments of mineralisation, intrusive history and the magmatic-hydrothermal transition, fluid compositions, ore-forming processes and genetic associations between porphyry and epithermal systems. David is Director of the TMVC ARC Industrial Transformational Research Hub, and CODES – the Centre for Ore Deposit and Earth Sciences. David received the Thayer Lindsley lecturer award in 2005, the SEG Silver Medal in 2013, and the Australian Academy of Science's Haddon Forrester King Medal in 2018.

Porphyry deposits are large tonnage, low grade resources that are primarily mined for copper, gold and/or molybdenum. This genetic class of ore deposits is unified by an intimate spatial and temporal link between porphyritic intrusions, alteration and mineralisation. Porphyry mineral systems extend from the upper mantle to the Earth's surface. Hydrous, oxidised magmas are typically derived by partial melting of metasomatised mantle in continental arc, island arc and post-collisional geodynamic settings. These magmas intrude to mid- to upper-crustal levels, exsolving hydrothermal fluids that cause extensive mineralisation and alteration around, above and to the sides of the apices of the intrusive complexes. Magmatism and mineralisation is typically controlled by regional-scale fault systems, but concentric and radial fracture arrays may develop locally around the apex of the intrusive complex. Unmixing of brines and vapours from supercritical fluids and/or direct exsolution of these two phases from the intrusive complex are essential prerequisites to ore formation in porphyry environments. The brines contain most, or all, of the ore-forming components, and their high densities typically restrict them to the apex and shoulders of the mineralising intrusive complex, where potassic alteration and mineralisation are localised. The vapour passes rapidly to the surficial environment, where it may discharge in fumaroles or condense into groundwater, forming a lithocap. Given the scale of porphyry mineral systems, exploration targeting is both scale and depth-dependent, as the depth of exhumation profoundly affects the geological, geochemical and geophysical expression of porphyry mineral systems, requiring flexibility in the application of targeting criteria.

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Building thematic and integrated services for European solid Earth sciences: the EPOS integrated approach

Harrison M[1], Cocco M[2], **Ludden J[3]**
[1]British Geological Survey, [2]INGV, [3]British Geological Survey

TS3 - 5.5 Planning the future of Geoscience & 5.1 Geology in society: geotourism and geoheritage, Room R8, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
British Geological Survey (BGS) Chief Executive
John is Chief Executive at the British Geological Survey (BGS) a £60 million science organisation that is part of UK Research and Innovation and is associated with the UK Natural Environment Research Council. He has held numerous science direction and management posts and prior to his current role he was Director of the Earth Sciences Division at the French National Centre for Scientific Research (CNRS). He holds a doctorate from the University of Manchester, UK and a BA from Lancaster University, UK. He has visiting and honorary professor status at several universities and is a Foreign Member of the Russian Academy of Sciences and past president of the European Geosciences Union and also EuroGeosurveys. He received the CBE for contributions to Geosciences in 2016.

One way that the European solid earth geoscience community is self-organising for the next decade and beyond is though EPOS (the European Plate Observing System). EPOS has been designed with the vision of creating a pan-European infrastructure for solid Earth science to support a safe and sustainable society. In accordance with this scientific vision, the EPOS mission is to integrate the diverse and advanced European Research Infrastructures for solid Earth science relying on new e-science opportunities to monitor and unravel the dynamic and complex Earth System. EPOS will enable innovative multidisciplinary research for a better understanding of the Earth's physical and chemical processes that control earthquakes, volcanic eruptions, ground instability and tsunami as well as the processes driving tectonics and Earth's surface dynamics.
To accomplish its mission, EPOS is engaging different stakeholders, not limited to scientists, to allow the Earth sciences to open new horizons in our understanding of the planet. EPOS also aims at contributing to prepare society for geo-hazards and to responsibly manage the exploitation of geo-resources. Through integration of data, models and facilities, EPOS will allow the Earth science community to make a step change in developing new concepts and tools for key answers to scientific and socio-economic questions concerning geo-hazards and geo-resources as well as Earth science applications to the environment and human welfare.
Particular attention in this talk will be given to connecting EPOS with similar global and national initiatives and identifying common best practice, approaches and value in interoperability between communities.

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Using Remote-Sensing in Support of the Victorian River Health Audit

Quadros N[1]
[1]*FrontierSI*

Biography:
Dr. Nathan Quadros completed his PhD at The University of Melbourne in 2009 dealing with LIDAR technology in the coastal zone. He then managed the acquisition, delivery and quality assurance of large LiDAR project for the Victorian Government, which included the remote-sensing component of the Victorian index of stream condition assessment. In 2011 Nathan moved to FrontierSI (formerly CRCSI) where he is now the Chief Commercial Officer. Nathan has worked in many LiDAR applications, having led research projects in LiDAR quality assurance and feature extraction, specialising in water applications.

This presentation discusses the River Lines Toolkit and its role in the 2018 Victorian Government's river health audit, and subsequent comparisons to the 2009-10 Victorian state-wide river health assessment.

Over the past four years FrontierSI (formerly the CRCSI) has worked with the Victorian Government's River Health program to resolve issues in the generation of metrics from remote-sensing data for the assessment of river health. Over this period FrontierSI has successfully developed the River Lines Toolkit to automatically extract river features, such as streambed and bankfull from DEM and point cloud data. FrontierSI has also developed an automated stratification approach for dividing the river network into discrete polygons in support of the assessment and scoring of river health.

The delineation of streambed and bankfull by the River Lines Toolkit has overcome many issues in support of the Victorian assessment. This presentation will discuss the methods used to generate a continuous, detailed map of Victorian rivers, along with the issues experienced and unique results within each of the catchments.

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Automatic landscape mapping using supervised learning

Albrecht T[1], Smith G[2], González-Álvarez I[1], Klump J[1]
[1]CSIRO Mineral Resources, [2]CSIRO D61

Biography:
Thomas has a background in Computational and Experimental Fluid Dynamics. His current research interests include machine learning, modelling & simulation and high-performance computing.
He joined CSIRO Mineral Resources in 2018 as data scientist for minerals exploration.

The study of landscapes links surface features to geological processes. This lets us explore relationships between climatic changes, lithological distribution, and sedimentary and tectonic processes, as well as their effect on landscape evolution. To this end, being able to accurately map features and their extent at large-scale (1000 km) is fundamental. However, existing quantitative methods in geomorphology were developed for much smaller scales (10 km) and more rugged terrain. Extending these classifications to continental scale studies is complicated by the complexity and variability of the landforms, data availability, and the difficulty to define quantitative criteria to differentiate diverse landscape types.

This study aims to develop a methodology to classify and automatically map landscapes at regional and, potentially, continental scales, utilising machine learning (ML). We use DEM-derived products (e.g. flatness, slope classification, topographic wetness index) as input data. Spatial aggregation based on overlapping quadratic tiles, followed by computing per-tile histograms of input data, produces 48 features on which we train supervised ML models. As expected, resolution and spatial aggregation scales affect classification performance; for 3" data, aggregated over at least 13 km, cross-validation evaluates an accuracy >95% for our test region, the Albany-Fraser Orogen in Western Australia. Unsupervised strategies have been tried but failed to produce accurate maps.

Automatic landscape mapping—repeatable, scalable, and objective—has direct impact on a wide variety of research and applied science disciplines that span from mineral exploration to geoarchaeology and environment, among many others.

741

Pb isotope geochemistry in exploration under cover – new opportunities from new technologies

Carr G[1], Desum C[2], Maas R[2], Woodhead J[2], Korsch M[1]
[1]CSIRO, [2]School of Earth Sciences, University of Melbourne

TS1 - 3.1.1 Effective exploration and discovery under cover, Hall E2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Dr Graham Carr is an Honorary Fellow at CSIRO Mineral Resources and immediate past President of the Geological Society of Australia. During his career at CSIRO he undertook research into geochemical techniques in mineral exploration working closely with industry. He became Deputy Chief of the Division of Earth Science and Resource Engineering and later, Chief Scientist and was closely involved with the establishment of CSIRO Minerals Down Under Flagship and the Deep Exploration Technologies CRC.

The use of Pb isotopes in mineral exploration has been well established, principally through research at CSIRO sponsored by AMIRA over the last four decades. Technological advances in mass spectrometry over this period has resulted in increased analytical precision and thus a greater ability to discriminate different Pb isotope fingerprints of different metallogenic events. In situations where a small number of drill core samples or highly anomalous regolith material is being assessed, the common analytical cost of up to $500 for high precision analysis and interpretation is not a great inhibitor for many exploration companies. However, more recently there have been attempts to apply Pb isotope tracing in the low-Pb regolith environment using soils, groundwaters and vegetation as sampling media. Indeed, Pb isotopes can be shown to be a powerful tool in exploration through cover.
We have developed a Pb isotope model for soils that can be used to differentiate Pb from different sources – Pb from the soil matrix and mobile Pb from another source, potentially a blind or buried ore system or from human activity. However, the cost of analysis using common high resolution techniques and equipment militates against the uptake of this model in normal exploration programs. It is also clear that commercially available, low precision quadrupole analysis is not sufficient to allow valid interpretation. However, more recent developments in mass spectrometry, particularly SF (Sector field) – ICP – MS have the potential to provide adequate precision at a cost compatible with standard geochemical analysis.

742

Micron-scale thallium mapping of drill-core provides evidence for an epigenetic origin for mineralization in the McArthur River (HYC) Zn-Pb Deposit

Spinks S[1], Pearce M[1], Ryan C[1], Kunzmann M[1], Fisher L[1]
[1]CSIRO

TS2 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Sam Spinks is an exploration geochemist who has worked across both research and industry on mineral systems in Australia, North America, Europe and Africa. Dr Spinks primarily specializes in understanding the genesis and geochemical footprints of sediment-hosted base metals and gold, and advancing geochemical exploration undercover.

Shale-hosted massive (Zn-Pb) sulfide deposits such as those described as synsedimentary exhalative (sedex) in origin, are commonly associated with lithogeochemical haloes of trace elements such as thallium (Tl). The giant McArthur River (HYC) Zn-Pb deposit in northern Australia, classically described as exhalative in origin, is one such deposit, where Tl anomalies have been reported in equivalent stratigraphy many kms from mineralization. However, the Tl host mineral phases and their distribution in the mineralization is poorly understood, partly due to barriers to imaging Tl using traditional electron microscopy techniques. A resultant lack of knowledge of such trace element behaviour results in poor understanding of these mineral systems, and acts an obstacle to mineral exploration.
Here we present high-resolution (30 µm; >100 M pixel) trace element mapping data of large mineralized samples from HYC using the newly developed Maia Mapper which allows high-definition imaging of trace elements, such as Tl, and place them in a detailed spatial context. Our data show that, 1) while syngenetic laminated pyrite is common, Zn sulfide (sphalerite) mineralization is predominantly associated with replacement of nodular carbonate rather than syngenetic deposition; 2) late-stage zoned pyrite overgrowths broadly contemporaneous with replacive sphalerite is highly enriched in Tl compared to the earlier laminated pyrite.
These findings provide evidence for an epigenetic mineralization model rather than a sensu stricto exhalative model for HYC. This may have implications for exploration for shale-hosted sulfide mineral systems similar to HYC with high Tl anomalism.

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Realistic and Theoretical 3D Modelling of the Sedimentation and Burial Tectonic History of the Gippsland Rift Basin

Yang X[1], Smith G[1]
[1]*Curtin University*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Xuemei Yang is a PhD candidate in Curtin University. Xuemei holds a B.Sc. (Hons) in Petroleum Geology Engineering and a M.Sc. in Geology. She has been awarded a Research Training Program (RTP) Stipend Scholarship to support her PhD research studies. She is now working on the Gippsland Basin 3D modelling in looking at the basin history T, P burial and maturation history over time based on seismic interpret etc in Petrel/PetroMod. Her study is to calibrate the sedimentary, burial, thermal and tectonic history of the Basin, using actual Realistic 3D models of the basin, to constrain the Theoretical Deterministic models.

Significant advances have been made in the theoretical understanding of basin development in the past few decades but it has proved difficult to reconcile these models with actual well, seismic and field data. Theoretical tectonic, sedimentary, burial and thermal models for sedimentary basins have been proposed but they have rarely been tested or calibrated by empirical data. Even simple cases of rift basins have not been rigorously tested, using actual 3D basin models constructed using well and seismic data, to assess the fit of the theoretical models for significant variables (eg subsidence, uplift, sedimentation, P-T changes with time, rate of spreading).
The Gippsland Basin is being used as a basis to calibrate the sedimentary, burial, thermal and tectonic histories of a rift basin. This basin was chosen because it is relatively simple, rapidly buried, young, divergent margin tectonic basin that has a wealth of well, seismic and other geophysical data. Realistic 3D models of the full Gippsland basin have been made in Petrel (Schlumberger) software that allow backstripping and 3D balancing. The results have been used to constrain the variable ranges input to the sedimentary and burial history deterministic models, made in the forward simulation modelling software Badlands. The results identify the main variables that have controlled the evolution of the Gippsland Basin which include the amount of extension, rate of subsidence, dynamic topography, hinterland uplift, dynamic topography and sea level changes. These are key factors controlling the facies distribution, porosity, permeability, generation and distribution of hydrocarbons in the basin.

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What pyrite textures reveal about Proterozoic sedex deposits

McGoldrick P[1]
[1]*University Of Tasmania*

TS5 - 2.6 Geobiology & 2.8 Earth, life and ores, Room R1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Peter has been playing in Proterozoic oceans for more than 40 years, ably supported, for much of that time, by an eclectic team from CODES, and funded by the ARC and Industry. UTas stopped paying him a few years ago and he now spends his time gardening and trying to learn more about mid-Proterozoic paleobiology.

So-called "sedex' Zn-Pb-Ag deposits are stratiform accumulations of base metal sulphides and pyrite in fine grained (reduced) sedimentary rocks, and are the major source of the world's Zn. They peak in abundance in the mid-Proterozoic. There is consensus that they form early in the history of their host basins from low-temperature saline fluids, but the precise timing of base metal sulphide precipitation has been much debated. Ideas range from syngenetic (from a brine pool or water column) to deep subsurface replacement or infill. Sulphur isotopes indicate the sulphide needed for base metal sulphide (and pyrite) formation ultimately derives from seawater sulphate. Both low-temperature, biologically mediated, processes and high(er) -temperature thermochemical mechanisms have been ascribed roles in sulphate reduction.
Pyrite is ubiquitous to all deposits and appears to be paragenetically early. Macroscopic pyrite textures range from fine grain disseminations in shale and siltstone, to dispersed clusters and aggregates, to planar and crinkly laminated beds. Curvi-planar pyrite associated with carbonate can have shapes reminiscent of micro-stromatolites.
This presentation will discuss the origin of these pyrite textures and how they speak to the timing and mechanisms of sulphate reduction in the Fe-dominated, low oxygen, mid-Proterozoic oceans.

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Efficacy of low frequency passive seismic attributes – Feasibility study at Hydrocarbon Reservoir sites in Gujarat region, Northwestern India

Dixit M[1], Singh A[1]
[1]*Institute Of Seismological Research*

Biography:
The presenting author works as a geophysicist at Institute of Seismological Research, Gandhinagar, Gujarat, India. He completed M.Tech. from Kurukshetra University, Kurukshetra, India and pursuing Ph.D. from the same university.

Passive seismic attributes based on spectral properties, usually between 1 to 6 Hz have been suggested as potential indicators for sub-surface hydrocarbon targets. Low Frequency (LF) seismic anomalies associated with hydrocarbon Reservoirs have been observed by various industry and academic groups in different parts of the world. Passive data can be acquired in hydrocarbon exploration areas to focus seismic data collection, corroborate Trap and optimizing drilling location. The Institute of Seismological Research (ISR) had acquired low frequency passive seismic (Microtremor) data in and around Meshana and Gandhinagar regions for site response analysis in seismic microzonation deploying 5sec seismometers. These data have been analyzed to verify reservoir / non-reservoir response utilizing Infrasonic Passive Differential Seismic technology. Preliminary analysis provides anomalous spectral signatures over Meshana and Gandhinagar area which has later been proved to be hydrocarbon prone area. Motivated by the anomalous spectral observations across Meshana and Gandhinagar region of Gujarat, a 2D profile was acquired, covering a distance of 3km with 15 stations at 200m station interval, over the producing oil field in Meshana and Gandhinagar area. The results were not only encouraging but clearly delineated additional reservoirs pockets which need to be corroborated with seismic / log data for further drilling. The present work is a first step that has been initiated by this Institute to verify effective use of the microtremor which has been reported by many researchers in the world.

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Sequestration of trace metals into framboids: biotic or abiotic?

Hu S[1], Evans K[2], Grice K[3]
[1]CSIRO-Mineral Resources, [2]School of Earth and Planetary Sciences, Curtin University, [3]Western Australia Organic and Isotope Geochemistry Centre, Curtin University

TS4 - 2.6 Geobiology, Room R1, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Siyu Hu is a postdoctoral fellow in CSIRO-Mineral, focusing on the interaction between organic matter / microbes and metals in mineral systems with a variety of cutting-edge analytical techniques, such as Synchrotron-based techniques, NanoSIMS, LA-ICP-MS and TEM. The current project focuses on biotic and abiotic contribution to sulfide deposition in modern seafloor hydrothermal chimneys.

Pyrite framboids in black shale are the major host for trace metals and possible sources for some particular sedimentary rock-hosted ore deposits. The origin of framboids is related to bacterial sulfate reduction activities. However, the sequestration of trace metals into framboids via biotic or abiotic processes is not fully understood.
In this study, we describe a novel type of framboid with mixed pyrite and zinc sulfide microcrystals from pelites of the Otago Schist, New Zealand. A combination of optical microscopy, SEM, Synchrotron XRF, NanoSIMS and LA-ICP-MS were utilized to assess the association between trace metals, sulfides and organic matter in framboids. The spatial distribution of Zn in framboids is variable, but consistent with that of organic matter, suggesting that Zn is incorporated into framboids with various stages during bacterial sulfate reduction. The concentrations of Au and Ag are positively correlated with that of Zn, indicating similar sequestration processes. Meanwhile, other trace metals, including As, Co, Cu, Mo, are not correlated with Zn and supposed to be sequestrated into framboids via abiotic processes. This study will provide insights into the potential application of framboids-bearing shales as proxies for paleo-environments through Earth history.

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As-bearing sphalerite as new microbial habitats for As-oxidising microorganisms in modern deep-sea hydrothermal vents

Barnes S[1], Binns R[3], Grice K[4], Hu S[1], Pages A[1], Parr J[3], Quadir Z[2], Rickard W[2]
[1]CSIRO-Mineral Resources, [2]John de Laeter Centre, Curtin University, [3]CSIRO-Mineral Resources, [4]Western Australia Organic and Isotope Geochemistry Centre, Curtin University

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Siyu Hu is a postdoctoral fellow in CSIRO-Mineral, focusing on the interaction between organic matter / microbes and metals in mineral systems with a variety of cutting-edge analytical techniques, such as Synchrotron-based techniques, NanoSIMS, LA-ICP-MS and TEM. The current project focuses on biotic and abiotic contribution to sulfide deposition in modern seafloor hydrothermal chimneys.

Deep-sea hydrothermal vents present some of the most extreme conditions on Earth, however, they provide unique habitats for a variety of macro- and micro-organisms and have been suggested as a potential environment where primordial life could have evolved. The investigation of microbial activities in modern seafloor hydrothermal vents can, therefore, provide insight into ancient metabolic processes on the early Earth. Microbes thriving in hydrothermal vents have been suggested to be closely associated with metals and minerals, however, the detailed mechanisms involved in biogenic-inorganic interactions in such settings remain poorly understood.
In this study, we examine the microbe-metal interactions in a hydrothermal chimney from the Manus Basins in Papua New Guinea using a combination of optical microscopy, Synchrotron-based XRF, SEM-EBSD and TEM analysis. Biogenic Pb-As sulfosalt nanotubes overgrowing realgar are observed in a sphalerite-barite dominated zone and are interpreted to be by-products of As-based metabolism. As-bearing sphalerite grains with porous edges are encrusted by those nanotubes and are proposed to act as shelters for microorganisms, protecting them from the toxic As- and Pb-rich hydrothermal fluids. The observed biogenic nanotubes and associated habitats detected in this study can be important bio-signatures, presenting implications for early life studies and the search for life on other planets.

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Multiple Pulses of instability in the recovery from the end-Permian mass extinction at Boreal Sea and the North Norwegian Sea

Fox C[1], Melendez I[1], Foster C[2], Bottcher M[3], Whiteside J[4], Holman A[1], Twitchett R[5], Primio R[6], Grice K[1]
[1]WA-OIGC, Curtin University, [2] Research School of Earth Sciences, Australian National University, [3] Leibniz Institute for Baltic Sea Research, [4]School of Ocean & Earth Science, University of Southampton, [5]Natural History Museum, [6]Lundin, Norway

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Calum Fox completed his MSci Oceanography degree at the University of Southampton in 2015 and is expected to complete his PhD at Curtin University under the supervision of Prof. Kliti Grice in January 2019. Research interests include mass extinction events, biomarkers, organic geochemistry, palaeoclimate, and ocean biogeochemistry. Major work of the PhD includes the biomarker and isotope analysis of the end-Triassic mass extinction and end-Permian mass extinction from European sections.

The end-Permian mass extinction is the most severe mass extinction event to have occurred within the Phanerozoic with approximately 95% of marine and 75% of terrestrial species becoming extinct. The event is marked by volcanism and large igneous intrusions, marine transgression, and global photic zone euxinia (PZE); a process in which toxic hydrogen sulfide extends to the sunlit region of the water column. One such biomarker found across many global sections associated with the end-Permian marine ecosystem collapse is the C33 ACH. C33 ACH is found as three major pulses in a marine section from Svalbard, coinciding with marine transgression. Furthermore, shortly after the Permian-Triassic boundary, poly-aromatic hydrocarbons from the North Norwegian Sea indicate marine ecosystem collapse and terrestrial wildfires. Much of the lower Triassic marked by persistent PZE becoming less persistent and tending towards episodic throughout the remaining lower Triassic, indicating PZE continuing within the subsequent recovery period. The lower Triassic is also dominated by autotrophy (marked by more negative values in the change of compound specific carbon isotope values [δ13C] of short chain C17-19 n-alkanes and pristane and phytane) therefore indicating a greater presence of algae. These values are increased indicating greater amounts of heterotrophy and therefore bacteria when bulk organic carbon isotope values are increased and between periods when C33 ACH is increased. Furthermore, similar shifts in the δ13C and δD (deuterium isotope) values of pristane and phytane indicates synchronous shifts in the organic carbon and hydrogen cycles.

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Deep crustal to SCLM controls on Ni-PGE-Cr and Au mineralisation, northern Superior Province, Canada

Harris L[1], Cleven N[2,3], Guilmette C[2]
[1]INRS-ETE, [2]Université Laval, [3]Geological Survey of Canada

TS3 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Lyal Harris is an Australian-Canadian professor of structural geology at INRS-ETE, an applied research university in Québec City, Canada. Research integrates enhancement and interpretation of aeromagnetic, gravity, and seismic tomographic data with field studies and analogue modelling for regional structural and tectonic syntheses, especially for Archaean and high-grade Proterozoic terrains, with applications to mineral
exploration targeting and non-plate tectonic models for the Archaean. He is especially interested in the link between deep crustal and upper mantle structures and mineral deposits and Venus as an analogue for the Archaean Earth.

Enhanced geophysical data show that margins to Mesoarchaean 'proto-cratons' with deep subcontinental lithospheric mantle (SCLM) keels and their rifted fragments and reactivated deep structures formed during terrane assembly and intracratonic rifting (at high angles to near-surface regional trends) exert fundamental controls on the emplacement of Archaean to Mesoproterozoic mafic-ultramafic intrusions hosting Ni-PGE-Cr mineralisation and Neoarchaean Au, IOCG, and polymetallic occurrences in the northern Canadian Superior Province.

For example, approximately N-S margins of terranes assembled at ca. 2.9 Ga localised E-W extension and formation of N-S, ca. 2.8-2.7 Ga, greenstone belts in the NE Superior and contemporaneous mafic-ultramafic complexes hosting Ni-PGE-Cr mineralisation in the McFaulds Lake greenstone belt, aka 'Ring of Fire', in Ontario. The Ring of Fire is only part of much larger deep crustal, concentric elliptical features (intrusion or ring fractures?) on whose margins other mafic-ultramafic intrusions of the same age were emplaced at their intersection with N-S faults. In the Eeyou Istchee James Bay area, whereas upper crustal gneisses of the La Grande and Opinaca subprovinces record ductile distributed strain during ca. 2.65 Ga E-W dextral transpression, the Éléonore Au deposit is situated on the N-S margins of a deep crustal block above an E-W SCLM structure. In the NE Superior, Au, IOCG, and polymetallic mineralization occur at the intersections with 2.6 Ga sinistral shear zones with N-S rift margins.

Identification of deep, early-formed structures from enhanced aeromagnetic, gravity, and seismic tomographic data is therefore important in regional mineral exploration targeting.

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Deep structures in the Pilbara Craton, WA, and their relationship to overlying deformation, mineralisation and kimberlite emplacement

Harris L[1], Lu Y[2]
[1]INRS-ETE, [2]Geological Survey of WA

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Lyal Harris is an Australian-Canadian professor of structural geology at INRS-ETE. an applied research university in Québec City, Canada. Research integrates enhancement and interpretation of aeromagnetic, gravity, and seismic tomographic data with field studies and analogue modelling for regional structural and tectonic syntheses, especially for Archaean and high-grade Proterozoic terrains, with applications to mineral exploration targeting and non-plate tectonic models for the Archaean. He is especially interested in the link between deep crustal and upper mantle structures and mineral deposits and Venus as an analogue for the Archaean Earth.

Enhanced pseudogravity (magnetic potential) images of Archaean granite-greenstones of the Pilbara Craton, WA, support Hf isotope studies suggesting that the eastern East Pilbara Terrane (EPT) is geologically distinct. Overlying the edge-enhanced short wavelength aeromagnetic image on pseudogravity portrays relationships between upper and deep crustal features: one can thus 'look through' diapiric granite-gneiss domes to see the underlying, basement blocks, that in part control their form, and deep crustal faults. In the N Pilbara, conjugate ductile transcurrent shear zones both cross and occur on the margins of basement blocks. Most Au and other mineral occurrences in greenstones occur on the margins of the deep N-S elongate blocks that underlie the granite-gneiss domes, commonly at their intersection with NNW to NNE-striking faults. Similarly, iron ore deposits of the overlying Hamersley Basin occur on the margins of blocks with distinct pseudogravity signatures and/or along deep N-S, NNW-SSE and NNE-SSW faults; this suggests that basement features, highly oblique to regional structural trends in the upper crust, controlled hydrothermal fluid flow associated with hypogene hematite mineralization. Palaeoproterozoic Brockman kimberlite dykes in the Pilbara Craton ca. 50 km NNW of Nullagine occur on a N-S structure that can be traced on pseudogravity images to link with the contact between the Youanmi and Eastern Goldfields terranes in the Yilgarn Craton. Diamondiferous Nabberu kimberlites and ultramafic lamprophyres on the N margin of the Yilgarn Craton also intrude this structure, suggesting Palaeoproterozoic reactivation and northwards propagation of this lithospheric structure from the Yilgarn to cross the Pilbara Craton.

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The StraboSpot digital data system: A shared resource for field mapping through microstructural analysis

Chatzaras V[1], Newman J[2], Tikoff B[3], Williams R[3], Cunningham H[2], Snell A[2], Roberts N[3], Walker J[4]
[1]University of Sydney, [2]Texas A&M University, [3]University of Wisconsin-Madison, [4]The University of Kansas

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Dr. Vasileios Chatzaras is Lecturer in Geology in the School of Geosciences at the University of Sydney. He joined the University of Sydney in 2018, following 5 years of postdoctoral research experience in USA (University of Wisconsin-Madison, Boston College) and Europe (Utrecht University). His research interests include the links between lithospheric rheology and plate tectonics, transient deformation in plate boundaries, formation and evolution of the oceanic lithosphere, tectonic evolution of metamorphic terranes, regional tectonics of eastern Mediterranean and southwest Pacific, as well as development of digital data systems for data sharing in geology.

The StraboSpot digital data system is a graph database that allows geologists to standardize structural geology data collection (field-based through microstructural), share primary data, interact with other geoscience communities, and develop new types of scientific questions. The database can be accessed through either a desktop system or a field-based mobile application that runs on iOS and Android mobile devices.

The StraboSpot data system uses two main concepts – Spots and Tags - to organize the data. A Spot is any observation that characterizes a specific area. Because Spots are inherently spatial, they are a way of organizing the field-based data. That is, one Spot can enclose multiple other Spots that themselves contain other Spots. Consequently, Spots inherently organize data from a field area, distinguishing between a mapped area, field outcrops, outcrop-scale images, and thin section images. In contrast, Tags provide a conceptual grouping of Spots. A Tag is a user-defined attribute of a Spot, which can be correlated independent of spatial position or extent.

The organization of the StraboSpot data system allows a powerful connection at different spatial scales, such that data from a thin section can be directly tied to the field context. A major struggle in developing the StraboSpot data system is the lack of community standards for thin section analysis. We present an orientation system for thin sections used for microanalysis, in an attempt to allow communication between researchers and sharing of microanalytical data, which will facilitate new types of science in the field of structural geology.

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Exploring the Structure of the Snowy Highlands, NSW

Jacques C[1], Lawrence R[1], Forster D[1], O'Neill C[2], Yildego Y[1]
[1]SMEC Australia, [2]Macquarie University

TS6 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Cara has over 12 years of experience across the fields of hydrogeology and geophysics. She completed her Doctor of Philosophy in Geology/Geophysics in the area of thermal structure and undertook specialist desktop studies for geothermal exploration in the Sydney-Gunnedah-Bowen Basin system (eastern Australia). Cara is experienced in hydrogeological field investigations and has developed skills and experience in desktop studies, interpretation of geological logs and maps, 3D geological modelling, temperature logging, thermal modelling, geothermal assessment, geophysical techniques, aquifer testing, data analysis, environmental sampling and project management.

The geotechnical investigation stages of the Snowy 2.0 project, located between Tantangara and Talbingo Reservoir in the Snowy Mountains of NSW, provides unique insight into the deep structure of a remote part of the Snowy Highlands. Situated across the major headwaters of the Murrumbidgee and Eucumbene Rivers this project alignment differs to the early nation-building work of the Snowy Hydro-electric Scheme in that it is orientated perpendicular to major geological structures, through which it will pass, traversing numerous geological units of varying composition.
In addition to snowmelt and peat bogs the major creeks, which flow North-East, feed the Murrumbidgee River and are sourced from groundwater discharge that originated as rainfall recharge from the highlands at Gooandra Hill and Zinc Ridge. Yarrangobilly Creek, which flows south west to the Tumut River, receives groundwater discharge that originates as rainfall recharge predominantly from the Gooandra Hill with contribution also from Tollbar Ridge.
The construction of this civil infrastructure project requires an integrated geological and geotechnical understanding developed with geological, geophysical, thermal, groundwater and geotechnical data. Major structures like the Long Plain fault provide unique design challenges. The Long Plain fault is hydraulically variable along its length and width and limits flow in an east west direction with a high vertical flow component. When considered in a 3-dimensional nature, the fault can act a barrier, conduit and both for fluid and heat. Understanding the hydro-geological setting with the geotechnical details is essential for a successful project.

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Planning for the Future: Australia as a Key Collaborator in Global Networks of Solid Earth and Environmental Science Data Infrastructures

Wyborn L[1], Rawling T[2], Robinson E[3], Glaves H[4], Cox S[5], Evans B[1], Stall S[6], Ramamurthy M[7], Lehnert K[8]
[1]National Computational Infrastructure, Australian National University, [2]AuScope Limited, [3]Earth Science Information Partners, [4]British Geological Survey, [5]Land and Water, CSIRO, [6]American Geophysical Union, [7]University Corporation for Atmospheric Reserach, [8]University of Columbia

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Lesley Wyborn is an Adjunct Fellow at the National Computational Infrastructure and RSES at ANU. She had 42 years' experience in scientific research and geoscientific data management in Geoscience Australia. Her scientific interests are in Mineral Systems and granite geochemistry, whilst her informatics interests are in generating High Performance Data National scale datasets. She is currently Chair of the Academy of Science 'Data for Science Committee' and is on the American Geophysical Union Data Management Board. She was awarded the Australian Government Public Service Medal in 2014 and the Geological Society of America Career Achievement Award in Geoinformatics in 2015.

In Australia, USA and Europe, Earth and environmental science research communities are developing best practices for data management/stewardship, cyberinfrastructure development, vocabularies and common data services. Major initiatives include:
1. AuScope provides research infrastructure to the Australian Earth and geospatial science communities with a focus on data discovery, delivery and interoperability;
2. Earth Science Information Partners (ESIP), an US-based independent forum for the Earth science data and technology communities, addresses topics such as data stewardship, data citation and documentation;
3. European Plate Observing System (EPOS), supports integrated use of data products and facilities from distributed research infrastructures for European solid Earth science;
4. EarthCube develops cyberinfrastructure to improve access, sharing, visualization, and analysis of geoscience data and related resources in the US research community.

Currently these initiatives are somewhat disconnected. Australia needs to be a key collaborator in these increasingly integrated global integrated networks that are coordinating and harmonizing these efforts, reducing duplication, increasing efficiency, and promoting partnerships and adoption across communities and domains. The recently formed ESIP/RDA Earth Space and Environmental Sciences Interest Group aims to coordinate and harmonize efforts internationally in the research community. Associated satellite activities such as the Australian ESIP downunder (E2SIP), has formed an ESIP cluster in collaboration with the National Earth and Environment Sciences Facilities Forum.

The key question is how to extend these efforts to include all research, government and industry initiatives and create a truly global network of solid Earth and environmental science data infrastructures to underpin fundamental research into global geoscience processes?

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Chicken or Egg? A diverse microbialite assemblage coeval with the Great Oxidation Event.

Allen H[1], Martin D[1]
[1]*Geological Survey Of Western Australia*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Heidi Allen is a senior geologist at the Geological Survey of Western Australia where she has been employed for the last decade. Heidi works within the Basins and Energy team where she has worked on projects that include regional mapping and targeted stratigraphic revisions. She has worked as a palaeontologist during the remapping of the West Australian portion of the Amadeus and Murraba Basins. Recently she has been working on a targeted mapping project of the Hamersley Province.

Systematic description of microbialites coeval with the Great Oxidation Event (GOE) provides an opportunity to understand links between the atmosphere and biosphere during this important period of Earth history. Intrinsically connected with stromatolite-building cyanobacteria, the GOE (2450–2220 Ma) marks a period of change when free oxygen accumulated in the atmosphere. The Paleoproterozoic Turee Creek Group was deposited during the GOE, between c. 2445 and 2208 Ma. Disconformably overlying the Hamersley Group, the Turee Creek Group consists of the Kungarra, Koolbye and Kazput Formations, with microbial carbonates present in the Kungarra and Kazput Formations. The Kazput Formation postdates three glacigenic horizons preserved in this area, and is interpreted to record the terminal stages of the GOE.

Perhaps as a result of the GOE microbialites of the Turee Creek Group are both abundant and diverse. Recent field investigation of carbonates within the Kazput Formation has revealed previously unknown microbialites from the western end of the Turee Creek Syncline, a marked expansion of microbialites known from the Hardey Syncline, and chronologically rapid changes in microbialite forms within the Turee Creek Group. Microbialite assemblages of the lower and upper Kazput Formation are distinct and regionally persistent. These assemblages include new stromatolite and thrombolite forms that have proven valuable as temporal markers during a targeted regional mapping program of the Hamersley province.

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Trends in FAIR scientific publishing for the Earth and space sciences enabled through a coalition of publishers, repositories and researchers

Wyborn L[1], Stall S[2], Robinson E[3], Lehnert K[4], Russell K[5], Rawling T[6]
[1]National Computational Infrastructure, Australian National University, [2]American Geophysical Union, [3]Earth Systems Information Partners, [4]University of Columbia, [5]Australian Research Data Commons, [6]AuScope Limited

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Lesley Wyborn is an Adjunct Fellow at the National Computational Infrastructure and RSES at ANU. She had 42 years' experience in scientific research and geoscientific data management in Geoscience Australia. Her scientific interests are in Mineral Systems and granite geochemistry, whilst her informatics interests are in generating High Performance Data National scale datasets. She is currently Chair of the Academy of Science 'Data for Science Committee' and is on the American Geophysical Union Data Management Board. She was awarded the Australian Government Public Service Medal in 2014 and the Geological Society of America Career Achievement Award in Geoinformatics in 2015.

For many years, the limited accessibility of datasets, software and samples that are key inputs into the majority of research publications has been a frustrating issue. Many journals accept copies of data and software as supplements or have a line in the paper 'please contact the author for access': most samples underpinning key research papers are inaccessible. Yet open, accessible, high-quality data, as well as related data products, software and samples are critical to ensure the integrity of published research and to facilitate reuse of these inputs in future science projects.

In 2017, a grant from the Laura and Arnold Foundation was awarded to the American Geophysical Union (AGU) and other partners (including AuScope, National Computational Infrastructure, Australian Research Data Commons) to significantly improve the interconnection of data and literature in the Earth and space sciences (ESS), based around the Findable, Accessible, Interoperable, and Reusable (FAIR) principles. Experts from publishers, disciplinary data repositories, and supporting organizations have joined forces to work together to provide easy directories of repositories, standards for reporting data, software and samples, as well as future governance.

The overall vision is that:
1. ESS publishers will follow consistent and rigorous policies and guidelines for sharing and citing data used in scholarly literature;
2. Open ESS repositories will enable those policies and other data applications by providing persistent identifiers, rich metadata, and related services for the data they hold; and
3. ESS researchers will understand how to consistently share, document, and reference the data they collect and use.

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The details are in the (Geoscience) DeVL

Wyborn L[1], Rawling T[2], Fraser R[3], Friedrich C[4], Evans B[1], Rees N[1], Heinson G[5], Salmon M[6], McInnes B[7], Martin J[8], Burton A[8]
[1]National Computational Infrastructure, Australian National University, [2]AuScope Limited, [3]Minerals Resources, CSIRO, [4]Data 61/CSIRO, [5]The University of Adelaide, [6]Research School of Earth Sciences, Australian National University, [7]Curtin University, [8]Australian Reserach Data Commons

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Lesley Wyborn is an Adjunct Fellow at the National Computational Infrastructure and RSES at ANU. She had 42 years' experience in scientific research and geoscientific data management in Geoscience Australia. Her scientific interests are in Mineral Systems and granite geochemistry, whilst her informatics interests are in generating High Performance Data National scale datasets. She is currently Chair of the Academy of Science 'Data for Science Committee' and is on the American Geophysical Union Data Management Board. She was awarded the Australian Government Public Service Medal in 2014 and the Geological Society of America Career Achievement Award in Geoinformatics in 2015.

In 2017-2018, the Australian Research Data Commons (ARDC) Project funded the Geosciences Data-enhanced Virtual Laboratory (DeVL), a collaborative project between AuScope, CSIRO, the National Computational Infrastructure (NCI) and the Research School of Earth Sciences (RSES) of the Australian National University (ANU), The University of Adelaide and Curtin University.

The 2017-2018 Geoscience DeVL project aims to create the foundations for the AuScope Virtual Research Environment (AVRE) and has four separate but related work packages:
1. Magnetotellurics (MT): making the University of Adelaide MT data collection discoverable and accessible online through NCI's catalogue (led by NCI and The University of Adelaide);
2. Passive Seismic: Assist QA/QC for data released through the RSES AusPass Seismic Server (led by RSES);
3. AuScope Virtual Research Environment (AVRE): commence building AVRE to support multiple data portals and virtual laboratories through a common core infrastructure. Description and discovery for software, tools and workflows relevant to Australian geoscience and geospatial infrastructures is provided through our Science Software Registry Service (led by CSIRO);
4. An ARDC International Geo Sample Number (IGSN) minting service for the allocation of unique identifiers for physical samples used in Australian academic research in the geosciences and beyond (led by the ARDC).

More data, tools, software and workflows will be added progressively to AVRE as part of a broader AuScope strategic goal to create the AuScope Data Assimilation and Geoscientific Discovery Platform for the Australian Continent. Ultimately, this platform will comprise 3 'discovery' networks for data analysis and interpretation supporting Geochemistry, Geophysics and Geoscience datasets.

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Predicting processing domain response using hyperspectral mineralogy: Applications for coarse waste separation

Jackson A[1,2,3], Fox N[1,2,3], Parbhakar-Fox A[2,3,4], Cracknell M[2,3,4]
[1]CRC Ore, [2]CODES, [3]University of Tasmania, [4]ARC TMVC Research Hub

Biography:

Amery Jackson completed an undergraduate degree in Science at the University of Tasmania with a double major in Earth Science's and Chemistry. After completing his undergraduate course he went on to complete an honours degree at the University of Adelaide in Petroleum Geology and Geophysics. Following the honours degree Amery began working as a full time FIFO Mine Geologist at Garden Well Gold Mine in the Duketon Gold Fields of Western Australia.
After 3 years of working as a Mine Geologist Amery returned to study to commence his gradue research in gold mine grade engineering.

The tendency for ore phases to preferentially fractionate into fine size fractions is referred to as natural deportment and allows separation of coarse, low grade material from the mill feed stream to improve ore quality. This processing response is inherently driven by mineralogical and textural heterogeneity within the rock mass. Equotip is an impact hardness device used in geometallurgical studies for estimating comminution performance of ore domains. This study evaluates the relationship between impact hardness and mineralogy at a gold prospect in Colombia. Hyperspectral core scanning technologies were used to mineralogically characterise drill core intervals from a vein gold system hosted by equigranular tonalite. Equotip measurements were collected at standard intervals of 2.4 cm along the drill core for comparison to the corresponding hyperspectral mineralogical data. Alteration domains characterised by chlorite and muscovite vein selvages were identified in the hyperspectral data and correspond to areas with lower Equotip hardness measurements. In contrast, least altered domains comprising unveined tonalite are dominated by feldspar and quartz with lower relative abundance of muscovite and chlorite have distinctly higher corresponding hardness measurements. This emphasises the capability of hyperspectral mineralogical characterisation techniques to be used as a proxy for geometallurgical hardness tests. Here we demonstrate the significance of measuring mineralogical and textural heterogeneity in drill cores for predicting coarse liberation responses during early comminution stages (blasting and crushing) with implications for early rejection of coarse waste.

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Intrusion-related Geochemical and Alteration Mineral Zonation associated with Low Sulphidation Epithermal Fields and Exploration Implications

Howard N[1], Halley S[2], Pinder J[3], Pike S[1]

[1]Evolution Mining Ltd, [2]Mineral Mapping Pty Ltd, [3]Minjar Gold - Pajingo

TS7 - 3.1.2 Making better exploration decisions through an integrated geoscience approach & 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Ned Howard graduated from UTas in 2004 with a BSc (Hons) in geology and has since spent 14 years in the gold exploration industry. In that time he has worked on exploration projects for a variety of gold deposit styles in Australia, PNG, Canada and Indonesia. Since 2013 with Evolution Mining he has worked as a specialist in application of geochemistry and spectral analysis to exploration before his current role leading the company's project generation effort.

The potential importance of magmatic contributions to low sulphidation epithermal gold-silver deposits has long been recognised. However, manifestations of intrusion-related hydrothermal activity are often not considered during exploration targeting and ranking for this deposit type.

The Pajingo (~5 Moz Au) and Cracow (~2 Moz Au) low sulphidation epithermal deposits hosted in eastern Australian Palaeozoic back arcs displaying features interpreted to represent magmatic hydrothermal fluid input and controls on mineralisation. At both Pajingo and Cracow, gold bearing veins occur adjacent to interpreted intrusion-related hydrothermal alteration zones represented by elevated Te, Bi, Mo and acid clay-bearing alteration assemblages (kaolinite, dickite and pyrophyllite). The best endowed and most vertically continuous mineralised zones at Pajingo are associated with elevated Te/Au and relatively extensive, pyritic and acid clay-bearing hanging wall alteration assemblages elevated in Te and Bi compared with smaller mineralised zones. Larger ore zones are also spatially associated with thickening of a more mafic unit in the host andesite package, and with a porphyritic stock in the footwall to the vein hosting fault.

The above manifestations are useful for identifying and ranking exploration targets in low sulphidation epithermal camps. They are best mapped by spaced, field-wide analysis of drill core, rock chip and soil samples using (a) low detection limit 4 acid digest ICP-MS multi-element geochemical analysis and (b) short wave infrared (SWIR) spectral analysis followed by integration with geological and geophysical datasets to constrain the interpretation of pathfinder element and alteration mineral patterns.

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Future Exploration challenges - unlocking new energy resources

Elders C[1], Grice K[1], Coolen M[1], Smith G[1], Brocks J[2], Peyrot D[3], Gurevich B[1], Foster C[2], Edwards D[4], Grosjean E[4], Clennell B[5]

[1]Curtin University, [2]The Australian National University, [3]The University of Western Australia, [4]Geoscience Australia, [5]Commonwealth Scientific and Industrial Research Organisation

TS3 - 5.5 Planning the future of Geoscience & 5.1 Geology in society: geotourism and geoheritage, Room R8, October 17, 2018, 9:30 AM - 11:00 AM

Biography:

Chris Elders is Professor of Petroleum Geology at Curtin University. Having graduated from OxfordUniversity with a BSc and PhD, he spent four years working for Shell as an exploration geologist in the Netherlands, followed by 20 years at Royal Holloway College, part of the University of London. He moved to Curtin in 2013 has enjoyed spending the last 5 years helping to unravel the complex evolution of Australia's continental margins

The Future of Geoscience will increasingly depend on deriving new insights from the integration of diverse data sets that have previously been treated in isolation. A clear example where this might be applied is in the search for new energy resources. Sedimentary basins are rich in subsurface geophysical data, while innovative techniques have greatly increased our understanding of organic matter at the molecular scale. At the same time, new developments in geomicrobiology promise to push the boundaries of deep life, and the ways in which it can be used to compliment more traditional techniques. We aim to demonstrate how we can "close the loop" between observations at an atomic, molecular, particulate and seismic scale to predict the occurrence, type and maturation of hydrocarbon source rocks in undrilled sedimentary basins, to determine the quality, distribution and effectiveness of hydrocarbon source rocks in mature sedimentary basins, the productivity of source rocks in proven, multi-phase basins and the application of innovative microbial techniques to reduce production costs, enhance recovery and identify new sources of energy. Such an integrated approach will not only advance our understanding of the cycling of carbon in sedimentary basins, but will also address the need to develop reliable and affordable sources of energy to underpin the Australian economy

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Major and trace element geochemistry of Bitter Ground Volcanics and Jasper Creek Gabbro, Yarras district, Southern New England Fold Belt.

Caprarelli G[1], Leitch E[2]
[1]Hypatia Scientifica Pty Ltd, [2]University of Technology Sydney

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Graziella Caprarelli obtained her MSc and PhD from University La Sapienza of Rome, Italy, before moving to Japan and then to Australia. Prior to founding Hypatia Scientifica, she has been Senior Lecturer and Associate Professor at UTS and UniSA. She is Research Professor (Adj.) at the International Research School of Planetary Sciences in Pescara, Italy, and member of the scientific team for Mars Express - MARSIS. She has been Chair of the NSW and SA Divisions of the Geological Society of Australia, and Inaugural President of the Japan Society for the Promotion of Science Alumni Association in Australia.

The Yarras Suture Zone (YSZ) bounds two major structural elements of the Southern New England Fold Belt (NSW, eastern Australia): the Hastings Block (east), and the Yarrowitch Block (west). The zone is marked by serpentinite lenses associated to disrupted igneous and metasedimentary rocks. The oldest stratigraphic igneous unit recognised in the district is the Devonian Bitter Ground Volcanics (BGV), comprising basalt and silica-poor andesite, uncommon siliceous extrusive rocks, and widespread mafic sills, dikes, and (rare) ellipsoidal lenses. The BGV are west-bound by the Taylors Creek Fault, the structural contact between the Hastings and Yarrowitch blocks in this district. Wedged between the YSZ serpentinites and the BGV are the gabbroic bodies of the Jasper Creek Gabbro (JCG). Field observations have not clarified the stratigraphic attribution of JCG, which could either be a component of the YSZ, or of the BGV. To address this question, we conducted a major and trace element geochemical investigation of JCG and BGV. Here we report our main results: (1) the rocks are characterised by MORB and IAB affinities; (2) major element abundances of the gabbros and of some BGV are consistent with fractional crystallisation processes; (3) removal of the fractionated solidus was accompanied by increasing oxygen fugacities in the residual melts; (4) three main groups are identified based on slight, but detectable, differences in LREE patterns, possibly indicating different or mixed magma sources. These results highlight the complexity of JCG and BGV magma origin and evolution. Further studies are required to clarify the JCG stratigraphic position.

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The JORC Code for the Benefit of all Stakeholders

Stoker P[1]
[1]*AMC Consultants Pty Ltd*

Biography:
Peter Stoker HonFAusIMM(CP) is a geologist experienced in mine geology, mineral resource estimation, feasibility studies, project evaluation, mineral exploration and public reporting.
Peter is an Honorary Member of China Mining Association. He is the deputy chairman of the Joint Ore Reserves Committee (JORC), was Chairman from 2005 to 2014, and Secretary from 1999 to 2005. He is a JORC representative on the Committee for Mineral Reserves International Reporting Standards (CRIRSCO). Peter was a contributor and steering committee member for Monograph 23 “Mineral Resources and Ore Reserves Estimation – The AusIMM Guide to Good Practice” and the second edition, Monograph 30.

The Australasian Joint Ore Reserves Committee (JORC) developed the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (The JORC Code, or the Code) in response to poor reporting practices in Australia during the Poseidon Boom and Bust in the late 1960s. The JORC Code is a code for the benefit of many stakeholders including investors, management, financiers and governments; it is mandatory for companies listed on securities exchanges in Australia, New Zealand, and Papua New Guinea, and is also one of the reporting standards required to be used in exchanges in Singapore and Hong Kong.

The Code is not primarily concerned with the technical aspects of the estimation of resources and reserves, although it does provide in the JORC Code Table 1, an extensive ‘Checklist of Assessment and Reporting Criteria’. However, to properly inform stakeholders the Code includes the requirement to report on an ‘if not, why not’ basis against all the relevant items in Table 1 for initial or materially changed estimates for significant projects. This ensures that investors are adequately informed of the material information underlying the reporting of resources and reserves. The Code is adopted in various regulatory environments where it is supplemented by securities exchange listing rules and guidance and market regulatory regimes and in a professional and technical sense by guides to good practice prepared by professional bodies, such as The AusIMM Monographs 23 & 30, Mineral Resource and Ore Reserve Estimation – The AusIMM Guide to Good Practice.

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NDRRA Gold Coast Springbrook Road Slope Remediation – Digital Innovation in the Hinterland

Casey T[1], Gerig J[1]
[1]*Arup Pty Ltd*

TS7 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Tom is a Chartered Geologist (CGeol) and Senior Geologist with Arup. He has been with Arup for 13 years and based in Brisbane since January 2017.
He is an experienced engineering geologist with a combination of specialist skills in the identification of geohazards, geotechnical ground investigation, and design of major infrastructure. Tom leads teams in fieldwork investigations on major infrastructure projects and has undertaken geological and geomorphological mapping, including slope hazard assessments, in steep mountainous terrain in Northern Europe and the Middle East.
He has worked extensively throughout the UK, Europe, North and East Africa, the Middle East and Australasia.

Severe Tropical Cyclone "Debbie" and associated extreme rainfall event in late March 2017 resulted in widespread disruption and damage to TMR infrastructure in south east Queensland.
Gold Coast-Springbrook Road suffered multiple instances of slope instability, including erosion, debris slides, rock falls and damage affecting the road between Neranwood and Springbrook. Initial inspections during the emergent phase identified 14 no. slip sites requiring treatment, subsequent inspections during the design phase identified 21 no. individual large slip features and over 40 no. minor features requiring treatment.
The challenges of inspection and survey of the sites in the densely vegetated, steep mountainous terrain meant that state of the art survey technology had to be employed to obtain detailed information to enable design under the intense program initiated by NDDRA process.
The engineering design team in collaboration with specialist surveyors, used a suite of digital survey and inspection techniques including panoramic photo survey, drones and laser scanning to enable rapid acquisition of high resolution survey data for accurate 3D modelling and visualisation feeding directly into the design and analysis process. The valuable data enabled site visualisation throughout design and tender of construction phase services, whilst managing the health and safety of site based activities to minimise exposure to remaining hazards.
The techniques utilised proved to be a key component in achieving completion of design works and will continue to play a key role in the digital transformation of our industry and application of innovative techniques to support aging infrastructure across future similar engineering works.

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U-Pb Detrital zircon constraints on the maximum depositional age and provenance of the dinosaur-bearing Wadi Milk Formation of Sudan

Owusu Agyemang P[1], Roberts E[1]
[1]James Cook University

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Prince is using sandstone petrography coupled with U–Pb geochronology and Lu-Hf isotope geochemistry analyses of detrital zircons to investigate Jurassic and Cretaceous tectonics, sedimentary provenance and paleogeography of central Africa. The study is tracking sediment pathways into continental sedimentary basins and drainage patterns across central Africa to help understand Mesozoic tectonics and its effect on paleogeography and landscape evolution. The U-Pb detrital zircon geochronology approach employed in this study has the potential to improve age resolution, particularly in continental sedimentary successions for which biostratigraphy is often imprecise or inconclusive.

Cretaceous continental deposits in Sudan have long been recognized as important archives of continental vertebrate fossils in central Africa. A number of different sedimentary units including the Omdurman, Wadi Milk and Shendi formations from northern and central Sudan are known to yield dinosaur and other vertebrate fossils. The ages of these deposits are poorly constrained and traditionally considered to be between Albian and Cenomanian based on biostratigraphic evidence. However, recent palynological analyses suggest Campanian–Maastrichtian age for the Shendi Formation. Not only are the ages of these units poorly resolved, provenance and regional correlation within and between these deposits and similar aged units in central Africa remains tenuous. To address these issues a detailed sedimentary provenance analysis of the Shendi and Wadi Milk formations was conducted using a multifaceted U-Pb geochronology, Lu-Hf isotope analysis and trace element geochemistry on detrital zircon grains. Based on U-Pb detrital zircon results from 18 samples (>1400 detrital zircons), we report a population of six Cretaceous age grains from the Wadi Milk Formation yielding a Campanian maximum depositional age of 79.2 ± 2.4 Ma (MSWD = 0.65, probability 0.62), which significantly refines the Albian to Cenomanian age of this unit and its fauna. The U-Pb age spectra of both units are dominated by juvenile Neoproterozoic crustal sources and minor Paleoproterozoic and Archean sources within the Arabian-Nubian Shield to the east-southeast of the study area, suggestive of a north-north westerly flowing fluvial system draining into the Tethys Sea during the Late Cretaceous.

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Airborne electromagnetic inversion for regolith structure

King A[1], Gonzalez-Alvarez I[1]
[1]*Csiro*

TS1 - 3.1.1 Effective exploration and discovery under cover, Hall E2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Andrew has a broad background in geophysics, having worked in potential field and EM techniques for exploration, and seismic methods for mining problems. He has a PhD from Macquarie University in electromagnetic geophysics. He has worked for CSIRO since 2000, apart from a three-year fellowship in the US, where he worked on seismic monitoring for mine safety.
His current interests include geotechnical applications of geophysics as well as using seismics and EM for exploration under cover.

Exploration for new mineral deposits in Australia is increasingly in regolith-dominated terraines -- areas of deep weathering and transported sediments -- and requires an improved understanding of the architecture and properties of the overlying cover. Understanding of the regolith is crucial for designing efficient geochemical sampling and drilling programs. Airborne electromagnetic (AEM) datasets can provide a useful means of imaging stratigraphic and structural features within the regolith.

In this paper, we explore methods of using geology, and an understanding of landscape evolution, to constrain the inversion of AEM data for regolith stratigraphy. Understanding of landscape evolution allows the likely stratigraphic units and their geometrical relationships to be specified. We therefore use a simplified model consisting of known lithological layers, with varying thicknesses and laterally-varying conductivities, as well as a water table which splits units into conductive wet and resistive dry sections. Use of borehole information to constrain lithology and depth allows AEM data to be inverted for the conductivity range of each lithology in the specific geological context. Certain sediments are known to be well-mixed, which means that they have much longer spatial correlation scale lengths than other sediments, information which we incorporate into the prior covariance matrix. We show examples of AEM data inverted using this methodology.

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Using crystal clusters to link the Gawler Range Volcanics to the Hiltaba Suite intrusive rocks, Gawler Craton, South Australia

Ferguson M[1], Meffre S[1]
[1]College of Sciences and Engineering, University of Tasmania

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Matthew is finalising his PhD study of South Australia's Olympic Dam basement rocks and Gawler Range Volcanics extrusive rocks in an effort to improve our understanding of their genesis and relationship to iron oxide-dominated mineralisation in the Gawler Craton.

The Roxby Downs Granite (RDG) – host to the supergiant Olympic Dam deposit – and the Gawler Range Volcanics (GRV), South Australia, both contain clusters of touching silicate and oxide minerals. Crystal clusters in the RDG comprise magnetite + apatite ± titanite ± biotite ± zircon which are typically enveloped in a plagioclase crystal-matrix. In the GRV, crystal clusters comprise pyroxene + titanomagnetite ± plagioclase ± apatite ± zircon, display variably glomeroporphyritic, equigranular, poikilitic, and loosely packed habits, and are enclosed by texturally varied groundmass. Comparable crystal clusters are present in the Snake River Plain-Yellowstone Volcanic Province, and the Cascade Range and Rio Grande rift magmatic systems. Of the GRV lavas studied, pyroxenes and titanomagnetite show systematic trends in major and trace element compositions conformable with the stratigraphic position of their hosts. This suggests the lavas are related through differentiation in the upper crust and represent the inversion of a normally zoned reservoir. Consistent Fe-Ti oxide + apatite + zircon + plagioclase assemblages in both the GRV and RDG suggest a similar genetic scenario. For hot and dry magmas such as those that formed the GRV and RDG, cooling causes pyroxene + Fe-Ti oxide + plagioclase in GRV-like crystal clusters to react with both each other and the melt, forming RDG-like magnetite + titanite + biotite + feldspar crystal clusters.

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From magma to mush to lava: insights from voluminous felsic lavas in the Gawler Range Volcanics, South Australia

Ferguson M[1], Meffre S[1]

[1]College of Sciences and Engineering, University of Tasmania

TS8 - 1.6 Advances in structural, igneous metamorphic and sedimentary geology, Room R1, October 18, 2018, 3:00 PM - 4:30 PM

Biography:

Matthew is finalising his PhD study of South Australia's Olympic Dam basement rocks and Gawler Range Volcanics extrusive rocks in an effort to improve our understanding of their genesis and relationship to IOCG mineralisation in the Gawler Craton.

The Gawler Range Volcanics (GRV) are important extrusive analogues to the Mesoproterozoic Hiltaba Suite intrusive rocks of the Gawler Craton. We study three voluminous lavas in the GRV that contain abundant clusters of pyroxene, titanomagnetite, plagioclase, K-feldspar, fayalite, apatite, and zircon. The last-erupted lava contains the highest proportion of clusters comprising complex and anhedral intergrowths. This is consistent with a normally zoned reservoir where the crystal:melt ratio is greatest at depth. Loosely packed, touching crystal frameworks and eventually free crystals are found in the middle and upper sections of the reservoir, which are represented by the first erupted Upper GRV lava, and quartz-phyric portions of the lavas. Plagioclase is the most abundant phenocryst throughout the lavas, but is present in only a subset of crystal clusters. We propose that the low abundance and absence of feldspar and quartz in clusters is due to loss and separation of these components prior to and during the eruption the studied lavas. Mafic magmatic enclaves recognised throughout the GRV likely represent the replenishing mafic magmas that provided the thermal and volatile input that drove mineral resorption. Continuing mafic replenishment and injection of sufficient volumes of magma into the GRV reservoir may have also driven the eruption of the lavas. Prolonged fractionation and interaction with mafic magmas could have potentially conveyed or enhanced the distinctive A-type signature of these rocks, negating the requirement of a specialised precursor composition.

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Contrasting PCD and IOCG tectono-magmatic settings: insights from the Gawler Craton and North America

Ferguson M[1], Chapman N[1], Meffre S[1]
[1]*College of Sciences and Engineering, University of Tasmania*

TS4 - 3.1.4 Tectonic and earth evolution controls on the spatial and temporal, Hall E2, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Matthew is finalising his PhD study of South Australia's Olympic Dam basement rocks and Gawler Range Volcanics extrusive rocks in an effort to improve our understanding of their genesis and relationship to IOCG mineralisation in the Gawler Craton.

Porphyry-style copper deposits (PCD) and iron oxide-copper-gold (IOCG) deposits have both been linked to metal-bearing, magmatic-hydrothermal fluids released from crystallising intrusions. While PCD formation is favoured by continental arc stress regimes and melting/storage conditions, a diversity of formation environments have been proposed for other PCD-like mineralisation styles, including IOCG deposits. In the Mesoproterozoic Olympic Province and broader Gawler Craton, hot, dry, F- and HFSE-rich magmatic rocks (A-type) are associated with iron oxide-dominated (IO) deposit types. In order to improve constraints on the genesis of ancient IO deposit-related rocks in the Gawler Craton, we compared them to well-studied rocks in North American Cenozoic magmatic provinces.
The Mesoproterozoic Gawler Craton magmatic rocks share several textural and geochemical features with rocks of the Snake River Plain-Yellowstone Volcanic Province and Basin and Range Province. In these provinces with major silicic extrusive components, magma reservoir rejuvenation and long magmatic locus lifetimes result in enrichment of Fe and K relative to other compatible elements, and lower water contents and higher magma temperatures at a given SiO2 relative to typical arc magmas. In contrast with PCD-related arc magma fertility attributed to combinations of water-fluxed melting, undepleted sources, and differentiation in overall compressive regimes with brief periods of extension, our results indicate that the magmas associated with the Gawler Craton IO deposits formed in continental back-arc and intracontinental environments. In these arc-distal settings, IO deposit-related magmatism reveals more open-system behaviour, higher magma generation rates and melting temperatures, and involve higher degrees of crustal melting than their arc counterparts.

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Applications of hyperspectral mineralogy for geoenvironmental characterisation

Fox N[2], Jackson L[1], **Jutzeler M**, Parbhakar-fox A[1]
[1]ARC TMVC Hub, CODES, University of Tasmania, [2]CRC ORE, University of Tasmania

Biography:
Anita is a Senior Research Fellow in Geoenvironmental Studies at UTAS. She works with the mining industry and government bodies to find new ways to characterise a range of future and existing mine waste. Specifically she explores for new techniques to predict geoenvironmental behaviour and has recently been focussed on evaluating the commodity potential of existing mine wastes.

Hyperspectral technologies are increasingly being used to understand a range of drill core properties enhancing deposit knowledge across the mining chain. From the earliest stages of mine-life, accurate mineralogical identification can enhance geoenvironmental characterisation which is traditionally understood using a range of chemical tests to predict acid generation and neutralisation. The limitation of using these is that only discrete samples can be tested as dictated by a range of logistical and financial constraints. Instead, collecting and interrogating hyperspectral data in a geoenvironmental context can provide a broad insight into the characteristics of future waste materials enabling better sampling for chemical testing. Drill core (n=288) collected from a porphyry prospect in Northern Europe were scanned using a HyLogger HS3 system. TSG software suggests three possible minerals for each measurement collected which was manipulated to give a relative abundance of each (scored out of 1). Using these, a new TIR geoenvironmental forecasting index (termed the Hy-GI) was developed. This index calculation uses published neutralising potential and relative reactivity values which are multiplied by the relative abundance of each of the given three minerals. These are then totalled to give the final Hy-GI score, with higher values indicating a greater neutralising potential. In this study, Hy-GI values were screened alongside sulphur assay data and compared against XRD and static chemical data. Results showed that the Hy-GI can be effectively used as a first pass tool to forecast geoenvironmental properties of future waste materials and demonstrates an opportunity to leverage more from these datasets.

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Satellite thermal unmasks the Gawler

Pendock N[1]
[1]DIRT Exploration

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Neil Pendock is an applied mathematician with over 30 years experience developing algorithms and software for the processing of remotely sensed data.

Most of the highly prospective Gawler craton is covered by regolith: a thin layer of residual or transported surface cover. Regolith has hindered exploration by fossicking geologists and remote satellites such as Landsat, Aster and World View as well as airborne scanners like Hymap. These remote sensing systems all focus on the reflected visible near infrared [VNIR] and shortwave infrared [SWIR] region of the electromagnetic spectrum and thus image regolith rather than buried mineral deposits as they image the top millimeter of the surface..

Gawler exploration to date has been either serendipitous discoveries; brute force investigation of geochemical anomalies (pace the Challenger gold mine discovered by pattern drilling calcrete anomalies); or by investigating geophysical targets from ground and airborne magnetic, magnetotelluric, electromagnetic, gravity or induced polarization surveys. These geophysical datasets are often ambiguous to interpret and expensive to acquire. They can sometimes be substituted by free satellite longwave infrared [LWIR] imagery that can see beneath the regolith thanks to the emissivity property of rocks..

We present several examples including mapping sericite to find gold near Challenger; pyrophyllite as a vector to silver at Paris and hemimorphite as an indicator of zinc at Menninnie Dam.

Satellite thermal images have moderate spatial resolution (90m in the case of Aster LWIR) which can be complemented by high resolution airborne and ground based systems. The multiband thermal response can be unmixed to infer abundances of particular minerals beneath regolith and large scale mosaics made as an aid to regional exploration.

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Identification of LIP through multiple proxies: A Paleoproterozoic case study from Singhbhum Craton

Shankar R[1], Sarma D[2]
[1]National Centre For Earth Science Studies, [2]National Geophysical Research Institute

Biography:
Dr Ravi Shankar is currently working as Project Scientist 'B' at National Centre for Earth Science Studies, Thiruvananthapuram, India.
He has earned his PhD (Sciences) from Academy of Scientific and Innovative Research (AcSIR) while working at CSIR –National Geophysical Research Institute (NGRI), Hyderabad, India. He is an active Reviewer with several reputed Journals like Precambrian Research, Journal of Earth System Science etc.
His areas of Research Interest are Geodynamic evolution of Archean Cratons, Paleogeographic reconstruction of Supercontinents and supercratons using Geochronology, Geochemistry and Paleomagnetism.

An integrated Geochronology, Geochemistry and Paleomagnetic study of now exposed mafic intrusions like dykes can reliably predict the existence of LIPs in Earth's past. We are presenting here the case study of Singhbhum dykes to explain our approach.
WNW–ESE trending dykes from Singhbhum craton were dated to yield Pb–Pb ages of 1765.3±1.0Ma. The paleomagnetic study of these dykes has resulted in key paleopole, which was used for paleogeographic reconstruction among India, Baltica Craton and North China Craton which has indicated that the Baltica Craton and India linkage can be stable for at least ~370 Ma (~1770–1400 Ma) and also supported India-North China Craton spatial proximity at ~1770 Ma. The geochemical analysis of these dykes has classified them as sub-alkaline to tholeiitic to andesitic basalts. These are derived from partially melted and fractionally crystallized primary High-Mg mantle source. The tectonic environment responsible for emplacement of these dykes is a stable continental rift setting. The comparison of geochemistry of coeval dykes at ~1770 Ma from India, North China craton, East Antractica and Baltica craton is indicating that these may have a same deep seated Mg-rich mantle source. Detailed geochemical comparisons of has supported the Paleoassembly of India, North China craton, East Antractica and Baltica craton next to each other and has indicated that a single mantle plume source might be source of all these dykes. As a result, a hitherto unknown LIP spread across India, North China craton, Baltica craton and East Antartica at ~1770 Ma is proposed.

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Hydro-illogical cycle, socio-hydrogeology and collective action; lessons learnt from groundwater management in the Angas-Bremer irrigation district (South Australia)

Hopkinson J[1,3,4], Ordens C[1], Shalsi S[1], Curtis A[2], Simmons C[3,4]
[1]University College London Australia, [2]The Graham Centre for Agricultural Innovation, Charles Sturt University, [3]Flinders University, [4]National Centre for Groundwater Research and Training

TS1 - 3.3.1 Groundwater challenges and opportunities & 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
James studied a BSc (Geology and Geophysics) at the University of Adelaide going on to complete Honours in Geology in 2015. He obtained a MSc in Energy and Resources Management from UCL Australia in 2017 and has recently commenced a PhD candidature in groundwater hydrology at Flinders University, focusing on numerical modelling of ephemeral streams.

The Angas-Bremer (AB) irrigation district (South Australia) is located at the lower end of the Murray-Darling Basin. Economically supported by a thriving wine industry that relies on water availability for irrigation, the region is especially vulnerable to water crises because water security depends on upstream management. Groundwater pumping in AB started in the 1950s leading to declining groundwater levels and rising salinities. AB faced major groundwater crises, (late 1970s and early 2000s (Millennium Drought)), which drove the community to embrace innovative approaches that were highly-successful and nation-leading, improving resilience to future water shortages. AB offers a unique opportunity to observe examples of integrated groundwater management concepts such as co-management, collective action, conjunctive water management, the hydro-illogical cycle (HIC), and socio-hydrogeology.
The innovative nature and success of AB's example of community-driven IGM was examined from the late 1970s. We collected and analysed biophysical data from the 1950s to 2017 including groundwater pumping, artificial recharge, surface water usage and rainfall. These data were integrated with a chronology of groundwater management practices, historical interaction between government and irrigators, and qualitative interview data from key regional stakeholders. The HIC was observed to be broken in places whilst other periods show regression back towards the illogical approach to water. Lessons learned are identified for real-world IGM, including how to break the HIC by introducing proactive measures to improve resilience and reduce vulnerability to drought. The conclusions will benefit those aiming at resolving groundwater management problems considering the multi-disciplinary nature of complex socio-ecological systems.

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SOCIAL GEOLOGY : PRESENT STATUS AND FUTURE PLANNING

Rai V[1]

[1]Department of Geology, University of Lucknow

Biography:

Professor of Geology with research experience of 36 years. Teaching Experience of 34 Years in the University. Worked in the fields of basic researches on the Early evolution of Life on earth, Himalayan geology and Tectonics, Rodinia, isotope Geology and Sedimentology. In the fields of Applied geology, my contribution has been in Urban Flooding, Ground Water Quality, Water resource Management. Lately, I am involved in Gemological researches and teaching besides participating in Outreach programmes of Federal Government of India as a resource person in the fields of environment and climate.

The subject of Geology has lately become relevant amongst the Society ever since aspect of climate change and its impact on the biosphere has been recognised. The impact of natural disasters and their complexity has been understood through geological processes and now most of the general public look forward to know the “inside story” from the geologists in case of any eventuality such as earthquake, landslides, floods, volcanic eruption or land sinking.

In addition, the exploitation of natural resources such as water, minerals, soils and energy material have lately emphasised the importance of a geologist in a day-today life of common people. . However, the absence of popularising the subject has left a lot of people to underestimate the potential of the subject as a foundation of all the subsequent development in terms of Evolution of the Earth and the Life on it.

I propose that the Geologist’s fraternity should chalk out a plan where all the intricacies of a developed world can be boasted as a contribution from Geology. We have to inform that 95 % of the resources on which we have built a modern world have been contributed by geologists.

Popular Lectures, Field related discoveries, Natural resource potential and energy contribution alongside outreach programmes can be put before various levels of society to make the subject of Geology coming in the main front-line subject of study by younger generation. A well laid out plan is proposed to address the above issues.

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The geology and geochemistry of intraplate volcanoes offshore of Australia's Southern Margin

Parr J[1], Ross A[2], Kempton R[2], Mole D[3], Pickard A[2], Talukder A[2], Trefry C[2], Crawford A[4]
[1]CSIRO Minerals, [2]CSIRO Energy, [3]CSIRO Minerals, [4]A & A Crawford Geological Research Consultants

TS8 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Joanna Parr gained her PhD in 1988 (University of Wales) on the genesis of ore deposits in a Proterozoic volcanic sequence in central Sweden. After a postdoc at Newcastle University (NSW) she joined CSIRO as a research scientist specialising in modern ore-forming environments. She now leads the Ore Deposit Geology Group in the Discovery Program of CSIRO Mineral Resources.
Joanna is the Honorary Secretary of the Geological Society of Australia and is also a member of the London Geological Society, the Society of Economic Geologists, and the American Geophysical Union.

The Great Australian Bight Deepwater Marine Program (GABDMP) aims to build a regional understanding of the deep water GAB marine geology and benthic ecology. In this paper we describe the petrography and geochemistry of samples collected from volcanic edifices (some previously unidentified) in the Ceduna sub-basin, providing the first insights into the mechanisms and formation of these features and their tectonic setting.

Dredging and seafloor drilling indicates that the volcanic edifices are composed of stacked lavas and hyaloclastite layers. They are predominantly well-preserved (but altered) massive amygdaloidal-vesicular olivine+augite-phyric basalt (pillow) lavas and auto-brecciated vesicular basaltic breccia flows with incorporated calcareous sediments. Hyaloclastite deposits include variably altered fragments suggesting multiple sources from across the unstable submarine slopes of the volcano.

The basalts have Ocean Island Basalt (OIB) geochemical characteristics, consistent with an intra oceanic tectonic setting. HFSE ratios differentiate two groups: one with a geochemical fractionation trend parallel, but outside, the MORB-OIB array, suggesting mixing/interaction of the magma with additional sources (a lithospheric component?); and a second with a well-defined fractionation trend within the MORB-OIB array, suggesting no crustal contamination.

The magma show similar characteristics to the Older and New Volcanic Provinces of SE Australia (particularly the NVP), suggesting a possible genetic link. Their enriched-OIB signature is inconsistent with a craton edge-driven model of mantle upwelling, and a mantle plume origin does not fit with our knowledge of the wider south Australian region. Possibly, the magmatism is linked to the large alkaline magmatic province proposed by Finn et al. (2005).

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Deep lithological domains, structures, and reconstructions for the eastern Superior Province, Canada: implications for mineral exploration and tectonic models

Harris L[1], Cleven N[2,3], Guilmette C[2]
[1]INRS-ETE, [2]Université Laval, [3]Geological Survey of Canada

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Lyal Harris is an Australian-Canadian professor of structural geology at INRS-ETE, an applied research university in Québec City, Canada. Research integrates enhancement and interpretation of aeromagnetic, gravity and seismic tomographic data with field studies and analogue modelling for regional structural and tectonic syntheses, especially for Archaean and high-grade Proterozoic terrains, with applications to mineral exploration targeting and non-plate tectonic models for the Archaean. He is especially interested in the link between deep crustal and upper mantle structures and mineral deposits and Venus as an analogue for the Archaean Earth.

Existing subprovince and domain boundaries and models for the formation of the eastern and central Superior Province are questioned in the light of geophysical enhancements that accentuate the geometry of deep lithological domains and structures:
- In the NE Superior, were Ashuanipi Complex high-grade para- and orthogneisses and diatexite translated SE from initially N of the Bienville Subprovince (an area of thinned SCLM)? If so, a N-S ca. 2.8-2.7 rift would extend from the northern extremity of the NE Superior into the SW Bienville and La Grande subprovinces; strain increases southwards from open folds in the N to isoclinal folds with E-W axial traces in the S.
- Were 2.7 Ga metasedimentary rocks of the Opinaca and Nemiscau suprovinces deposited in both N-S and ENE-WSW to E-W trending rifts affecting the La Grande and Opatica basement? Undoing displacements on discrete deep crustal dextral shear zones implies margins to basement crustal blocks were ca. N-S. These and similar features in the central Abitibi illustrate the importance of early ca. N-S structures for the entire E Superior.
- Do similar deep geophysical signatures of the SE Abitibi (including TTGs of the Attic Complex) and Pontiac Subprovince imply they were once contiguous?
- Does the Proterozoic Kapuskasing structural zone reactivate one of several NNE-SSW regional Archaean basement structures?
Interpretations are inconsistent with conventional N to S accretion of E-W arcs and back-arc basin models and have implications for structural controls on Au and other mineral deposits, in the Superior and other Archaean terrains.

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Mesozoic magmatism in the eastern North China Craton: Implication for lithospheric thinning and craton destruction

Yang F[1,2], Santosh M[1,2]

[1]School of Earth Science and Resources, China University of Geosciences Beijing, [2]Department Of Earth Sciences, School Of Physical Sciences, The University Of Adelaide

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

Fan Yang is a PhD Candidate at the China University of Geosciences Beijing, China. His major research interests mainly involving Mesozoic craton destruction and lithosphere thinning in the North China Craton, Mo-W-Pb-Zn-Ag metallogeny associated with Mesozoic intra-plate magmatism, as well as three-dimensional (3D) geological modeling and metallogenic prediction. The research areas cover the North China Craton and Qinling polymetallic metallogenic belt, and associated research fields include petrology, isotope geochemistry, geochemistry, geochronology, metallogeny, metallogenic prediction and tectonics.

The North China Craton (NCC) is one of oldest cratonic nuclei in the Eurasian continents, and have been thinned in its eastern domains with the subcontinental lithospheric mantle (SCLM) replaced by the juvenile SCLM during the Mesozoic. Mesozoic magmatism is generally regarded as an important marker of the craton destruction and lithospheric thinning, and the peak of craton destruction occurred in the Mesozoic, tectonically linked to the southern subduction/collision with the Yangtze Craton during the Triassic and eastern Paleo-Pacific plate subduction in the Early Cretaceous. Mesozoic magmatism in the eastern and northern NCC show arc affinities, whereas that in the central domains of the NCC exhibit adakitic affinity, and both preserve geochemical overprint of extensional tectonic setting. Zircon age data show that the main stage of magmatism occurred during Late Jurassic to Early Cretaceous (145-110 Ma), and inherited Paleozoic, Proterozoic and Paleoproterozoic zircons which were sourced from the Yangtze Craton and basement rocks. Zircon Hf isotopic data exhibit negative εHf(t) values with major Paleoproterozoic and minor Neoarchean Hf crustal model ages, indicating that magma sources involved Paleoproterozoic basement rocks of the NCC, with minor reworked Neoarchean components. Integrating the results from our studies with those from previous studies, we propose that multiple tectonic events contributed to the craton destruction of the NCC, among which the Paleo-Pacific plate subduction beneath the NCC with the slab rollback induced lithospheric extension, back-arc spreading, asthenospheric upwelling and interaction with lithosphere was the major contributing mechanism for lithospheric thinning and delamination during the Early Cretaceous.

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Volcanic CO2-induced intensification of the hydrological cycle across the end-Triassic extinction

Whiteside J[1], Yager J[2], Olsen P[3], Palmer M[1], Milton J[1], Schaller M[4]

[1]University of Southampton, [2]University of Southern California, [3]Lamont-Doherty Earth Observatory of Columbia University, [4]Rensselaer Polytechnic Institute

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:

I am a broadly trained geologist (PhD Columbia University, Earth and Environmental Sciences; BSc Mount Holyoke College, Geology and Biological Sciences) specializing in paleobiological and geochemical proxies with an emphasis on molecular fossils (biomarkers) and their isotopic composition to assess causes and process of mass extinctions and global environmental changes. My work places these extinctions into a broader context of orbital pacing of climate and biotic provinciality informing future climate scenarios and the limits of habitability via mineral-organic matter interactions. The venues for my studies are globally dispersed field expeditions augmented by focused ICDP and IODP drilling campaigns.

Global models of increasing pCO_2 predict an enhanced hydrological cycle coupled with warming, and amplification of the effects of orbitally paced precipitation cycles. High-pCO_2 Mesozoic warm intervals should show this and be analogues to our future greenhouse world. We present Late Triassic and Early Jurassic lithological, plant physiognomic, $\delta^{13}C$, soil carbonate pCO_2, and leaf wax n-alkane hydrogen isotopic (δD) data from marine and non-marine records from eastern North America, Peru, and England with an emphasis on the end-Triassic mass extinction (ETE).

Rhaetian cyclicity is muted at all scales, consistent with a damped hydrological cycle under lower pCO_2 (<2,500 ppm) compared to the preceding Norian, while cyclicity is strongly enhanced during the ETE pCO_2 zenith (~5,000 – 6,000 ppm) caused by the Central Atlantic Magmatic Province (CAMP). Cyclicity variance drops again as pCO_2 declines (<2,000 ppm) during the Jurassic.

Marine $^{87}Sr/^{86}Sr$ records suggest the Rhaetian pCO_2 minimum was driven by exposure of the Wrangellia oceanic plateau, while the increase in radiogenic Sr across the ETE was driven by globally enhanced continental weathering associated with the extreme high pCO_2, followed by Jurassic declines as CAMP weathering drove down $^{87}Sr/^{86}Sr$ and pCO_2. In tropical rift valleys flooded by CAMP basalts, lacustrine limestones were deposited after the major CAMP pulses due to transient extreme local weathering.

Pronounced variability in leaf wax δD across the ETE records variations in relative evaporation, tracking other environmental perturbations across the extinction interval, all suggesting strong coupling among the hydrological cycle, carbon pools and expression of orbitally paced cyclicity.

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Seeing Red: The Myth of an Arid Triassic

Whiteside J[1], Olsen P[2], Kent D[3,2], Sha J[4], Fang Y[4]
[1]University of Southampton, [2]Lamont-Doherty Earth Observatory of Columbia University, [3]Rutgers University, [4]Nanjing Institute of Geology and Paleontology

TS5 - 2.6 Geobiology & 2.8 Earth, life and ores, Room R1, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
I am a broadly trained geologist (PhD Columbia University, Earth and Environmental Sciences; BSc Mount Holyoke College, Geology and Biological Sciences) specializing in paleobiological and geochemical proxies with an emphasis on molecular fossils (biomarkers) and their isotopic composition to assess causes and process of mass extinctions and global environmental changes. My work places these extinctions into a broader context of orbital pacing of climate and biotic provinciality informing future climate scenarios and the limits of habitability via mineral-organic matter interactions. The venues for my studies are globally dispersed field expeditions augmented by focused ICDP and IODP drilling campaigns.

The textbook example of an arid period in geological time is the Triassic, with commonly cited red-bed sequences, a mega-monsoon, and an inferred aridification trend. Here we propagate the thesis that this is an artifact of: 1) major metropolitan cites of Europe and the Americas being located in zones that were in the subtropics and higher latitude tropics; and 2) the northward drift of central Pangea across zonal climate belts during the Triassic and Jurassic which broadens the apparent arid zone when viewed through the fog of low temporal resolution. In fact, the Triassic, especially the Late Triassic – the most arid of the arid times – was characterized by an equatorial humid zone and high-latitude humid zones, all of which produce significant coal and black shale deposits of potential or realized economic importance.

Low-latitude arid zones are only apparently broad, because the regions occupied by mid-late 20th century centers of research in Europe and temperate North America translated rapidly northward in the Triassic from the tropics through the sub-tropics, requiring previously unavailable levels of temporal precision to properly resolve.

Equatorial examples of Triassic coal and black shale sequences include rift-basin sequences in southeastern North America and Sonora Mexico and extensive high-latitude coal and black shale deposits occur in southern Africa, Australia, China, and arctic Canada. As the high-latitude (including polar regions) were coal- and black shale- producing environs in the Triassic, and these regions include the polar deserts today, the Late Triassic was actually more humid than the present.

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Triassic Arctic Ice and the Origin and Ecological Ascent of the Dinosaurs

Olsen P[1], Whiteside J[2], Kent D[3,1], Fang Y[4,1], Chang C[1], Kinney S[1], Hemming S[1], Sues H[5], Schaller M[6], Sha J[4]
[1]LDEO/Columbia University, [2]Ocean and Earth Sciences, National Oceanography Centre, University of Southampton, [3]Earth and Planetary Sciences, Rutgers University, [4]Nanjing Institute of Geology and Palaeontology , [5]Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, [6]Earth and Environmental Sciences, Rensselaer Polytechnic Institute

TS1 - 2.3 Mass Extinctions, Room R1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
I am a paleontologist and stratigrapher with degrees in Geology (1978) Biology (1984) from Yale University. My research projects examine patterns of evolution and extinction as a response to and cause of climate change, especially in early Mesozoic continental ecosystems, as well as mapping the chaotic history of the Solar System using climate archives. My research methods include sedimentology, paleontology, geochemistry, geophysics, and time series analysis, frequently employing scientific drilling. I am currently Arthur D. Storke Professor of Earth and Environmental Sciences at Columbia and a member of the US National Academy of Sciences

The Mesozoic is usually portrayed as having a CO2-driven warm and equable climate, in which dinosaurs and pterosaurs evolved during ice-free times. But, four sets of observations suggest that cold, in fact, freezing, was key in not only to their origin, but also their survival through the end-Triassic extinction (ETE) and consequent ecological ascent.

First, the most parsimonious phylogenetic hypothesis has pterosaur and dinosaur insulating filaments as feather homologs. Insulation was thus present in basal dinosaurs conferring selective advantages for cold-climate resource use. Second, Late Triassic continental biotas were profoundly provincial with herbivorous dinosaurs restricted to higher-latitudes where they are among the most abundant tetrapods. High-latitude regions were also extensively vegetated. In contrast, non-insulated pseudosuchians and small non-dinosaurian dinosauromorphs dominated low-latitudes. Third, only small protosuchian and sphenosuchian pseudosuchians survived the ETE, while dinosaurs and pterosaurs were virtually unaffected. The continental ETE is consistent with volcanic-winters of the Central Atlantic Magmatic Province decimating large non-insulated pseudosuchians, allowing dinosaurian ecological ascent. Low-latitude plants were similarly decimated, while high-latitude forms were not. Finally, we have found abundant lake-ice-rafted debris in the Early Mesozoic, coal-bearing, ~70°N Junggar Basin (China) associated with dinosaur footprints. Thus, that region had freezing winters, and dinosaurs were there and could take advantage of the vegetation.

Thus, both the high-latitude restriction of herbivorous dinosaurs during the Triassic and the survival of dinosaurs though ETE volcanic winters, suggest that dinosaurian and pterosaurian success was fundamentally connected with adaptations for cold, specifically insulation and high metabolism.

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Platinum group elements (PGE) occurrence in ultramafic and associated rocks from Piparia-Ramgara tract, Madaura Igneous Complex, Bundelkhand massif, central India

Kumar Singh P[1], Bharti S[1], Kumar Sharma A[1]
[1]*Directorate Of Geology And Mining, UP*

Biography:
MSc Geology, 6 years of experiance in production geology

ABSTRACT:

The major PGE deposits of the world are generally found to be associated with ultramafic/mafic complexes. Likewise, the serpentinized peridotite & talc actinolite schist of ultramafic/mafic enclaves of Bundelkhand Gneissic Complex(~3.3Ga) from Piparia-Ramgara tract district, Lalitpur are PGE containing. Ultramafic rocks comprising dunite & peridotites occur as intrusive in the form of small hillocks at into the granite–gneisses of Bundelkhand Gneissic Complex . Platinum & Palladium value found as 0.023 & 0.014ppm respectively in samples of ultramafics from Piparia area with significant amount of Ni & Cr. These peridotites & Talc actinolite schist rocks are in contact with granitic rocks in the north and dioritic rocks in the south. The talc actinolite schists are highly sheared and deformed. The general trend of rocks of Piparia area is E-W while NE-SW trend is occupied by dykes and veins and major shear direction is also E-W. The preliminary exploration reveals that there are 4-5 ultramafic lenses exposed of 1-2km long and 100-300m width dimension while only 20% of outcrop is found in the area. These Piparia-Ramgara lenses are eastern extension of Ikauna ultramafics(PGE enriched) & bigger dimension indicates that as exploration advances in this tract then Piparia-Ramgara tract will be a potential PGE resource of Madaura- Karitoran area for PGE deposit of Northern India.

KEY WORDS: Bundelkhand Gneissic Complex, PGE, Ultramafic rocks

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Platinum group elements (PGE) occurrence in ultramafic and associated rocks from Ikauna area in Madaura Igneous Complex, Bundelkhand massif, India

K. Singh P[1]

[1]*Directorate Of Geology And Mining, UP*

Biography:

Ph D, Geology, 13 years of pge exploration

ABSTRACT:

The serpentinized peridotite & talc actinolite schist of ultramafic/mafic enclaves of Bundelkhand Gneissic Complex(~3.3Ga) from Madaura-Ikauna tract district, Lalitpur have been found enriched with PGE. Ultramafic rocks comprising dunite & peridotites occur as intrusive in the form of small hillocks at Ikauna in to the granite–gneisses of Bundelkhand Gneissic Complex. The peridotites are dominated by olivine cumulates where precious metal-bearing sulphides crystallized along with pyroxenes, amphiboles subsequent to crystallization of olivine into the interstitial spaces of cumulates during cooling. Ultramafic rocks of Ikauna are characterized by high MgO (up to 30.76 wt%) and Fe2O3 (up to 8.76 wt%); low SiO2 (upto 42.14 wt%) . Platinum value found as high as 2.78ppm in samples of peridotites from Ikauna area with significant amount of Au, Ag, Ni, Co &Cr. These peridotites & Talc actinolite schist rocks are in contact with diorite and granitic rocks in the north and dioritic rocks in the south. The Peridotite(serpentinised), talc actinolite schist & chlorite schist rocks are traced in 3.5 km.in strike length. The margins of peridotites are wrapped by talc actinolite schists, which are highly sheared and deformed. The general trend of rocks of Ikauna area is E-W . The detailed exploration of more than a decade reveals G-2 stage resource of 7 mT of 0.49 ppm PGE grade estimated in Ikauna area. These PGE resources indicate that this area has good potential to be a PGE deposit of Northern India.

KEY WORDS: Bundelkhand Gneissic Complex, PGE, Ultramafic rocks

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Sulfur-oxidising bacteria with transferable genes degrade thiocyanate in mine waste

Watts M[1], Wick R[1], Le Cao K[1], Spurr L[1], Thomas B[2], Holt K[1], Banfield J[1,2], Moreau J[1]
[1]*The University Of Melbourne,* [2]*University of California-Berkeley*

Biography:
Dr. Moreau is a geomicrobiologist who researches microbial community responses to heavy metals contamination in manmade and natural environments. He is particularly interested in microbial species interactions and impacts on biogeochemical cycling of nutrients and trace metals, as well as the evolution of resistance genes in extremophiles. He obtained his Ph.D from the University of California-Berkeley in 2006, and served as a U.S. Geological Survey postdoctoral fellow before taking up his current position at The University of Melbourne in 2008.

Thiocyanate forms upon reaction of reduced sulfur and cyanide in the environment, and is a major waste produce of gold ore processing. Here, we combined a bioreactor experiment with genome-resolved metagenomics to reveal that thiocyanate biodegradation proceeded autotrophically in the absence of added organic carbon. The bioreactor microbial community was, in turn, sustained by sulfur oxidizers, and developed ecological niches both spatially and over time within the bioreactor. A significant shift in community composition occurred at higher temperature. We inferred that multiple plasmid-located genes were involved in carbonyl sulfide utilisation, an intermediate step of thiocyanate biodegradation. Our work represents the first evidence for genes encoding thiocyanate degradation on a mobile genetic element.

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Halokenesis: A Critical Component of the Stratigraphic Architecture and Taphonomy in the Late Triassic of Southwestern North America

Olsen P[1], Huber P[2], Parker W[3], Whiteside J[4]

[1]LDEO/Columbia University, [2]Geoscience Books, [3]Petrified Forest National Park, [4]Ocean and Earth Sciences, National Oceanography Centre, University of Southampton

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:

I am a paleontologist and stratigrapher with degrees in Geology (1978) Biology (1984) from Yale University. My research projects examine patterns of evolution and extinction as a response to and cause of climate change, especially in early Mesozoic continental ecosystems, as well as mapping the chaotic history of the Solar System using climate archives. My research methods include sedimentology, paleontology, geochemistry, geophysics, and time series analysis, frequently employing scientific drilling. I am currently Arthur D. Storke Professor of Earth and Environmental Sciences at Columbia and a member of the US National Academy of Sciences.

Analysis of extensive outcrops and cores of the Colorado Plateau Coring Project (Petrified Forest National Park, AZ, USA - PFNP) suggests that a major control of Late Triassic stratigraphic architecture was halokenesis (salt tectonics) of Paleozoic salt, not tectonics or eustasy. Integration of subsurface information on the distribution of Paleozoic salt basins and present salt structure and surface outcrops in early Mesozoic strata of the American Southwest in Arizona, New Mexico, Utah and Texas demonstrates a clear relationship between apparent unconformities and growth structures in the Late Triassic deposits and show that the distribution of lacustrine taphofacies are directly related to the salt structures. Most structures involve: 1) pronounced folding or tilting of strata along with growth packages nearly unique to the structures themselves that also can be deformed; 2) erosion of most relief on the structures; 3) development of a pronounced angular unconformity above which is often a lacustrine sequence in a gentle sag covering a larger than that of the deformed strata. Where subsurface information is available on the underlying top of the salt surface, these Late Triassic structures lie in salt withdrawal basins adjacent to salt walls. Notably all of the main Triassic localities producing articulated fossil fish are associated with these salt-related basins. At this point we do not know if these structures formed at the same time or represent independent similar sequences of events, although at the PNFP, St. Johns, AZ and Fort Wingate, NM areas, the overlying lacustrine intervals seem correlative.

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The Growth Rate of the Australian Continental Crust

Chen B[1]
[1]*Australian National University*

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Bachelor degree, Jilin University, China
Master degree, Guangzhou Institue of Geochemistry, University of Chinese Academy of Sciences
PhD Student, Australian National University

Continental crust is the record of Earth's history. It generally formed from the mantle and evolved compositionally. However, when and how it formed remain a considerable debate. In-situ U-Pb, Lu-Hf and O isotopic data of detrital zircons from major rivers and sand dunes in Australia provide insights to examine the evolution of Australian continental crust. In this study, we identified U-Pb ages of over 1500 detrital zircons from Australian continent showing five major periods of zircon crystallization, 0.1-0.35, 0.4-0.8, 0.85-1.4, 1.5-2.05, 2.5-3.0 Ga. Our O isotopic data are consistent with the secular evolution of O isotope trend of Valley et al. (2005). The variable O isotope of zircons was used to constrain the 176Lu/177Hf ratios of the crustal source region of the zircons, which were used to calculate Hf model age. However, taking into consideration of general depleted mantle model, New Crust (NC) evolution curve of Dhuime et al. (2011) were adopted to calculate the model age. Thus, at least 25% continental crust formed since the end of the Archean. Moreover, the juvenile proportion of newly formed crust is significant during several major periods: 0.2-0.6, 1.1-1.4, 1.8-2.5 Ga, which may be related to the formation of supercontinents.

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Lithogeochemical discrimination of a fractionated sill at Cowal Gold Mine, NSW, and implications for exploration and resource estimation

Murphy Z[1], Howard E[1], Reid B[1]
[1]*Evolution Mining*

TS8 - 4.2 Mining geology and geometallurgy, Room R6, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Ned Howard is currently the Principal Geologist of Generative Exploration for Evolution Mining Ltd. He has an extensive history of the use of spectral and lithogeochemical methods for both exploration and modelling of ore systems in deposits on the east coast, Western Australia and beyond.

Lithogeochemical analysis can be successfully applied to exploration, mineral resource estimation and mining by providing more accurate and reliable rock classification, correlation and ore characterisation. At Cowal gold mine, a combination of 4 acid digest, ICP-MS multi element geochemistry and portable XRF analysis has been used to define fractionated zones within the Muddly Lake Diorite.
Lake Cowal gold mine (>8Moz Au) is a late Ordovician, structurally controlled, intrusion-associated low sulphidation epithermal deposit hosted in Ordovician volcanic rocks of the Cowal Igneous Complex. The Muddy Lake Diorite (MLD) is a fractionated, intrusive sill consisting of a mafic (gabbro to diorite) margin, and internal dioritic and quartz monzonite zones. At the E42 deposit, the MLD is an important host rock to mineralisation, which manifests differently in different phases of the sill. Fractionation zones within the MLD can be defined from multi-element geochemistry, using Ni, Cr and Sc to define pyroxene trends, Ti and V to identify magnetite fractionation, and HFSE and LILE elements to identify the most highly-fractionated phases of the sill. This fractionated phase shows an average gold abundance of ~0.7g/t, approximately 5 times the average of other phases of the diorite.
The observations above can be used to constrain resource estimation domains, potentially improving reconciliation and tailoring of mining practices. Integration of 4 acid digest ICP-MS multi element geochemistry with pXRF analysis allows cheaper and shorter turnaround times for geochemical analysis and modelling of lithological domains.

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Examining geochemical links between mineralizing fluids in the southern Irish Cu deposits and the Irish Midlands Zn-Pb field

Johnson S[1]

[1]*iCRAG*

TS2 - 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:

Dr Sean Johnson is a SFI Senior Research Fellow and Geochemistry manager in the Irish Centre fro Research in Applied Geosciences (iCRAG). He read Geology at the University of St Andrews, Scotland, before working in mine, exploration and project geology roles. After this he switched to academia and pursued a PhD at CODES, after this he worked as an industry-funded research fellow at CODES, working with companies and running the commercial analysis arm of CODES. He moved to iCRAG in late 2017 but still maintains strong ties with Australia as the GSA Treasurer.

Many studies have utilized sulfur isotopes to understand the processes governing formation of the Zn-Pb deposits of the Irish Midlands. However, no attempts have been made to understand the overall trace element content of the ore minerals in order to understand the nature and tempo of mineralization pulses. Furthermore, almost no geochemical work has been conducted on the copper occurrences in the Munster Basin to the south. This study combines LA-ICP-MS trace element chemistry with in-situ sulfur isotopes from a variety of ore minerals from copper occurrences in the Munster Basin and the Zn-Pb deposits in the southern part of the Irish Midlands in an attempt to understand potential links between the two systems. Detailed structural work in S.Ireland has identified multiple fluid events focusing along the orientation of early extensional structures in the Munster Basin, suggesting that large, early basinal structures were utilized in the movement of metal bearing fluids to form the copper deposits present. Initial geochemical and mineralogical work has identified a late stage fluid is common in the both the copper and the Zn-Pb deposits, and may be co-eval across the region. Presented is our preliminary work using trace element, and isotope geochemistry of the major ore minerals from a variety of different deposits (Cu; Zn-Pb-Cu; and Zn-Pb) in order to identify, and trace, common fluids, and sources, between the two regions. This work may have future implications for camp-scale vectoring, and the identification of potential pathfinder elements to track mineralization events and sources across Ireland.

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Supporting groundwater characterization and management using space geodesy

Castellazzi P[1]
[1]*CSIRO*

TS5 - 3.3.2 New groundwater technologies and approaches & 3.3.5 Groundwater science for policy development and decision making, Room R5, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
My work focuses on understanding how recent developments in geodesy and remote sensing can support groundwater exploration, help evaluate the sustainability of water resources, infer aquifer-system dynamics, and prevent water-related hazards.

In the last decade, remote sensing of the temporal variation of ground level and time-variable gravity data has improved our understanding of groundwater dynamics and storage. Mass changes are measured by GRACE satellites, whereas ground deformation is measured by processing the phase signal of space-borne radar (SAR) imagery. Both methods are complementary and offer different sensitivities to aquifer system processes.
Sentinel-1A and 1B satellites (S1) are constituting the first SAR mission with a fully automated and global acquisition plan, providing freely accessible SAR imagery globally since late 2014. Currently, any study site in Australia is covered by 50 to 120 S1 images, i.e. the time-series are now long and dense enough for precise measurement of ground deformation in almost any land cover settings. InSAR has become widely and cost-effectively useable. While operational use in water science is still limited to InSAR practitioners, it is expected to greatly develop in the near future, along with the continuation of the Sentinel mission and the launch of the NovaSAR satellite in late 2018.
The first GRACE mission has been acquiring time-variable gravity data during 2002-2017. GRACE-Follow-On has been launched in early 2018. This atypical ‘mass field’ vision over water stocks has been one of the major breakthrough of the last decade in quantitative water sciences, even though it is not yet fully understood.
This presentation will explore the advantages and challenges of both methods, explore recent applications, and explain their developments.

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Geoscience and Our Future - A Broad Vision

Shaw B[1]
[1]*Ore Control*

TS2 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Bill has over 40 years of experience in economic geology including mineral resource and ore reserve estimation, mining grade control, sampling studies and mining project evaluation. He has operational experience in gold and ferrous metals and has audited mineral resources and ore reserves for many commodities to international standards.
He has many voluntary roles including on JORC, VALMIN and IMVAL for the AusIMM and AIG. He is currently the President of the Australian Geoscience Council, on the Executive of UNCOVER AUSTRALIA, was involved in preparing the Australian Academy of Science Decadal Plan for Geoscience, and is the Chair of the AGC Convention (AGCC 2018) to be held in Adelaide during Earth Science Week.

The AGC has focused on Education and Advocacy. Our achievements are helping provide a strong base for the future, with the AGC Convention now established as an inclusive forum for communication within and about our science, in our Region. Other bodies like the NCES, GA, CSIRO and a multitude of special interest groups are also part of the 'grand conversation' about Geoscience and all are collectively part of our future.

The National Committee for Earth Sciences has championed the Decadal Plan for Geoscience and this provides a vision for the future, of which many aspects are being addressed in this forum. The vision is clear and will continue to develop.

Geoscience provides and characterises the framework for all life in that it defines location, mineralogy (chemical structure) and the constantly evolving physical constraints of temperature, pressure and time.

Resource management in the broadest sense is about knowing what we have and how we can maximise our utility. It is about a lot more than minerals, energy, water, land use, and hazard mitigation.

Geoscience is about the past but it is poised to become the science of the future. It cultivates skills about deep time and space, massive datasets, and complex fuzzy systems. By broadening our understanding of what Geoscience is about and offers, we become a more inclusive science that provides options and pathways forwards.

By mapping the potential pathways of our Geoscience future we can define the required investment to achieve broad social benefits.

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Mapping alluvial gully environments using regolith terrain mapping techniques

Thwaites R[1], Brooks A[1], Zund P[2], Spencer J[1]
[1]Griffith University, [2]Department od Environment and Science

TS5 - 4.1 Geohazards, risk and mitigation, Room R7, October 17, 2018, 3:30 PM - 5:30 PM

Biography:
Robin Thwaites is a Soil Geomorphologist currently at Griffith University, having worked natural and land resource science for over 35 years in both public and private sectors. His interests have been in landscape development and land resource science and management in natural environments as well in the forestry and agricultural industries in S Africa and Australia.
Robin has been a researcher and lecturer at The University of Queensland, co-ordinating the Land Resource Science programs, at QUT, co-ordinating the Environmental Science program, as well as a private consultant in soils, geomorphology, and land rehabilitation for the resources industries in Queensland.

Introduction
Investigations into alluvial gully erosion in Great Barrier Reef (GBR) catchments require new tools to describe and classify the suites of soil and sedimentary materials, sometimes in complex associations. A combination of regolith-terrain and 'soil materials' mapping approaches is being developed for alluvial gully erosion management and rehabilitation purposes.

Methods
Soil material mapping is being carried out at two major alluvial erosional gully research sites at Strathalbyn Station on the Burdekin River, and Crocodile Station in Cape York Peninsula. The mapping approach comprises the concept of regolith-terrain units which can be based on gully system catchments and soil-material units. This particular system has been used in erosional/depositional environments before, but this is the first attempt to use the system in alluvial environments, for which it is particularly suited, and where conventional techniques are limited.

Field description and sampling was carried out by
- soil coring up to a maximum of 2.0 m, around and beyond of extent of gully system;
- vertical and lateral observations of exposures within gullies in long- and cross-profile within selected gullies,
- a soil-material layer description approach.

Regolith Terrain Unit mapping, using catchments, and Soil Materials conceptual modelling were employed to create Soil Material Systems and Soil Material Units of the soil-sediment layers.

Outcomes
The project has produced outputs that are technically and scientifically acceptable whilst still appropriate for the gully management and rehabilitation purposes. The system presented here will be eventually produced with formalized guidelines for use in all alluvial gully systems.

789

A Technical Classification for Erosion Gullies in Queensland

Brooks A[1], **Thwaites R[1]**, Spencer J[1], Pietsch T[1], Daley J[1]
[1]*Griffith University*

TS7 - 5.2 Prediction, process, place: Geomorphology & 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Robin Thwaites is a Soil Geomorphologist currently at Griffith University, having worked natural and land resource science for over 35 years in both public and private sectors. His interests have been in landscape development and land resource science and management in natural environments as well in the forestry and agricultural industries in S Africa and Australia.
Robin has been a researcher and lecturer at The University of Queensland, co-ordinating the Land Resource Science programs, at QUT, co-ordinating the Environmental Science program, as well as a private consultant in soils, geomorphology, and land rehabilitation for the resources industries in Queensland.

Introduction
The focus on erosion gullies as part of research and management development to reduce sediment and nutrient loads in the Great Barrier Reef (GBR) has led to a requirement for a common nomenclature usage, a comprehensive generic classification, and a communication tool for land resource managers and authorities in GBR catchments.

Methodology
A versatile approach is required. The field identification and characterization are a linked, relational module (Field Module) that is employed subsequent to the generic, broader scale taxonomic concept, ‘desktop’ approach (Spatial Module). The Field Module for assessment and typing will be eventually developed into a field guide with photo-referencing relating to the generic gully classification.

Spatial Module classification: core criteria that relate to morphology and processes as well as environmental conditions:
- Geomorphic – Slope shape and type; gully shape and complexity; erosion processes; parent material domain; catchment area
- Vegetation cover
- Climate – Rainfall regime
- Soil-sediment materials

The module is based on the best DEM data available; soil and material type; drainage pattern and is sensitive to environmental and data scale complexity. This leads to a grouping of types to four broad categories of potential sediment yield for prioritization of action and rehabilitation methods.

The conceptual approach taken is hierarchical, with modifiers to the core classifier criteria.

Classifiers: Landscape Domain; Gully Pattern; Contributing Catchment Area; soil material types

Modifiers: complexity of the system; secondary incision; vegetation cover.

The Field Module is an aggregative field-scale observational (mapping) structure with land management/rehabilitation purposes foremost.

790

Large Australian earthquakes since 1964

Stepin B[1]
[1]*Geoscience Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:
Geophysicist with a background in seismic processing and seismology.
Early career physicist having had involvement in the international aerospace industry changed career to earth observations.

This poster shows large earthquakes occurring in Australia since 1964. Also included are images produced as part of the analysis of the Meckering WA Earthquake -, the Cadoux WA Earthquake-, the Tennant Creek NT Earthquake -, and the Newcastle NSW Earthquake. A breakdown of number of quakes by magnitude in Australia as well as the top 10 Australian earthquakes is presented.

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CO2CRC Otway Project - Assurance Monitoring and Verification of a CO2 Storage Site

Schacht U[1]
[1]*CO2CRC, University of Adelaide*

TS2 - 3.2.3 Petroleum and its co-products & 3.2.5 Geoscience aspects of the storage of energy related waste, Room R2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Ulrike holds a BSc in Geoengineering Sciences and Applied Geosciences, a MSc in Applied Geochemistry (both from the Technical University of Berlin) and a PhD in Marine Geochemistry from the University of Kiel, Germany. In January 2007 she joined the CO2CRC at the Australian School of Petroleum, University of Adelaide. Her research currently focuses on the geochemical monitoring and verification of CO2 storage sites.

Assurance Monitoring is a key regulatory requirement for CO2CRC's Otway Project in Western Victoria, Australia. It provides for the generation of clear, comprehensive and accurate information that effectively and responsibly manages environmental, health and safety risks associated with the injected CO2. Further, it provides the necessary assurance to the local community that the carbon storage activities at the Otway Site are being managed in a responsible manner.

Assurance monitoring and verification at the Otway Site began in September 2005, two and a half years before the first CO2 injection commenced in March 2008. Since then CO2CRC Ltd has made progressive improvements to the monitoring and verification program of the Otway Site, using the learnings of past years to adapt this program to the specific needs of the site.

The presentation will provide an overview of the Otway Project, while focussing on the challenges associated with monitoring and verification of CO2 storage sites, and how these were overcome to benefit the Otway Project.

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LANDSLIDE PATTERN CHANGES IN NEO-TECTONICALLY ACTIVE HIMALAYAS, INDIA

YADAV D[1]
[1]CSJM UNIVERSITY KANPUR, U.P.

Biography:
I have Teaching (Three years) and Research (Four year) experience in the field of Environmental Science, Remote Sensing & GIS, GPS technology,Disaster Management, Natural Resource Management, Biodiversity, Pollution Monitoring and its impact on environment.

I have presented several oral and poster presentations in National and International level conferences and attended more than 30 trainings, workshops also visited Canada and worked with IITR-CSIR, RSAC-UP and many reputed national institutes, recently coordinating IIRS, ISRO outreach training programme.
I have been awarded for the "Teaching Contribution as Science Faculty" in women day 2018 by Chhatrapati Shahu Ji Maharaj University (C.S.J.M.U.) Kanpur- 208024, U.P.

4. Steep bedding
5. Excessive water (Rainfall/Cloud burst/Toe cutting by Ganga river)
6. Strongly fractured rocks due to multiple sets of joint planes
7. Removal of soil and vegetation cover due to road building and widening activity

The study suggests that there is more than one causes which makes this Himalayan tract susceptible to mass destruction by way of imbalance in various factors of stability. The paper discusses these aspects in the light of climatic conditions, surface and ground water conditions, rock stability and anthropogenic causes.

Key words: Landslide, Pattern, Neo-tectonic, Himalaya

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PETROGENESIS AND AGE OF THE MIRKANI GRANITOIDS, LOWER CHITRAL, PAKISTAN

Anjum M[1,2], Arif M[1], Pease V[2], Wohlgemuth-Ueberwasser C[2,3]
[1]Department Of Geoogy, University Of Peshawar, [2]Stockholm University, [3]Holmholtz Centre Telegrafenberg

TS7 - 1.1.7 Advances in volcanology and igneous geochemistry, Hall A, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
The presenting author is a PhD Scholar and Lecturer at Department of Geology, University of Peshawar and has recently submitted his PhD thesis for evaluation. He also holds a BSc, MSc and MPhil from the same Department. His field of interest include understanding the magmatism processes and their related mineralization in the Himalayas, Pakistan. Mr. Naveed has been teaching at BS and MS level at Geology Department, University of Peshawar. He has also worked as a PhD researcher under the supervision of Professor Vicky Pease at Department of Geological Sciences, Stockholm University, Sweden during 2015-16.

The Mirkani granitoids constitute the westernmost continuation of the Kohistan batholith (KB). They comprise diorite, quartz-diorite, granodiorite and granite of calc-alkaline, peraluminous to metaluminous compositions. Geochemical characteristics, e.g. relatively high Mg, low total rare earth element (REE) abundances, high Na2O/K2O (mean=3.58), lack of Eu anomaly and relatively high large ion lithophile/heavy REE ratios demonstrate their essentially un-fractionated character. Enrichment in highly incompatible elements (Rb, Ba, Th and U) and depletion in high field strength elements such as Nb and Ti suggest that the rocks formed through fractional crystallization of mantle-derived low- to medium-K mafic magma emplaced in an oceanic volcanic arc setting. These features are comparable to other oceanic arcs such as New Britain, Izu-bonin Mariana, Lesser Antilles and Sierra Maestra Cuba. U-Pb zircon dates indicate that the bulk of Mirkani granitoids crystallized at c. 120 Ma (120 ± 1 and 121 ± 2, 2σ errors). These are the oldest crystallization ages reported from the KB and coincides with the development of an Andean-style margin farther north that resulted in the emplacement of the Tirich Mir and Bune-Zom plutons.

Unlike their eastern counterparts, the Mirkani granitoids are un-deformed and un-metamorphosed despite their older ages and proximity to the Main Kohistan-Karakoram suture. This observation suggests that directed stresses along the east-west extension of the Kohistan-Karakoram suture have been markedly heterogeneous in both space and time. It further implies that the 3-stage subdivision of the KB into oceanic volcanic arc, Andean-arc, and post-collisional granitoids can not be applied to the study area.

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Incremental evolution or radical transformation in mineral exploration - A case for change, Discovery 2.0

Rowe R[1]
[1]UNCOVER

TS3 - 3.4 Resources sustainability – responsible investment and management, Room R2, October 17, 2018, 9:30 AM - 11:00 AM

Biography:
Geologist with 30 years of experience in technical leadership and management of generative, greenfield to brownfield exploration programs in gold and copper throughout the Australia, Africa and Asia Pacific region.

In 2014 he founded NextGen Geological to provide strategic, management and technical advice to organisations associated with the minerals resources industry, mining and exploration companies.

Robbie is a Registered Professional Geoscientist in the field of Mineral Exploration with the AIG and a member of the AUSIMM and SEG. He is an Adjunct Senior Research Fellow at The University of Western Australia, School of Earth and Environment.

The trend of mineral discovery over the last 65 years is a story of two halves. During the adoption of new geophysical technologies, low level geochemistry and ore deposit knowledge the industry embarked on an era of discovery we know as ‘modern exploration’. This led to a period of growth in new discoveries that peaked in the late 1980’s. Post 1990 the numbers of new discoveries steadily dropping.
At the same time as new discovery rates were falling there has been exponential increase in identified resources. However, the increase in resources has not translated into an increase on non-ferrous commodity production rates. Many undeveloped resources remain challenged in converting to new mines and this despite the largest mining investment cycle in history from 2003 -2012.
We can conclude that although modern exploration is efficient at identifying mineral endowment in the near-surface, decreasing conversion rates into production highlights a decrease in economic viability of these new added resources. Reduction in economic discovery performance is best explained by increasing maturity of the near surface search space.
We know that re-setting the exploration maturity clock is possible by successful opening the undercover search space. Based on performance of undercover exploration it is becoming clear the modern exploration tool-kit, is not sufficiently effective. Addressing this capability gap through either evolutionary or radical transformational change is the single major challenge the industry now faces. New knowledge, technologies, data, and business models are now required to re-modernise exploration and transition from Exploration 1.0 to Discovery 2.0.

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Does Solar SME associated with particles prepare ground for ionospheric purturbance and confuse in Pre seismic signature of TEC accumulation

Verma U[1]

[1] State Innovative CouncilPlanning And Development Department Govt. Of Bihar,india, [2]Rtd Head of the department of geology patna University, [3]GIS Vancanuar,Canada, [4]Physics department Bihar University

Biography:

As a researcher in seismic precursory devlopment got success in developing astrogeophysical modelling and electromagnetic models based on Maxwell theory. Well analyses and expertised in Dealing with the EM signals processing and analysis work to interpretation.I have been successfully forecasting no of sesimic events on global basis with implication precursory tools, Illustrative are Pakistan 7M on 23 rd sep2013, Iran 6.8 in April 2013 , Nepal 2015 with 7.8 M and Mexico with 7.9 M in 2016 Equadore 7.1 M in 2016 May, Japan 6.8 in2017 .All are evident through my page earthquake update by u.p.verma on fb Google.

On number of prior seismic events of major magnitudes data on solar activity assigns Outburst associated with SME. These are particles released into terrestrial atmosphere and ionosphere causing ionospheric purturbance.Variation in status of existing electric field due to available electron density gets enhanced and brings about variation in magnetic field components .it exact variation prior the seismicity in the crustal block.Feature associated with the solar activity are sometimes caused to disturb the angular momentum and initiate the release of stress in the crustal block accumulated for duration and brings release of geophysical and geochemical changes in the lithosphere contact and thus initiate balance with the purturbance created due to solar activity. In consequent manner released holes carrier and electronic charge from within the rocks under stress prepare ground for electrical field in vertical as well as hoeizantal direction. Depending upon amount of released stress magnetic component amounts greater causing symptomatically pre seismic signature.

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DOES EXPONETIAL VARIATION IN VERTICAL COMPONENT OF GEOMAGNETISM ASSIGN PRESEISMIC SIGNATURE AT A SITE OF OBSERVATION BY EM SIGNALS?

Verma U[1], SINHA M[2], CHOUBEY A[3]
[1]Planning And Development Department Govt. Of Bihar,india, [2]PATNA UNIVERSITY GEOLOGY, [3]director ,Shri ganesh electricals , [4]Physics department Bihar University

Biography:
AS A TEACHER IN SCIENCE AND RESEARCHER IN SEISMOLOGY I COULD GET SUCESS IN DEVELOPING FIVE TO SIX UNIQUE PRECURSORS BASED ON EM SIGNALS AND ELECTROMAGNETIC THEORY Based on Maxwel equation.Ton global basis since 2011 . had been sternly successful popular seismic events viz pakistan 2013 7,6m sep24-26,japan 2011 tsunami march11, mexico 7.7m 2016 and nepal 2015 with 7.-9M on 25 April.page earthquake update by u.p.vwerma as quite conspicuous and evident to this,

Continuous monitoring of EM signals and its various parametric elements like magnetic components , electron flux and X-ray flux have interesting features prior seismic events.Data recorded on different important seismic events like Nepal 2015 with 7.9M Mexico 2016 7.6 M Iran Afghanistan border with 6.7 m on 2016 dec again Burma Indo border on 2017 January with6.8 M have shown more or less similar variation in the geomagnetic data and its components' nature. Recorded information by satellites on real time basis from NOAA Goes 12,13 and 15 have depicted the rise of MMC component specially vertical one Z direction exponentially rising by there to five days prior the events.
It merely be the coincidence or basic fundamental reason depending on analyzed by Maxwell theory of Electromagnetic wave generation and their propagation into ionospheric envelop.Extending from Lithospheric subsurface conjugation EM wave progresses into atmosphere by two fundamental distinct components electric and magnetic.
Key words:Ionospheric purturbance, Magnetic component, Lithosphere contact, EM signals, X-ray flux, NOAA.

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U-Pb ZIRCON CHRONOLOGY INTEGRATED WITH SEDIMENTOLOGY PROVIDES NEW INSIGHT INTO THE INCEPTION AND PERMIAN HISTORY OF THE SOUTHERN SYDNEY BASIN

Bann G[1], Jones B, Nutman A, Alcorn C
[1]University Of Wollongong

D1P - Day 1 Poster / Drinks Exhibition, GeoEXPO, October 15, 2018, 5:30 PM - 6:30 PM

Biography:
Continuing part time research from an Hons project almost 20 years ago,

The Sydney Basin formed in the back arc region of a Gondwanan Permian-Triassic arc system. In the southern Sydney Basin Permian Gerringong Volcanics (GV), several mafic and felsic tuffs are newly identified, interspersed with shallow marine sedimentary rocks. Some of these tuffs are laterally extensive, and hence are chronostratigraphic markers. Trace and body marine fossils, including death assemblages, are often associated with the tuffs, as are dropstones of extrusive and plutonic igneous material, both mafic and felsic, from igneous events prior to the first recognized flows of the GV. These dropstones were probably transported via coastal sea ice due to short and long term climatic cycles.
U-Pb zircon geochronology of the GV tuffs has been initiated in order to obtain a numerical chronology on the Permian southern Sydney Basin stratigraphy. These tuffs have been relatively ignored compared with dating the stratigraphically higher tuffs around the Permian – Triassic boundary. Preliminary SHRIMP U-Pb zircon dating on the GV tuffs has produced complex Permian zircon age spectra, indicating recycling of volcanic material from previous volcanic events admixed with zircons from the syn-depositional eruptive event. Numerous dykes in the southern Sydney Basin have been reported as being post-Permian in age. A late Triassic dyke at Bombo (Kiama) contains numerous gabbro inclusions with an uppermost Carboniferous U-Pb zircon age, sourced from a deep crustal gabbroic pluton formed at the inception of the Sydney Basin. However, many other dykes were intruded into unconsolidated wet sediments, hence are more likely to be associated with the GV.

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DISPLACEMENT OF MEGA BOULDERS ACROSS COASTAL ROCK PLATFORMS SOUTH OF WOLLONGONG, AUSTRALIA, BY LARGE STORM WAVES OR TSUNAMI?

Bann G[1], Nott J[2], Weiss R[3], Jones B[1]
[1]University Of Wollongong, [2]James Cook University, [3]Virginia Tech

TS6 - 1.3 Marine geoscience - The evolving oceans, Hall E1, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Has a background in geology and environmental science, lives at Jervis Bay and enjoys finding interesting things when undertaking field work.

Much work has been done on the movement of mega boulders along the New South Wales southern coastline, with the cause usually being attributed to periodical tsunamis, or large waves caused by unusual events. This research reports of mega boulders displaced across coastal rock platforms south of Wollongong, NSW. In some cases imbrication of these blocks is evident, whilst others have been moved laterally across the platform. The original in-situ position of one can be determined, weighing ~15 Tonnes has moved 42m across the platform and rotated 110o. More movement has occurred more recently, of ~1m sideways whilst being rotated back 50º. Much larger boulders, one at ~160 T. has been observed to move a few metres and another at ~100 T. has moved ~10m and rotated ~15º, both up a 13º rough rock platform, in the past 5 years. Quantitative analyses suggest that waves of considerable height and wave length are required to lift and displace these boulders across the platforms, however, results are problematical. Additionally, no tsunamis have struck the coast during this time. A new inversion model based on Newton's Second Law of Motion is adapted as to test whether storm waves or tsunamis are causative processes for boulder transport. This new model includes the boulder movement initiation and the basic physical processes of transport after the dislodgement. Therefore, this research contributes to the growing body of information regarding the capabilities of large storm waves along coastlines, particularly applicable to climate change and associated sea level rise.

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Establishing preconditions for trust and social acceptance: Applying the science of social licence

Walton A[1], McCrea R[1], Measham T[1]
[1]*CSIRO*

TS4 - 3.2.1 Future energy mix & 3.2.6 Using geoscience to address social licence concerns for energy projects, Room R5, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
Andrea is a social scientist with CSIRO's Adaptive Communities and Industries group. Since commencing with CSIRO in 2011, her work has included social science research into community resilience and wellbeing, social licence to operate, social acceptance and trust, and perceptions of risk and benefits in relation to contested industries and resources extraction. She has also delivered projects for the Gas Industry Social & Environmental Research Alliance (GISERA) investigating community expectations and social impacts associated with unconventional gas development in communities of the Surat and Gunnedah Basins.

Initial engagement with communities provides an opportunity for establishing vital first impressions that can underpin trust and acceptance of a new project. This presentation summarises findings from experimental research that tests the effect of providing different types of information to community members about a new resource development. The research analysed the effect of adding information about local benefits, company engagement plans, opportunities to have a say, and governance processes on people's views about a new mining development and their subsequent behavioural intentions to engage with or oppose the project. The research also included different types of resources (iron ore, coal, tech metals, and unconventional gas) and state-based differences in its analyses. The research found that providing early information to residents about engagement plans and governance had a significant and positive effect on attitudes, acceptance, and behavioural intentions. In contrast, while benefit information had a positive effect on perceptions of fairness it did not translate to significant changes in acceptance or behavioural intentions. This work builds on previous research that identifies the importance of initial engagement from a social licence perspective.

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Back to Basics-Deciphering Rank, Type and Grade Variation

Esterle J
[1]University of Queensland School of Earth and Environmental Sciences

TS6 - 3.2.2 Energy from coal, Room R2, October 18, 2018, 9:30 AM - 11:00 AM

Biography:

Following completion of her PhD, Joan undertook a post doctoral fellowship in New Zealand prior to joining the CSIRO in 1992 where she advanced from a junior scientist to a group leader in Coal Geoscience. In 2004 she joined the UQ part time and later GeoGAS-Runge Ltd as a coal seam gas consultant. In 2010 she joined the UQ full time, taking up the chair of the Vale-UQ Coal Geoscience Program. Further information on Joan's research is available on http://www.uq.edu.au/energy/esterle.

Whether coal deposits are being targeted for mining as metallurgical or thermal feedstock, for extraction of coal seam gas, or potentially future sources of rare earth elements, their quality and response to exploitation will be controlled by rank, type and grade. Techniques used to characterise coal under static and dynamic conditions have become increasingly sophisticated since the days of Seyler, Stopes and van Krevelen, with automated scanners that generate big data both downhole and on core for petrophysical, mineral and elemental properties, to synchrotron studies of pinhead size samples. In the latter, the GIGO principle must apply, and generally, the results are interpreted with respect to thermal maturity (rank), inorganic (grade) and organic (type) composition. Where these correlations disconnect, something disturbed the balance, and we search for variations in the processes operating from deposition, through burial, tectonic deformation coupled with igneous intrusions, uplift and interaction with surface weathering or groundwater circulation. To decipher the story, we still use the cross cutting relationships recognised by Steno, at all scales, but we also use isotopes of the organic, mineral and gas components to track and verify the paragenesis leading to the quality, and therefore utility of the deposit. This yields a powerful tool to predict variation in coal quality that will ultimately control the efficiency of utilisation, and management of coal resources. Similar to real estate, it's all about location, both through geological time and today, and examples of these processes operating in the Bowen Basin and elsewhere can guide the story.

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Optimising mineralogical interpretations by combining hyperspectral infrared spectroscopy with X-ray fluorescence-enhanced X-ray diffraction analysis

Wawryk M[1]

[1]*Geological Survey Of Western Australia*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:

Michael Wawryk graduated with honours in Geology from the University of Western Australia in 2016, studying the isotopic ratios and geochronology of shock detrital zircons from distal ejecta of the Acraman impact crater. Michael joined the Geological Survey of Western Australia (GSWA) in 2017, where he coordinates the daily operation of the GSWA HyLogger-3 (WA node of the National Virtual Core Library, and processes and interprets the hyperspectral infrared drill core data. Michael also routinely performs validation and mineral interpretation using other techniques, including X-ray diffraction, X-ray fluorescence, energy-dispersive X-ray spectroscopy and scanning electron microscopy.

Mineralogy of drill core and outcrop specimens is now routinely and rapidly determined by hyperspectral infrared spectroscopy using the HyLogger-3 instrument. However, current limitations of this analytical technique commonly lead to mineralogical misidentification, or even failure to “see” mineral species in particular specimens. Such ambiguities in mineral identifications may be resolved with X-ray fluorescence (XRF) and X-ray diffraction (XRD) data. Conversely, inconclusive XRF and/or XRD analyses may be clarified using infrared spectroscopy. We illustrate with several case studies a routine workflow in which we “simultaneously” apply HyLogger-3 and desktop XRF/XRD analyses to optimise mineralogical interpretations.

Semi-quantitative XRF analysis of visually logged fuchsite (Cr-mica) in core from diamond hole DD84MF1 (Fortescue Basin, Western Australia) indicated significant Cr content, but XRD could not positively distinguish it from other structurally similar micas. However, the HyLogger-3 provided confirmation with characteristic 435nm and 632nm absorptions of octahedrally co-ordinated Cr^{3+}. Retgersite (a hydrous Ni-sulfate) in core from diamond hole GDD001 (Youanmi Terrane, Western Australia) yielded no distinguishing infrared features, but was readily identified using XRF and XRD by its Ni content and distinct diffraction pattern.

Automated hyperspectral analysis of a mystery silicate in a specimen of the Greenbushes pegmatite (GSWA 201965) could not unequivocally identify the mineral phase. However, XRD analysis readily identified this mineral as the zeolite analcime from the large analcime 211 peak at ~5.60 Å and absence of a large pollucite 321 peak at ~3.66 Å. XRF analysis measured significant Cs, indicating that the analcime is a Cs-rich member of the solid-solution series.

802

Are we there yet? – Effectiveness of handheld IR spectrometers for exploration and mining.

Pontual S[1]
[1]*AusSpec International*

TS7 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Dr Sasha Pontual, a leading expert in spectral geology, is the MD and founder of AusSpec, a spectral geology solutions company founded in 1992. AusSpec has developed and sells the aiSIRIS cloud-based spectral interpretation solution to minex companies. Sasha was one of the first independent consultants working in providing spectral analysis services to the minex industry globally. In the last 25 years, she has played an important part in the industry take up of the technology. aiSIRIS is the realisation of Sasha's desire to make spectral geology accessible to all geoscientists and embodies 25+ years of experience.

Hand held spectrometer spectral data are on the verge of becoming an integral part of the toolkit geologists use for modelling alteration systems. Its tipping point will be when geologists and geochemists truly understand the value add of these data in assisting them to better understand the geochemical signatures when evaluating alteration histories.

Within the Minex community the use of handheld spectrometers is a poor cousin to portable XRF. Poor data handling, incomplete mineralogy, and lack of standardisation have contributed to its low uptake to date.

This paper discusses a new machine learning-based method for processing hand held spectral data. It has been refined using a very large training set of real world spectra from a wide range of geological settings. The method is built for rapid analysis of large spectral data sets, to provide accurate and consistent results.

Case studies will demonstrate that the routine application of this technology, when combined with geochemistry, will allow geologists to improve their geological, geotechnical and geometallurgical models.

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Modern seafloor hydrothermal systems associated with submarine arcs: how prospective are they for Cu-Au mineralization?

de Ronde C[1]
[1]*GNS Science*

PS3 - Plenary Session: Resource Security Into The Future (Hall C), Hall C, October 17, 2018, 8:30 AM - 9:30 AM

Biography:
Dr. Cornel de Ronde has been researching submarine hydrothermal systems related to intraoceanic arcs for more than 20 years. He leads the offshore minerals group at GNS Science in New Zealand. Together with his group, he has worked extensively with scientists from NOAA and WHOI in the US, in particular, but also others from Germany, Japan, Australia and Italy discovering, surveying and sampling seafloor hydrothermal systems around the world. Dr. de Ronde and his team have been at the forefront of research into massive sulfide mineralization associated with submarine arc volcanoes and has employed various deepsea assets such as manned submersibles, ROVs and AUVs to better access and ultimately understand these systems. Recently, he was co-chief scientist aboard the JOIDES Resolution that drilled Brothers volcano as part of the IODP Brothers Arc Flux expedition.

Scientific discovery of submarine hydrothermal systems associated with intraoceanic arcs, and to a lesser degree backarcs, has been continuous and largely systematic since the first methodical survey in 1999 of plumes discharging from volcanoes of the southern Kermadec arc. Since then, systematic surveys for hydrothermal activity have occurred all along the Kermadec-Tofua, Mariana and Aeolian arcs, with more ad hoc surveys of individual volcanoes along the Izu-Bonin, New Hebrides and Tabar-Lihir-Tanga-Feni arcs.
The introduction of deepsea vehicles, such as manned submersibles, ROVs and AUVs, has facilitated more focused studies on these arc hydrothermal systems, placing any mineralization in an appropriate geophysical, geological, structural and geochemical context, and at a scale that is applicable to ore deposit formation. The pinnacle of scientific endeavor on volcano-hosted hydrothermal systems has come with the recent drilling by IODP of Brothers volcano, Kermadec arc.
The majority (~70%) of submarine arc hydrothermal systems are dominated by magmatic volatiles and acid fluids (pH of 2). Disproportionation reactions involving SO2 and H2S are common, with a related mineral assemblage of predominantly native sulfur, polymorphs of silica, natroalunite and pyrite (± kaolinite ± bornite). Systems that are host to ‘black smoker’ vents (with fluid temperatures ≤320°C) and massive sulfide mineralization account for ~25% of the hydrothermal systems surveyed, and have a related mineral assemblage of smectite, illite, chlorite, kaolinite, pyrite, sphalerite and chalcopyrite. These systems appear to be older and associated with seawater-dominated hydrothermal circulation cells. Evidence exists for remobilization of metals from depth to the seafloor and immediately below.

804

Next generation applied geoscience for the complex orebodies of the future

Valenta R[1]

[1]WH Bryan Mining & Geology Research Centre SMI UQ

TS7 - 4.2 Mining geology & geometallurgy, Hall E3, October 18, 2018, 11:30 AM - 1:00 PM

Biography:

Rick Valenta is the Director of the WH Bryan Mining and Geology Research Centre at the Sustainable Minerals Institute at The University of Queensland. Prior to that, he spent 23 years in Exploration and Development with major and junior mining companies in Australia and Canada in senior technical and executive roles. He has been involved in numerous mineral discoveries and research relating to exploration targeting. His current role is focused on maximising the value of geological information in the entire exploration and mining continuum

It is now well-documented that for many commodities we are facing a future of supply gaps, decreasing grades, and increasing orebody complexity. It is also very likely that those supply gaps will not be met by new discoveries and recycling alone, and a significant contribution will have to come from presently unviable “complex” orebodies. In the case of copper, only approximately 25% of currently undeveloped orebodies could be made viable by price rises or more traditional “bigger is better” mining and processing innovations alone. The rest face social, permitting and legal challenges which will have to be met through drastic changes in corporate social performance and transformative reductions in project footprints. Geoscience has a key role to play in this, through development of the tools and understanding which will facilitate higher resolution and more rigorous definition of the orebody characteristics and variability which will allow more flexible and low footprint mining and processing. A review of progress in the five years since the production of an industry-driven geometallurgical roadmap has been carried out through a survey of journal and conference publications in the area since 2013. This review has shown that there has been significant progress against some identified gaps (eg perceived lack of case studies) whilst other gaps (eg better analysis and visualisation tools) have received very little attention. Overall, a range of significant gaps remain which will have to be addressed in order for geoscience to play a role in unlocking the complex orebodies of the future.

806

Is Technology Helping Us?

Buerger R[1]
[1]*Mining Plus Pty Ltd*

TS8 - 4.2 Mining geology and geometallurgy, Room R6, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Richard is a qualified Geologist (with Honours) and has over 20 years' experience in the resources industry, the majority of which have been in Mine Geology. Richard has experience in multiple commodities (gold, nickel, copper, zinc and lead) on a number of continents. Richard's broad expertise in the resources industry includes: resource definition and estimation, grade control, reconciliation, resource/reserve audits, cost modelling and staff development and mentoring. Richard is particularly skilled at identifying the key strengths and weaknesses in teams and operations and is able to then develop strategies to maximise the value generated by these operations.

Is technology helping us?

Mining Geology is a relatively simple pursuit – we collect geological and grade data for the purpose of telling a truck whether to turn left to go to the waste dump or right to go the Process Plant. The hardest parts of our job is to not get this wrong and for the trucks that have turned right, to maximise the revenue within that truck. That means that every piece of information we collect from the deposit has to be done quickly and accurately enough for us to make that call efficiently. Recent advances in technology have enabled us to collect greater amounts of information than we have ever been able to and also given us the processing power to collate and analyse them quickly. Why then, are we still seeing mining operations struggling to make the most of their orebody? Are we collecting the wrong information? Are we not processing it and interpreting it quickly enough or correctly? Are we so busy learning about and playing with our cool new toys that we forgot the geology and whether the truck has to turn left or right? Technological advances are awesome, but only if they allow us to make our decisions quicker and more accurately – do yours?

807

All hands on deck! Voyage 1 for the Collaborative Australian Postgraduate Sea Training Alliance Network (CAPSTAN)

Moore L[1], Armand L[2], Abbott A[3], Dadd K[4]
[1]Institute for Applied Ecology, [2]Australian-New Zealand International Ocean Discovery Program Consortium, [3]Collaborative Australian Postgraduate Sea Training Alliance Network, [4]School of Geosciences

TS8 - 5.3 Geoscience, education and professional development (AUGEN Symposium), Room R8, October 18, 2018, 3:00 PM - 4:30 PM

Biography:
Teaching and researching in: Regolith Geology, Hydrogeology, Siliciclasitic Sedimentology, Clay Mineralogy, Engineering Geology, Physical Volcanology
Specialisation: Earth and Environmental Science Education, Science Education (Curriculum), Science Teacher Education

The marine national facility RV Investigator was commissioned in 2014, triggering a national response from university and stakeholder groups to form the Strategic Marine Alliance Research, Teaching and Training initiative, CAPSTAN. This program aligns current developments in higher education postgraduate learning with development of an applied shipboard curriculum. The program delivers contextualised learning in the marine science, geoscience, oceanography, marine biology, engineering, physics, communication and teaching discipline areas. The vision is that CAPSTAN will enhance Australian marine student qualifications, scientific outputs and reputations, increase the use of national scientific infrastructure, and provide a platform for generational, institutional and industry knowledge transfer and collaboration. The inaugural CAPSTAN voyage from Fremantle (WA) to Hobart (TAS) took place in November 2017 and involved students and trainers from across Australia. Participants engaged in a structured workshop program that complemented their rotation through five scientific stations: marine bird and mammal survey; oceanography and hydrochemistry; water column organisms (plankton); marine sedimentology and geophysics (bathymetry, sub-bottom profiling). Individuals were introduced to marine safety procedures, learned shipboard protocols and etiquette, undertook shift-based work programs, and participated in logistical and scientific planning. This presentation will review the preliminary scientific findings of the inaugural CAPSTAN voyage and evaluate the STEM education experience for students and trainers.

808

Geometallurgy at Olympic Dam: mineralogical characterisation at the deposit scale, why it matters

Ehrig K[1], Liebezeit V[1], Pewkliang B[1], Li Y[1], Macmillan E[1], Smith M[1]
[1]BHP Olympic Dam

TS7 - 4.2 Mining geology & geometallurgy, Hall E3, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Kathy lead the team of metallurgists and geologists who developed and executed the complex testing program to characterise the mineralogy and geometallurgy of the Olympic Dam breccia-hosted Fe-oxide Cu-U-Au-Ag deposit. While geometallurgy only emerged as a discipline in the early 2000s, Kathy has always focused on the ways that minerals behaved in the processing plant, recognising that value is only realised when revenue is gained from those minerals. She has contributed significantly to the development and application of professional knowledge and practice in the fields of mineralogy, geochemistry and geometallurgy.

The breccia hosted Olympic Dam Fe-oxide Cu-U-Au-Ag deposit (IOCG-U) is one of world's largest metalliferous resources. In addition to Cu, U, Au, Ag, the deposit also contains geochemically anomalous concentrations of F, S, C, As, Ba, Bi, Cd, Co, Cr, Fe, In, Mo, Nb, Ni, P, Pb, Sb, Se, Sn, Sr, Te, V, W, Y, Zn and REE. Each of these elements, in fact most elements in the periodic table, occur as a major element and/or as a minor to trace constituent in minerals. Over 100 minerals occur within and are spatially zoned across the Olympic Dam deposit. Hence as the deposit is sequentially mined, the mineralogy of ores delivered to the processing facilities and waste delivered to long-term storage facilities will vary over the operating life of the mine. Minerals, not elements, exert the primary control on metallurgical processing performance. The Olympic Dam geometallurgy program is designed to identify all minerals within the deposit, measure the quantitative abundances of the minerals, determine the mineralogical deportment of all process critical elements, characterise the impact of all minerals on the extraction process and produce predictors of short-, medium-, and long-term metallurgical performance which are used for process design, production planning, optimisation/expansion studies and closure planning. Across the mining industry, as mineable grades of deposits continue to decrease and the concentrations of process deleterious minerals/elements continue to increase, deposit scale mineralogical characterisation should be a significant component of all studies which access the economic viability of extracting metals for any deposit.

809

Future Geoscience

Terry J[1]
[1]*BHP Billiton*

TS7 - 4.2 Mining geology & geometallurgy, Hall E3, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Jill completed a BSc Honours in Geology at the University of Melbourne in 1984 and post-graduate Mineral Economics (Macquarie University) in 1987. She commenced employment as a mine geologist with Newmont Holdings at Telfer Gold Mine in 1985 and has worked in various senior and chief/manager roles in mine, project, resource/exploration geology at Boddington Gold Mine, OK Tedi Mine and Sepon Mine before commencing a BHP Billiton resource evaluation role in 2006. She is currently accountable for excellence in Geoscience and public reporting of Mineral Resources and Ore Reserves. She has held the role of Vice President Geoscience since 2014.

Geoscience of the future will be fundamentally different to the current state. Education, training and workforce planning will be as critical for success as technology development and application. Fully automated mines will prevent geoscientists from manually collecting data. Sensor technology will enable real time, quantitative data collection, augmented by machine learning and artificial intelligence. Resource scientists will add value by applying technical knowledge to select and position sensors to optimise data collection, fine-tune interpretation and inform accurate real-time planning and extraction decisions. Similarly exploration geoscientists will overcome terrain and access challenges by remotely collecting data through deep cover to optimise target assessment.

810

The role of Geomorphic Research in Great Barrier Reef Water Quality Management

Brooks A[1]

[1]The Centre for Coastal Management, Griffith University

TS6 - 5.2 Prediction, process, place: Geomorphology, Room R8, October 18, 2018, 9:30 AM - 11:00 AM

Biography:

Dr Brooks' is a fluvial geomorphologist with 24 years experience undertaking research throughout Australia on river process dynamics and rehabilitation. His team's research recasting our understanding of sediment sources to the Great Barrier Reef (GBR)was recently recognised through the award of the 2017 Eureka Prize for Environmental Research.

His early research focused on the extent to which Australian rivers have changed as a result of European land use; particularly changes associated with alterations to riparian vegetation and large wood as a control on river channel morphology, sediment transport and aquatic ecology. He has subsequently undertaken extensive research on river restoration approaches and has pioneered the technique of using Engineered Log Jams (ELJs) as a river restoration tool in Australia. He has been involved in numerous river restoration projects in Eastern Australia, notably as lead CI on a large ARC linkage project; the Upper Hunter River Rehabilitation Initiative. He has spent the last 15 years undertaking research on the geomorphology of Australia's tropical savannah rivers – particularly throughout the Gulf of Carpentaria, Cape York and Burdekin, highlighting the significance of alluvial gully and bank erosion as dominant erosion processes in Northern Australia. From 2007-2011 he was a program leader within the Tropical Rivers and Coastal Knowledge (TRaCK) program. Since 2009 his primary focus has been on understanding the sediment sources to the Great Barrier Reef World Heritage Area (GBRWHA), and has led projects funded through various Australian and Queensland Government programs focused on developing improved methods for identifying and predicting bank and gully erosion in GBR catchments. He is currently working on a number of projects focused on alluvial gully and stream bank rehabilitation in GBR catchments.

The Great Barrier Reef World Heritage Area (GBRWHA) is an international asset that is under threat from a range of stressors, both at a global scale through ocean warming and acidification, and regionally through impaired water quality and crown of thorns starfish outbreaks, which are linked to water quality. Whilst Australia can contribute its part in mitigating climate driven stressors, for the most part addressing these impacts requires a global response. Water quality, however, is solely our responsibility, and there is increasing evidence that elevated sediment and nutrient loads delivered to the reef are largely a function of land-use driven exceedance of thresholds of stability in river channels and floodplains prone to alluvial gully erosion. In this presentation I will discuss how geomorphologists have led the way in undertaking the research that has identified the primary sources of sediment and nutrients threatening the GBRWHA, and how they are also driving the research into the solutions to the problems. In the last two years the Australian and Queensland Governments have both initiated major programmes focused on rehabilitating gully and streambank erosion, which represent the source of at least 80 percent of the pollutants delivered to the Reef lagoon. These programmes represent the first steps in the journey to turn around more than 100 years of landscape degradation and associated declining water quality. Ironically one of the biggest constraints we now face is a lack of suitability qualified geomorphologists, and soil conservation specialists following decades of neglect to a once vibrant profession.

811

Identifying new exploration opportunities in a mature basin

Trend S[1]
[1]Esso Australia Pty Ltd

TS2 - 3.2.3 Petroleum and its co-products & 3.2.5 Geoscience aspects of the storage of energy related waste, Room R2, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Sarah Trend is the Asia Pacific Exploration Director for ExxonMobil Exploration Company, with responsibility for operations across the region, including Papua New Guinea, Australia, and Malaysia, as well as new opportunities.

An active mentor, Sarah has developed and taught courses in forward seismic modeling, asset business planning, and inclusion & diversity. She holds a Bachelor's Degree in Earth Sciences from Dalhousie University and a Master's Degree in Exploration Geophysics from the University of Calgary.

Sarah is a registered Professional Geoscientist and member of the Society of Exploration Geophysicists.

Innovation and technology have long driven changes in the world's energy landscape and the petroleum industry. A few decades ago, many explorers drilled primarily for oil, and may have viewed a natural gas discovery like coming second in the Melbourne Cup. There was traditionally a huge perceived difference between the first prize – oil – and the consolation prize - gas.

Changing market fundamentals, both globally and within Australia, mean that natural gas is now a hot commodity. The abundance and versatility of natural gas make it a valuable energy source to meet a wide variety of needs, while also helping the world shift to less carbon-intensive sources of energy.

To help meet this growing demand, Esso Deepwater Gippsland is in the midst of an exciting exploration program specifically targeting natural gas in Bass Strait.

Generating new exploration concepts in a mature basin – especially one that's been producing nearly fifty years – requires a combination of improved technology and a culture that fosters innovation.

Seismic reprocessing, including proprietary algorithms, has enabled the identification of interesting new concepts and leads on the VIC/P70 exploration acreage. This technology would be worthless without a team that is willing to challenge its biases, many of which are deeply ingrained after evaluating this basin for decades.

Leveraging world-class technology with an innovation mindset has resulted in our first Gippsland exploration drill wells in nearly a decade. This combination will support continued exploration as we seek opportunities to meet Australia's growing energy needs.

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Uncertainty Quantification for Informed Decision-Making

Minnaikhmetov I[1]
[1]BHP

TS7 - 3.1.2 Making better exploration decisions through an integrated geoscience approach & 3.1.3 Understanding mineral systems for exploration – from craton to micron scale, Hall E2, October 18, 2018, 11:30 AM - 1:00 PM

Biography:
Ilnur is Principal Geoscientist in Numerical Modelling and Data in BHP, Perth,WA. He finished his PhD in Applied Mathematics and Physics in Moscow Institute of Physics and Technology. During his study Ilnur worked on developing and implementing basic geostatistical algorithms for oil-gas modelling software. In 2013 Ilnur started his postdoc in COSMO Lab, McGill University. During the following three years he developed high-order simulation methods for optimization of mining complexes. Last year Ilnur joined BHP and currently working on improvement of resource estimation practices and quantification of uncertainty. His area of interest is stochastic simulations, multi-dimensional approximation, and machine learning.

Uncertainty quantification is critical for informed decision-making processes in the mining and oil-gas industry. Conventional deterministic approaches use assumptions of Gaussianity of input variables and linearity of value-transfer functions, e.g. value chain in mining, hydrodynamic system in sub-surface reservoirs. However, in reality these value-transfer functions are quite non-linear and comprise multiple sources of uncertainty (geological, geometallurgical, geotechnical, financial, etc). The paper will demonstrate limitations of deterministic approaches using several examples of non-linear systems and highlights the advantages of stochastic approaches in uncertainty quantification processes

813

A potential 370 ka disparity between the initiation of the Terrestrial and Marine end Permian Mass Extinction events

Nicoll R[4], Fielding C[1], Mays C[2], Vajda V[2], Crowley J[3], Frank T[1], McLoughlin S[2], Bocking M[5], Holmes E[6], Bodorkos S[4]

[1]Department of Earth & Atmospheric Sciences, [2]Museum of Natural History , [3]Isotope Geology Laboratory, Boise State University, [4]Geoscience Australia, [5]Bocking Associates, [6]Geological Survey of NSW

TS1 - 2.3 Mass Extinctions, Room R1, October 15, 2018, 11:00 AM - 1:00 PM

Biography:

Worked for BMR, Geoscience Australia, consultant, 1971 to present as palaeontologist - stratigrapher. Now focused on CA-IDTIMS zircon dating of ashfall tuffs.

Three CA-IDTIMS U-Pb dates from an exposure of the top Illawarra Coal Measures – basal Narrabeen Group in southern Sydney Basin of eastern Australia strongly suggests that the Terrestrial (plant) extinction took place some 370 ka prior to the end Permian Marine Mass Extinction as dated in the Meishan GSSP section in China. The date from a black shale that directly overlies the Bulli Coal (dated as 252.60 my) contains zircons dated as 252.31 my and the contained flora reflects a post-extinction flora (post-glossopterid community), possibly more typical of the Early Triassic rather than the underlying Permian. The overlying bed is dated as 251.31 and as such is earliest Triassic.

Regardless of the age of the sample, the recovered flora of the overlying sediments is considered to be typical of the Early Triassic. Efforts are currently underway to locate additional zircon bearing samples to confirm this occurrence. The project also seeks to understand possible mechanisms that explain why a terrestrial flora extinction might have taken place prior to the marine extinction event that is related to the main focus of the Siberian Traps volcanism dated as occurring between 251.941 ± 0.037 and 251.880 ± 0.031 ma (beds 25 and 28 at Meishan).

814

Provenance and Structure of the Yancannia Formation, Southern Thomson Orogen: Implications for the Tectono-stratigraphic Evolution of the Cambro-Ordovician Western Tasmanides

Wong S[1], Collins W[1], Hack A[1], Huang H[1]
[1]*University of Newcastle*

D2P - Day 2 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 16, 2018, 5:30 PM - 6:30 PM

Biography:
Sebastian is a current Geoscience Australia Graduate, where he has worked on a groundwater, mineral and hydrocarbon potential project in the East Kimberley, and a 3D seismic interpretation project in the central Thomson Orogen. Sebastian has worked as a Geologist in the minerals and energy industries, and for the Geological Survey of New South Wales. In addition to hard-rock earth science based roles, Sebastian has worked on a broad range of projects ranging from palaeoclimate and glaciology, to biology and environmental sciences.

The late Cambrian Yancannia Formation is a small isolated basement exposure located in northwestern New South Wales. The Yancannia Formation offers a rare glimpse of the composition and structure of the mostly covered basement rocks of the southern Thomson Orogen. It consists of deformed fine-grained, lithic-rich, turbiditic metasediments, suggesting deposition in a proximal, low-energy deep-marine environment. A 497 ± 13 Ma U-Pb zircon analysis provides its maximum depositional age, the same as previously published for a tuff horizon in a correlative unit. Analysis of sedimentological, geochronological and geophysical data confirms the Yancannia Formation belongs to the Warratta Group. There is no sedimentological evidence for deposition following the Delamerian Orogeny, suggesting the group is syn-Delamerian. However, no geochronological or structural evidence for Delamerian orogenesis was observed, suggesting that the group was either unaffected by Delamerian orogenesis, or that no record currently exists. Provenance of the Warratta Group bears strong similarities with the Stawell Zone Saint Arnaud Group, whereas units east of Yancannia have similar provenance to the Lower Ordovician Girilambone Group. This suggests an early genetic link between the Lachlan and Thomson orogens. Structural analysis indicates major D1 structures were associated with tight-to-isoclinal folding, penetrative cleavage, and abundant quartz veining of probable Benambran age. Later dextral transpressional deformation (D2) produced a sporadic, weak cleavage and dextral faulting, possibly of Bindian age. Major south-directed thrusting (D3) on the adjacent Olepoloko Fault occurred in the early Carboniferous and appears to predate a later deformation event (D4), which was associated with kink folding.

815

Digital Earth Australia - Analysis of the remote sensing time series to understand the land surface

Lewis A[1]
[1]*Geoscience Australia*

TS2 - 4.4.3 Geoscience data delivery & 4.4.2 Understanding the Surface, Room R7, October 15, 2018, 3:30 PM - 5:30 PM

Satellite images captured over the last 30 years are a unique source of big data covering all of Australia. Recent developments in remote sensing are converting these images into quantitative measurements of the land surface - suitable for visualisation and for analysis as time series. Digital Earth Australia (DEA) is a world leading program for the analysis of these datasets to produce a range of products with diverse and often unforeseen applications. Applications include, for example, improved morphotectonic mapping of structures controlling ground-water, re-thinking of patterns of pre-European colonisation of Australia, mapping the terrain of Australia's intertidal zone, and visualisation of coastal change. Agricultural productivity and sustained natural resources management are being enabled as farmers, regulators and others exploit these information sources. For extractive industries these datasets contribute to the pre-competitive geoscience knowledge base. They may also help to establish and retain social licence to operate, by providing quantitative yet highly visual information on the temporal and spatial context for activities.

1630

Using surface and groundwater models to conduct cumulative impact assessments: the Bioregional Assessment Programme

Post D[1]
[1]*CSIRO*

TS2 - 3.3.3 Pre-competitive geoscience data and information to understand groundwater systems & 3.3.4 Evaluating the potential impacts to groundwater from resource development, Room R5, October 15, 2018, 3:30 PM - 5:30 PM

Biography:
Dr Post has been a research scientist with CSIRO since 1999 and his research interests focus broadly on the impacts of landuse and climate change on water resources, as well as on the regionalisation of hydrologic response to ungauged areas. He has a PhD in Resource Management from the Australian National University and is President of the Modelling and Simulation Society of Australia and New Zealand (MSSANZ). Currently he is Projects Director of the Bioregional Assessment Programme. This programme is investigating the impacts of coal seam gas and large coal mining on water resources and water-related assets across Australia.

Cumulative impact assessments are a valuable method for determining the impacts of multiple stressors on water resources. These have important application in assessing competing demands for water, as well as determining who is responsible for impacts that may require compensation to be paid. Carrying out cumulative impact assessments is not a trivial task. Typically, it involves multiple hydrological and other models in order to adequately represent the range of stressors that may impact water resources. The Bioregional Assessment methodology presented here is one way of carrying out a cumulative impact assessment. It has recently been applied to determine the cumulative impacts of multiple coal resource developments on water resources and associated water-dependent assets in Australia. It involved running a chain of models to understand how impacts might propagate from a mine site to water-dependent assets, which may be many kilometers away. Firstly, a conceptual model was built in order to represent the pathways via which hydrological changes could propagate through the system. Secondly, a geological model was built to represent the deep earth system in a way that could be codified into a groundwater model. Thirdly, a groundwater model was built to represent the impact of the depressurisation of aquifers both laterally and vertically. Fourth, surface water-groundwater interactions were modelled and changes propagated from the groundwater system to the surface water system. Fifth, these changes in surface water were modelled using both catchment and river routing models. Finally, the impacts of these changes in hydrology on ecosystems were modelled.

1633

Development of Geopark and Geotourism: Experience from Malaysia and Asia Pacific Region

Komoo I

TS4 - 5.1 Geology in Society: geotourism and geoheritage, Room R8, October 17, 2018, 11:30 AM - 1:00 PM

Biography:
IBRAHIM KOMOO, PhD, FIGM, FASc, DSNS, is Distinguished Professor at Langkawi Research Centre (PPL), Institute for Environment and Development, Universiti Kebangsaan Malaysia. He graduated from Universiti Kebangsaan Malaysia (UKM) in 1976 and obtained his PhD from Strathclyde University, Glasgow in 1979. He has held various management positions in Universiti Kebangsaan Malaysia (UKM): Head, Department of Geology; Director, Institute for Environment and Development (LESTARI UKM), (1998-2000 and 2001-2005); Deputy Vice Chancellor (Research and Innovation), Universiti Kebangsaan Malaysia (2005 - 2008); Founder Director/ Chair of Southeast Asia Disaster Prevention Research Institute (SEADPRI-UKM) (2008-2012)(2015-2016); Special Advisor to Minister of Higher Education, Malaysia (2011-2013); and Vice Chancellor of Universiti Malaysia Terengganu (UMT) (2012-2015).

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His fields of specialization include Engineering Geology (landslide; geohazards management); Environmental Geology (geoheritage conservation; geotourism; geopark); and Sustainability Science (environmental sustainability; regional sustainable development). As a scientist, he has published more than 50 books, and more than 330 scientific papers. He has also published numerous articles for public awareness in magazines and newspapers. He has served as Vice President, International Association for Engineering Geology (IAEG) (1998-2003); President, Geological Society of Malaysia (1998-2000); Vice President, Institute of Geology Malaysia (2000-2001); Council Member, Academy of Sciences Malaysia (ASM) (2010-2012); and Coordinator, Asia Pacific Geoparks Network (APGN) (2007-2017). Currently, he is Head of Natural Resources and Environment Cluster of the National Council of Professors (MPN); Vice President, Global Geoparks Network Association (GGN); Vice-Chair, UNESCO Global Geoparks Council; Council, UNESCO Global Geoparks; Expert/ Evaluator, UNESCO Global Geoparks; Advisor of Langkawi UNESCO Global Geopark; and Chair of Iskandar Malaysaia @ UTM.

He was appointed as Fellow, Institute of Geology, Malaysia (FIGM) (1995) and Fellow, Academy of Sciences, Malaysia (FASc) (2002). He received Darjah Dato Setia Negeri Sembilan (DSNS) conferred by the Sultan of Negeri Sembilan (2007), Langkawi Award (2009), Emeritus Professor UKM (2012), Science Excellence Award 2012 (Environmental Geology) from International Union of Geological Sciences (IUGS) (2013), Malaysia Geoscientist Award (2013); Honorary Member of Geological Society of Malaysia (GSM) (2014) and Langkawi Tourism Personality Award (2015).

Geological heritage or geoheritage is the most important component in a geopark. It represents a basic requirement in creating a geopark.In Malaysia, the movement towards mapping and assessing the value of geoheritage started in 1996 together with the establishment of the Malaysian Geological Heritage group (WGM). The nationwide mapping of potential geoheritage was conducted through collaboration efforts between WGM and the Department of Minerals and Geoscience, Malaysia. From 1996 to 2010, we have described and assessed more than 150 geosites in published in a series of 9 books entitled 'Geological Heritage of Malaysia'. These documents are the knowledge foundation for the development of geosites for geotourism activities and geoparks in Malaysia. Based on the understanding of geosites, we managed to establish Langkawi Islands as a national geopark in 2006, and a member of Global Geoparks Network (GGN) in 2007. Since than, Langkawi Global Geopark has become a focal reference point or experiential learning site for many countries in Asia, particularly for those who aim to develop their own geopark in Japan, Vietnam, Korea, Indonesia and Thailand. Geosites (geological and geomorphological features) development is the building blocks or basis for the establishment of geoparks and geotourism activities. Based on the Malaysian experience, this presentation will highlight the need to properly develop geosites as conservation entities, and how to utilise geosites for geopark development and geotourism products.

Keywords: geosite, geopark, geoconservation, geotourism & sustainable use.

1635

Resource-driven development of northern and regional Australia

Blewett R

BIIG4 - Resource driven development of Northern and Regional Australia, Hall C, October 16, 2018, 1:30 PM - 3:00 PM

Biography:
Dr Richard Blewett (General Manager - Minerals Systems Branch), Geoscience Australia, with carriage of the minerals component of the new Exploring for the Future programme. He has responsibility for leading GA's minerals science programme and the promotion of Australia as an attractive investment destination for minerals exploration. Richard graduated 1st class Hons in Geology from Swansea University (Wales) in 1985 and a PhD in structural geology from Leicester University (UK) in 1989. Richard joined GA in 1990 as a research scientist and has worked in a number of minerals-related mapping projects across many of Australia's mineral provinces.

Australia's mineral, energy, water and soil resources have delivered enormous benefit to national, state/territory, shire and local economies. The development of Australia's resources has powered Asia's industrialisation and urbanisation, which is reflected in more than $188 billion in 2017 exports. Australia attracted record investment in 2017, with more than $315 billion of Foreign Direct Investment in mining, which is almost 40% of the national account. The mining and METS sector employ more than 1.1 million Australians. Many of these jobs are technical and high paying, with salaries more than 65% higher than all-industry average.

Despite the impressive economic benefits, the ongoing and future development of resources faces a number of challenges and community concerns. Resource development directly impacts on those who live in the regions, including Traditional Owners, pastoralists, residents of towns and cities, as well as resource company workers and those who service them. Urban and city residents who are not directly impacted have mixed views regarding the merits of resource development. It is clear we need a more informed dialogue; one that is inclusive of all stakeholders and one that is informed both by the 'matter of facts' and the 'matter of concerns'.

Australia, due its long and diverse geological history, is blessed with a resources inventory that is the envy of the world. Much of the development has come from relatively well-known regions that were discovered decades or even a century ago. Despite this there remain large areas of the continent that are underexplored, which present opportunities for new discoveries.

Aboriginal and Torres Strait Islander people have lived and prospered for more than 65,000 years in Australia; making them the oldest continuous culture on the planet. The deep domain knowledge and connection to country of Traditional Owners is central to this unique culture. Because of this, and Native Title rights, access to work and potential development of resources 'on country' requires sensitive negotiation and mutual agreement.

Protecting the environment and the sustainability of resource-driven development is topical. Developing resources requires energy and with declining ore grades and deeper ore bodies, the trend is for more energy used per unit of metal recovered. Australia is the driest inhabited continent and all development intersects water in some way. For example, community groups such as ‘Lock the Gate’ have challenged the unconventional energy industry largely based on concerns about water. In contrast, other community groups favour development as a way of diversifying local economies, injecting fresh capital and ensuring opportunities remain in regional and northern Australia for locals to live and work.

Regional towns like Mt Isa, Kalgoorlie and Broken Hill depend on an ongoing pipeline of new discoveries to sustain the infrastructure, jobs and people. Replacing the inventory is essential as over the past decade there has not been a Tier 1 (world class) discovery in Australia. Ongoing exploration and new ways of exploring with new concepts and technology is required.

The Australian resources industry is the most productive and innovative in the world. They will need to continue to innovate if we are to unlock the hidden resource potential that undoubtedly lies beneath cover in the under-explored greenfield areas of the continent. They will need to do this with the acceptance of the community, ensuring all stakeholders are included.

Governments play major a role in resource development through regulation and the administration of the business operating environment. Governments also play a key role in creating the knowledge-base that lowers the technical risk of exploring in greenfield areas. They do this through pre-competitive geoscience initiatives, such as Geoscience Australia’s Exploring for the Future programme, which aim to attract investment through providing greater geological certainty around resource potential. Australian geological surveys lead the world in geoscience information, which is essential for robust evidence-based decision making for all stakeholders.

This session will explore the perspectives of four different stakeholders by examining the question “what will a prosperous and sustainable northern and regional Australia look like by 2050 and how can the resource potential be maximised for the mutual benefit of all Australians?”

1638

Geological Assessment and Landslide Risk Mitigation at Bulli Pass, Princes Highway, Illawarra Region, NSW

Flentje P, Hunter A[2]
[1]University of Wollongong , [2]GHD

TS6 - 4.3 Engineering geology – from underpinning our civil infrastructure to mine closure, Room R6, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Dr Phil Flentje has research Interests that span across the disciplines of Geomorphology, Engineering Geology and Geotechnical Engineering. Working primarily in the area of Landslide Risk Management, Phil's expertise lies in the areas of field techniques, mapping and remote Landslide Monitoring in near real-time, GIS techniques and landslide Susceptibility modelling using Data Mining and landslide frequency assessments.

Phil works along the east coast, mainly within NSW and has long term (20 years plus) industry partnerships with Wollongong City Council, the NSW Roads and Maritime and Sydney Trains.

The Bulli Pass section of the Princes Highway is a 100 plus year old two lane road that traverses steep slopes of the Illawarra Escarpment, about 11km north of Wollongong, NSW. It supports an annual average traffic of 15,000 vehicles per day. It is an important arterial road for the northern suburbs of Wollongong and it also connects t to Mt Ousley (M1 Princes Motorway) and Appin Roads - important commuter conduits to both Sydney and southwestern Sydney. The pass has a long history of landslide events dating from 1890. A recent significant o event occurred on 17 August 1998 during 1 in 100 year plus 6 hour peak intensity rainfall event, which resulted in an estimated 30 slide, debris flows and numerous large rockfalls. This event partially inundated and trapped about 15 cars.

A number of methods were used to investigate the geology, the hazards and assess risk at the site. This has included research into the landslide history, geomorphological mapping, acquisition and review of airborne laser scanning (ALS) data, review of rainfall data and the development of a landslide volume-frequency model. The development of this model allowed hazards to be readily communicated and risks to be assessed. Following a cost-benefit design process, the RMS selected a series of Geobrugg Shallow Landslide and Debris Flow Barriers. These have been installed in a two phase construction program in 2016 and 2017. This project recently won an Award at the Institute of Public Works Engineering Australia Conference (November 2017).

1639

Our energy trilemma options - security, accessibility and sustainability

Godfrey B

BIIG3 - Our energy trilemma options - security, accessibility and sustainability, Hall C, October 16, 2018, 11:00 AM - 12:30 PM

Biography:
In June 2017, Australian Chief Scientist Dr Alan Finkel released "Blueprint for The Future - Independent Review into The Future of The National Electricity Market". Interruption of supply and pricing projections of electricity and gas around the country are raising concern. Diminishing coal and gas reserves, worries about nuclear energy options and environmental agitation about unconventional gas (fracking and the "shut the gate" movement) all sit uneasily with the Australian public. How can the Geoscience community provide objective science to quell the alarmists and move forward in the face of this dilemma?

Bruce's career has been built in business, innovation investment, government, and technology development fields. He has focused on the advancement and commercialisation of technologies (particularly new energy technologies ranging from solar cells to fuel cells to low emission coal utilisation), investment readiness of products and companies, and innovation policy and programs.
A Fellow and Director of the Academy of Technology and Engineering, he is also the Chair of their Energy Forum. He has Chaired expert working groups for the Australian Council of Learned Academies on Delivering Sustainable Urban Mobility (2015) and on Energy Storage (2017).

Australia is undergoing an energy transformation that promises to intensify over the coming decades – the transition to clean energy is irreversible.

In the electricity generation sector, renewables are becoming the cheapest utility-scale generation source; steep battery cost declines and multiple energy storage options are making "firm" renewable power an economic reality and unlocking new value-generating use-cases; and the electricity system is becoming increasingly more distributed at all power generation levels.

Meanwhile Australian coal exports make up a third of the internationally traded coal with approximately 180 million tonnes/year supplying the power generation sector in developing countries. It is the source of over $57 billion in export earnings to Australia, and forecasts suggest this demand will remain and grow even as a broad portfolio of electricity generation technologies are exploited globally.

The contents of Australian geological pore space also continue to yield for us very valuable resources such as gas, oil and water. In a carbon constrained world, this pore space is taking on new and increasing value through carbon capture and storage (CCS), necessary to deliver a low emissions future for fossil fuel energy – whether for electricity or industrial manufacturing.

In the USA, shale gas arose through private sector adoption of government-funded applied research in rock mechanics, fluid flow, material science and drilling, and the USA is unexpectedly on the path to becoming a net energy exporter. Less well known is the shale gas impact on emissions. The displacement of coal-fired generation by natural gas is the principal reason for the recent significant decrease in the USA's CO_2 emissions, with coal-fired generation now projected to drop below 30% from a high of 50%.

In Australia, interruption of supply and the pricing of electricity and gas around the country are of high concern to energy consumers and politicians. Conflicted by the need to decarbonise the energy system – be it at the domestic household level, commercial and industrial, electricity, heating or transport – Australians are seeking energy that is clean, reliable and low cost. This is a conundrum not easily overcome. Finding agreement among policy makers, regulators, technology advocates and activist groups has, in recent years, resulted in a lot of 'dirty words' as options for a 'clean world' are debated at local, State/Territory, national and international levels.

How then does the lay public make decisions about how their energy is generated? What information and decision-making tools will assist the public to determine whether to provide their social licence to operate? Who can they trust to seek information on the topic? Is information even helpful at this stage?

An important question for the geoscience community is how its members provide objective science and data to support regulators, quell alarmists and move the debate forward. Since large energy systems change slowly, the ability to carefully engineer the subsurface is a vital component in the global move towards cleaner energy – and it must be done with transparency and safeguards to ensure safety and environmental protection.

1642

KEYNOTE: From Rocks to Robots: Life beyond Geosciences

Keay S

TS2 - 5.5 Planning the future of Geoscience, Room R8, October 15, 2018, 3:30 PM - 5:30 PM

This presentation would be a personal account of my own experiences navigating a career in Geosciences before abruptly changing path after a postdoctoral research fellowship. It will cover navigating new careers and how eventually I was able to incorporate geosciences back into my career in the form of a board advisory role. The presentation will also tackle diversity in the geosciences, the ongoing challenges facing women in STEM, the importance of role models and why diversity is important, especially in the tech sector.

1643

Advances in Robotics and Computer Vision and what this means for the Australian Resources Sector

Keay S

PS5 - Plenary Session: Applied Geoscience - Geohazards, Risks and Society (Hall C), Hall C, October 18, 2018, 8:30 AM - 9:30 AM

Biography:
Recognised as Superstar of STEM by Science & Technology Australia, Sue is a trained scientist with highly developed business skills, Sue runs the world's first robotic vision research centre. The Australian Centre for Robotic Vision, headquartered at QUT, has more than 200 researchers distributed across Australian and overseas research institutions. By creating robots that see and understand their environment, we will finally reach the tipping point where robots can assume capabilities that have previously only been imagined. With a PhD in Earth Sciences, Sue escaped the lab to move into research management and commercialisation where she has demonstrated national leadership. With interests in entrepreneurship and disruptive technologies, she is a judge for the James Dyson Awards, a graduate of the Australian Institute of Company Directors and serves on the Board of the CRC for Optimising Resource Extraction and the Advisory Board of Brisbane.AI.

It is only recently that computer processing power has been sufficient to allow robots to take advantage of computer vision techniques. Using cameras we can significantly expand the usability of robots. Many roboticists consider that we are finally at the tipping point, where, in the near future, we will see robots become more visible, no longer confined to warehouses and factories but out and about amongst us, safely helping with everyday tasks. This presentation will give an overview of findings from the recently published “Robotics Roadmap for Australia” will explore Australia’s uptake of robotics, its application in the resources sector, and what the future might look like if Australia can harness the natural advantages it has in the development of many robotic and vision technologies.

1645

Inversion in fold and thrust belts and in passive margins – basement controls on structural styles

Gharabeigli G[1], Hammerstein J[1], McClay K[1], Scarselli N[1]
[1]*Fault Dynamics Research Group, Department of Earth Sciences, Royal Holloway University of London*

TS1 - 1.2.1 Understanding basin formation and evolution from a plate-tectonic perspective, Hall A, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Ken McClay is Professor of Structural Geology, Department of Earth Sciences, Royal Holloway University of London. He graduated with a BSc Honours degree in Economic Geology from Adelaide University, has an MSc in Structural Geology and Rock Mechanics, a PhD in Structural Geology from at Imperial College, University of London and a DSc from Adelaide University.

Since 1991 he has been Professor of Structural Geology and Director of the Fault Dynamics Research Group at RHUL. Current major research projects include tectonic evolution of the Northern Chilean Andes, tectonic evolution of the Zagros fold belt, fold and thrust belts in accretionary terranes and on passive margins, extensional tectonics of the NW Shelf and the southern margin of Australia, and inversion tectonics.

Ken has carried out wide-ranging research on all aspects of structural geology applied to both the mining and petroleum industries. This has included extensive field-based research, scaled analogue modelling of fault and fold structures as well as seismic studies of both extensional basin systems and contractional terranes. Ken has written a book for mapping structures in the field, edited four major volumes on Thrust Tectonics, and has published widely on structural geology and tectonics. He is a consultant for the international mining and petroleum industries and has given many short courses to industry.

Many sub-aerial fold and thrust belts display characteristics of both thick-skinned and thin-skinned structural styles. This-skinned systems typically form critically tapered Coulomb wedges whereas thick-skinned systems form plateau-like uplifts bounded by reactivated steep basement faults. Reactivation of inherited, older basement structures, particularly those formed in rift systems and during the evolution of passive margins is particularly evident in many Cenozoic orogens – in the Sub-Andean basins of South America, in the Alps and Pyrenees as well as in North Africa and also in the Zagros fold and thrust belt. Inversion of passive margin extensional faults is evident on the southern and western Australian margins.

Inversion structures are usually broad, doubly-plunging anticlines with significant relief separated by complex, commonly tight synclines. Examples are described from the Sub-Andean basins of Argentina and Peru as well as from Papua New Guinea, the Atlas fold belt of North Africa as well as from the Zagros. Inherited basement structures compartmentalize these fold and thrust belts formed stepped topographies, lateral and oblique ramp systems. In passive margins and in many rift basins inversion is commonly subtle but significant in terms of producing structural culminations that set up many hydrocarbon traps. Evolutionary models are derived for inversion controls in sub-aerial fold and thrust belts as well as for those in passive margins.

1648

Good Geoscience means more gas; more gas means more clean, reliable and affordable energy

Ovenden B[1]
[1]Santos Ltd

TS1 - 3.2.3 Petroleum and its co-products, Room R2, October 15, 2018, 11:00 AM - 1:00 PM

Biography:
Bill is Executive Vice President Exploration and New Ventures for Santos, and joined the Company in 2002. He is accountable for developing and executing a targeted exploration and appraisal strategy across Santos' core asset hubs, while identifying new high value exploration opportunities.

Bill is a geologist with 35 years of experience in the oil and gas industry, much of this associated with exploration and new venture activities. He has worked on projects in Australia, PNG, Central and South-East Asia, North Africa, the Middle East and South America, with companies including AAR, Sun Oil, Kufpec, Ampolex and ExxonMobil. Bill is a member of the APPEA Exploration Committee.

Our region's growing demand for Australian natural gas is not only good for exports, it is good for domestic gas markets also. Australia's gas resources are mostly in remote areas a long way from our customers. These markets are relatively small in global terms and, on their own, are unable to support the scale of investment needed to produce Australia's gas economically. Access to export markets means we can afford to invest in the infrastructure necessary to produce gas economically, benefiting customers at home and in Asia. As more Asian countries make the switch from coal to gas to cut pollution, rising LNG exports are credited as one of the key drivers of Australia's strong economic growth results released in June. Over five decades, Australia's oil and gas industry has paid more than $250 billion in taxes and royalties.

With potentially enormous resources in under-explored basins such as the McArthur and the Southern Amadeus in the Northern Territory, the gas industry could have its best years ahead of it, continuing to create wealth and employing future generations of Australians, including geoscientists. Geoscience, as a critical discipline underpinning the future of the Australian resources sector, is the key to realising this positive vision for the gas industry. The challenge is identifying and maturing new sources of large scale supply. This is the panacea, not just for Asian market demand and the national income that it generates, but for sustainable, reliable and affordable domestic gas and energy that could, again, be a game changer for Australian industry.

There are promising opportunities in this growth space - Australian geology has tremendous remaining hydrocarbon potential. We need and will continue to rely on a vibrant and highly skilled geoscience community to realise the prize.

It all begins with the rocks.

1650

Spectral mineralogy from hand held spectrometers: third generation technologies driving a revival

Pontual S

TS2 - 4.7 The National Virtual Core Library, Room R6, October 15, 2018, 3:30 PM - 5:30 PM

4.7 NVCL Keynote presentation

Infrared spectral geology is a useful way of understanding the mineral distribution in altered and mineralised systems. When interpreted correctly, the information that can be extracted from the sample spectra is extensive and can provide invaluable insights into the geological history of a deposit as well as vectors to mineralisation. These data complement geochemical surveys, add confidence and reduce risk when making decisions at all stages of project development, from grass roots exploration to mining. There are also significant applications in geometallurgy in the identification and mapping of deleterious minerals.

The use of hand-held infrared spectrometers in the mining and exploration industry has been a growing technology over nearly 30 years. In spite of the development of other methods of collecting hyperspectral data over this time, hand-held spectrometers remain the most rapid and cost-effective way of collecting project- and deposit-wide mineral data at all stages of activity from exploration to mining.

This talk will present an overview of the history of the technology, from its early use to the current revival of activity in this field. The presentation will include case studies to demonstrate that the application of this technology is still a growing and active arena.

1651

Introducing New Technologies into Exploration: Pitfalls and Opportunities from an Early Adopters Perspective

Scott A

TS6 - 4.5 Exploration technology: future trends and adoption challenges, Room R7, October 18, 2018, 9:30 AM - 11:00 AM

Biography:
Andrew Scott has been involved in the mining innovation arena since the very beginning of his career over 30 years' ago. In his most recent role as Senior Director, Innovaton/Digital Mining at Barrick, Andrew had the scope of providing technology support for the entire mining process, from exploration through to mine closure. Andrew was In-coming Chairman, Chairman and outgoing Chairman for the Global Mining Guidelines Group between 2012 and 2018 working to improve the industry through collaboration, guidelines, and innovation. Andrew has recently taken up the position of Principal Innovator at Symbiotic Innovations, and coupled with his concurrent role as CORE Skills Facilitator, he is enthusiastic about further supporting the resource sector's successful digital transformation.

As the pace of technology development (in particular in the digital space) gets more and more rapid, resource companies are becoming spoiled for choice in terms of technologies to adopt. The growing number of real time chemical and mineralogical characterisation tools and the buzz around machine learning and data analytics are just examples of this. The question then becomes which technologies are actually going to improve the probability of exploration success – which after all is the goal, and then once a technology is selected how do companies incorporate the technology into their current workflows. When introducing a new technology to the industry the role of early adopters are key, companies that can see the opportunity and as a result are willing to take some risk and wear some pain in order to make any given technology work. Without early adopters technologies fail before they even begin and thus as an industry it is important for us to recognise the characteristics of early adopters, and perhaps for more of us to think like them. This talk will touch on some of the existing and up and coming technologies that will change the way exploration is done and outline from an early adopter perspectives what the challenges in adoption might be and how they could be overcome.

1655

Geoscience education and new modes of communication

Stewart I

BIIG5 - Geoscience education and new modes of communication, Hall C, October 16, 2018, 3:30 PM - 5:00 PM

Biography:
Iain is Professor of Geoscience Communication at Plymouth University and Director of its Sustainable Earth Institute. His long-standing research interests are in interdisciplinary investigations of geological hazards and abrupt environmental change, and more recently in the communication of 'contested Geoscience' to the public.
He regularly presents Earth science programmes for BBC television, including Earth: The Power of the Planet; How Earth Made Us, How to Grow A Planet, The Rise of the Continents and Planet Oil.

Geological issues are increasingly intruding on the everyday lives of ordinary people. Whether it be the exploration and extraction of hydrocarbons or mineral resources, deep injection of waters for geothermal power or the underground storage of carbon dioxide and radioactive waste, many communities across the country are being confronted with controversial geological interventions under their backyard. Alongside the complex scientific and technical challenges is the problem that, to most people – beyond dinosaurs and volcanoes - the geological world is unknown territory.
That unfamiliarity presents difficulties for professional geoscientists communicating what they do and what they know to decision-makers, politicians and the wider public. Equally, developing public participation strategies that effectively engage with citizens, communities and stakeholder groups requires geoscientists to better appreciate what the public knows and what they have concerns about. In that context, how can we best we promote geology to the next generation of wannabe scientists and engineers – reaching in to the education system to enthuse and inspire young students about planet Earth, how it works and what that means for Society.
This session will be a forum to bring together a mix of geoscientists, educationalists, communication professionals and media practitioners to explore the challenges of delivering geoscience to non-specialist audiences. It will draw from the experience of the popular media – making television and radio programmes how science in general, and earth science in particular, has been packaged for popular consumption. The predominance of the internet and the online media landscape, that conventional broadcast environment is changing, so how can geoscience make the most of that? At the same time we hear from media professionals about how to 'sell' geology in geology in the commercial marketplace, particularly in relation to contested societal issues.
Much of our understanding of how non-technical audiences understand and react to technical information comes from a rich body of empirical human and behavioural science, and the message from social science is that scientists need to switch from conveying 'matters of fact' to developing dialogues around 'matters of concern'. A case study in the development of such dialogue-based approaches will come from the burgeoning area of geotourism, which provides examples of the promises and pitfalls public geoscience.
The session will reinforce the broad popular appeal of the natural world and the pedogogic richness of 'the science of the planet' in STEM-based school education. But it will also highlight the societal challenges in selling 'brand geoscience' and in communicating geology to normal people.

1660

Smoothing the impact of boom and bust commodity cycles

Trench A[1]

[1]*University of Western Australia*

BIIG2 - Smoothing the impact of boom and bust commodity cycles, Hall C, October 16, 2018, 9:00 AM - 10:30 AM

Biography:

MBA Director, Professor: University of Western Australia Business School and Adjunct Professor: Centre for Exploration Targeting (CET), School of Earth Sciences, University of Western Australia

Our industry has a history of mineral commodity price cycles that are colloquially described as periods of 'Boom and Bust' or 'B&B'. Key participants in this repeated game of 'B&B' include the corporate decision-makers who sit in the boardrooms of our mid-size and large mining firms. One view is that decisions on new mining project investments, and just as importantly, the lack of new mining investments on occasion, inadvertently acts to drive an exaggeration of the commodity cycle. Few mining industry boards seem inclined to invest during a downturn for example. By contrast, mining companies seem to have a habit of paying too much for assets in the 'good times'.

This session of the AGCC conference will ask the obvious question about B&B. Why do we not collectively learn as an industry from our repeated mistakes of the past in managing the commodity price cycle?

A further key group of important participants in the repeated B&B game are the geoscientists and industry technical professionals. As attendees to the AGGC I 2018, we should all ask ourselves what more we each could do to avoid being in the firing-line when downturns hit – and take appropriate mitigation actions. Should geoscientists, for example, seek to learn additional skills beyond technical excellence in their respective disciplines – or would such multiskilling as a personal career strategy serve only to rob our industry of the key expertise it will need to develop and operate ever more complex and difficult orebodies in the future?

The aim of the 'Boom and Bust' session of the AGCC and the related 'Big Issues' agenda, is not to review and provide insight into contemporary and future global economics however. Rather, our narrower focus sits more at the individual and industry level – and specifically seeks to identify the actions that can be taken to capture upside opportunities for both individuals and their companies – and of course protect against the inevitable downside.

Keynote speakers will address aspects of the conundrum.

- Patrick Walta, Managing Director of New Century Zinc (ASX Code NCZ), will talk about the formation and implementation of his company's strategy. The questions that arises is how can we systematise the capture of such lateral thinking opportunities at a whole- of-industry level?
- Prabhav Sharma, partner at McKinsey & Company, will share a big picture view on our industry's track record and practice. How is the mining industry's track record in dealing with booms and busts in terms of investment outcomes? How can that record be changed and improved?
- Miriam Stanborough will share her insights on innovation management in the minerals sector. Becoming skilled at innovation is something that all companies now aspire to. How can individuals and companies become 'unconsciously skilled' at the practice of innovation?

1661

Mass Extinction System Science: a fully integrated field of study or just a MESS?

Twitchett R[1]

[1]Department of Earth Sciences, The Natural History Museum

PS2 - Plenary Session: Life Origins And Evolution (Hall C), Hall C, October 15, 2018, 2:00 PM - 3:00 PM

Biography:
Professor Richard Twitchett is Research Leader in the Department of Earth Sciences at the Natural History Museum in London. With a broad background in geology, biology and palaeoenvironmental analysis, Richard is a palaeoecologist whose multidisciplinary research integrates empirical data collected from rocks and fossils in the field and from museum collections. Richard's research is focussed on understanding how marine animals and ecosystems responded to the major biological and environmental changes of the past, particularly those associated with global warming and the mass extinction events of the Phanerozoic. He is best known for his studies of post-Permian recovery and body size evolution.

The scientific study of mass extinction events stretches back over 200 years and is more relevant than it has ever been. This early 21st century renaissance has been driven by catastrophic predictions of the near-future consequences of anthropogenic climate change, and recognition that the fossil record is an archive of global-scale, natural experiments documenting the responses of Earth's biosphere to past episodes of global environmental change. Although the archive is not perfectly preserved, it remains adequate for addressing key questions. Fossil data enable the testing of key predictions of future change, of organisms or whole ecosystems, under natural conditions, using empirical data at a range of critical spatial scales. The fossil record enables a whole-ecosystem approach that cannot be achieved with experiments on living animals and plants. Accurate interrogation of the record requires, however, a quantitative, multidisciplinary and multivariate approach to integrate high-resolution palaeontological, geological and geochemical data. Too often, scientists within these different fields work independently and, even though data may sometimes, fortuitously, derive from the same sites, sampling issues prevent full integration. As examples from the Permian-Jurassic show, we already have the potential to determine how marine animals, from the largest macrofauna to smallest meiofauna, plants (both marine and terrestrial) and microbial communities responded to environmental change using a single time series of samples interrogated using multivariate approaches. To date, however, a fully integrative whole-ecosystem approach to mass extinction science has yet to be achieved, and the full potential of the fossil record has yet to be realised.

We look forward to meeting up with you in Adelaide

AGCC Australian Geoscience Council **Convention**

BIG ISSUES AND IDEAS IN GEOSCIENCE

14–18 OCTOBER 2018 | Earth Science Week

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1664

Surviving against adversity – Colin..'Rocks On'… completing a PhD in geology and much more..., after being declared 'brain dead': My Story.

Winsor C[1]

[1]*Consulting Structural Geologist*

D3P - Day 3 Poster / Drinks Exhibition (GeoEXPO), GeoEXPO, October 17, 2018, 5:30 PM - 6:30 PM

Biography:

Colin N Winsor migrated to Adelaide from the UK in 1964 and developed an early interest in Geology. He subsequently undertook a BSc in Geology & Geophysics at Uni of Adel gaining a distinction in both. The following year Colin completed a 1st class honours degree in Geology. After a brief holiday in NZ he started a PhD at JCU in Structural Geology at Mt Isa. Six months later, while on a GSA excursion, his life was turned upside down. Colin survived a serious MVA but went on to achieve against the odds, continuing to undertake geological research, promoting geology and the environment to the broader community through volunteer roles and maintaining a high level of fitness.

Following completion of a 1st Class Honours BSc degree at Uni of Adelaide, I commenced a PhD scholarship at JCU in 1978. Six months later while on a GSA conference excursion I sustained a traumatic brain injury (TBI) while trying to avoid kangaroos and was initially believed brain dead. Fortunately my parents did not agree to organ donation and I was flown to Adelaide and remained in a coma at RAH, where staff and students from the Geology and Geophysics Department visited regularly. Early medical opinion was that I would remain in a vegetative state, but against the odds I resumed study within six months despite having residual disabilities. With determination and support from my family and Dr Tim Bell, I submitted my thesis in September 1982 and was awarded a doctorate in 1984. A varied work history followed and included post-doc research at Uni of WA, Otago Uni and UniSA as well as work with petroleum exploration companies. There has been extended periods of unemployment, largely due to my preference not to drive unaccompanied. Although there have been depressive times, I exercise regularly and undertake various volunteer roles which keep me motivated and occupied. Recovery from a TBA is individualistic and complex, but recovery from trauma is possible and my story could inspire others to achieve against the odds.