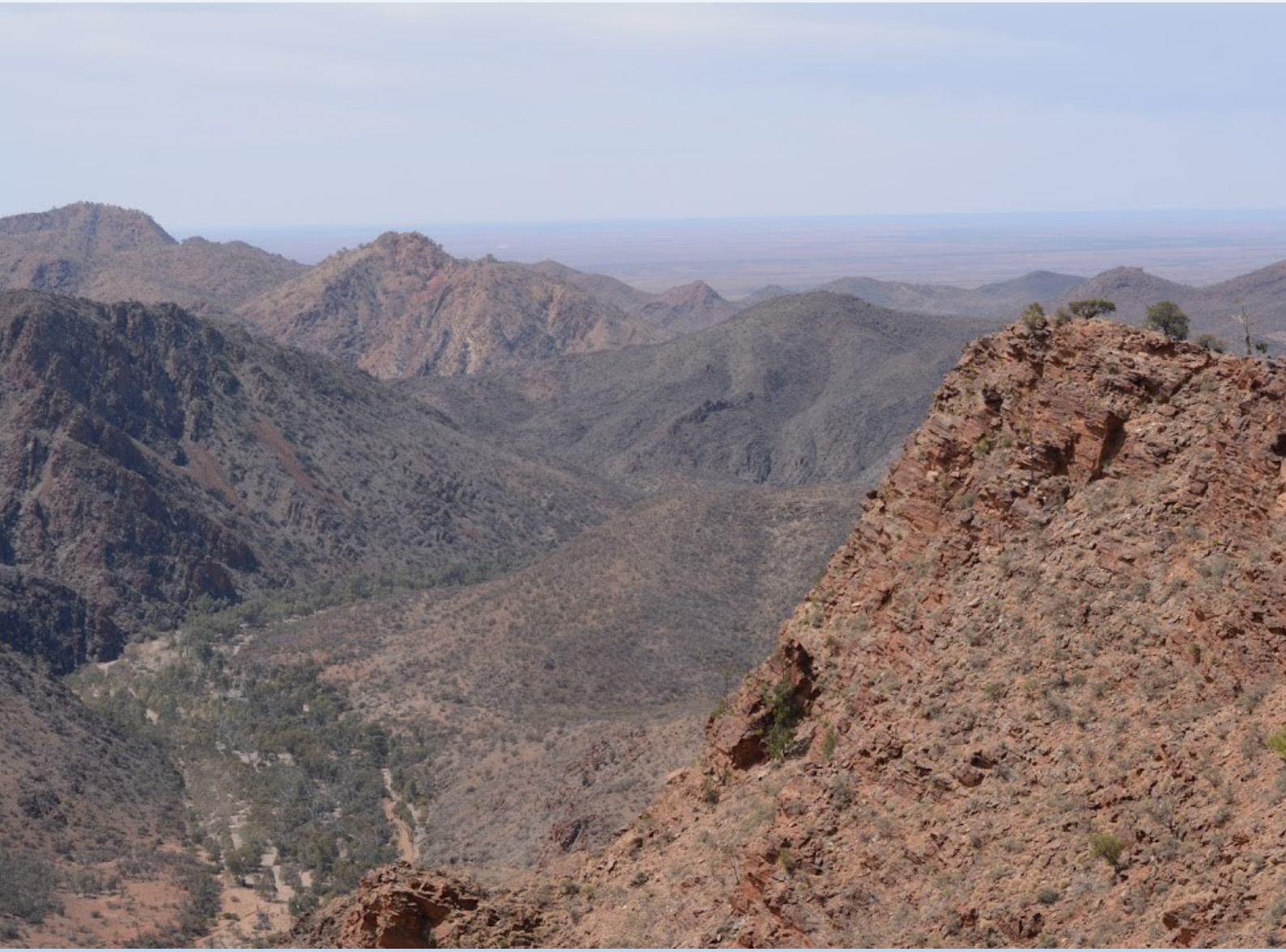
Geological Society of Australia

Earth Sciences Student Symposium

South Australia

2019

PROGRAM AND ABSTRACT VOLUME



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Welcome

Welcome to the annual Geological Society of Australia Earth Science Student Symposium of South Australia (GESSS-SA). We are pleased to have you join us at Bradley Forum in the University of South Australia's West Campus for a day that will showcase the best of South Australia's student research.

We sincerely thank all our partners for their support in making this year's conference possible, and we hope to continue these partnerships in future years.

Additional thanks are given to the University of South Australia, who kindly waived the fees for this year's conference venue.

As a committee we are extremely proud to have organised this conference for you and we hope this continues to provide a solid foundation for future GESSS-SA events.

Please enjoy GESSS-SA 2019!

Thank-you,

GESSS-SA 2019 Organising Committee

GESSS-SA committee of 2019

Chair: Adrienne Brotodewo

Vice-Chair: Amy Tschirn

Treasurer: Zhen He

Secretary: Dillon Brown

Sponsorship Officers: Mandy (Yuexiao) Shao & Michael Curtis

Programme and Abstracts Officers: Jacob van Zoelen & Isaac Kerr

Media Officer: Jarred Lloyd

8:30	**Registration opens**
9:00	Welcome from the GESSS-SA
9:05	Welcome from the GSA
9:10	A word from our sponsors
9:25	Keynote: Dr Zoe Doubleday
9:55	Poster advertisements: Jacob van Zoelen, Darwinaji Subarkah, Jacinta S. Greer
10:00	*Morning Tea*
10:30	Nimue Gibbs THE LATE QUATERNARY SQUAMATES FROM CATHEDRAL CAVE, WELLINGTON, NEW SOUTH WALES
10:45	Kailah Thorn MIOCENE ORIGINS AND PLIO-PLEISTOCENE GIGANTISM IN THE AUSTRALASIAN BLUETONGUED LIZARDS (SQUAMATA: SCINCIDAE)
11:00	Jacob Blockland PALEOCENE FOSSILS FROM THE TAKATIKA GRIT, CHATHAM ISLAND, ADD TO THE GROWING DIVERSITY OF THE EARLIEST PENGUINS (AVES, SPHENISCIFORMES)
11:15	Phoebe McInerney RECONSTRUCTION OF *GENYORNIS NEWTONI* CRANIA AND SEMICIRCULAR CANALS FOR PALAEOECOLOGICAL AND PHYLOGENETIC INFERENCE
11:30	Isaac Kerr A UNIQUE ARTICULATED FOSSIL SHEDS LIGHT ON THE TAXONOMY OF TWO PLEISTOCENE SPECIES OF GIANT KANGAROO FROM THE GENUS *PROTEMNODON*
11:45	Priya RECONSTRUCTING THE LATE PLEISTOCENE CLIMATE SEQUENCE AT ALEXANDRA CAVE, NARACOORTE, USING SINGLE-GRAIN OPTICALLY STIMULATED LUMINESCENCE DATING AND PALAEOENVIRONMENTAL PROXIES

Session 1: Palaeontology

12:00	Poster advertisements: Asika Dharmarathna, Kalimna Roe-Simons, Nathan Teder
12:05	Lunch
1:15	Reuben Wheeler FACTORS GOVERNING MICROBIAL HETEROGENEITY AND TRICHLOROETHYLENE BIODEGRADATION IN A CHLOROCARBON CONTAMINATED AQUIFER
1:30	Georgina Virgo DESCENDING INTO THE “SNOWBALL”: IMPROVING INTERPRETATIONS OF TONIAN AND CRYOGENIAN PALAEOENVIRONMENTS WITH DETAILED SEDIMENTOLOGY
1:45	Jarred Lloyd THE STATE-OF-PLAY OF GEOCHRONOLOGY AND PROVENANCE IN THE NEOPROTEROZOIC ADELAIDE RIFT COMPLEX
2:00	Mitchell Bockmann ARE THE PEAKE AND DENISON RANGES THE MISSING LINK BETWEEN THE GAWLER CRATON AND THE MT ISA PROVINCE? CORRELATIONS IN THE TIMING AND STYLE OF ALTERATION WITH IMPLICATIONS FOR CONTINENTAL RECONSTRUCTIONS AND IOCG EXPLORATION
2:15	Alex Van Leeuwen CRUSTAL HOTSPOT METAMORPHISM POWERED BY ANOMALOUS HIGH HEAT PRODUCING Th–U CONCENTRATIONS
2:30	Dillon Brown CAMBRIAN ECLOGITE-FACIES METAMORPHISM IN THE CENTRAL TRANSANTARCTIC MOUNTAINS, EAST ANTARCTICA: EXTENDING THE RECORD OF EARLY PALAEOZOIC HIGH-PRESSURE METAMORPHISM ALONG THE EASTERN GONDWANAN MARGIN
2:45	Renée Tamblyn CYCLING OF ECLOGITE WITHIN A SERPENTINITE FILLED SUBDUCTION CHANNEL

Session 2: Geological Processes

3:00	Poster advertisements: Alicia Pollett, Celina Sanso, Michael Curtis
3:05	*Afternoon Tea*
3:35	Michael Curtis IGNEOUS IMPACT ON CARNARVON PETROLEUM SYSTEM
3:50	Zhen He THE REPLACEMENT REACTION OF CHALCOPYRITE BY COVELLITE UNDER HYDROTHERMAL CONDITIONS
4:05	He Zhang ARSENIC INFLUENCE ON THE DISTRIBUTION AND MODES OF OCCURRENCE OF GOLD DURING THE FLUID-PYRITE INTERACTION
4:20	Belinda Bleeze UTILIZING BIO-LEACH MICROBES FOR THE SEPARATION OF SULFIDE MINERALS
4:35	Poster advertisements: Teagan Romyn, Adrienne Brotodewo
4:40	Thank you and closing remarks
4:50	Poster session and drinks
5:50	Awards
6:00	Finish and leave for drinks

Session 3: Mining and Petroleum

POSTER PRESENTATIONS

Pres No	*Name*	*Title*
1	Jacob van Zoelen	RESOLVING THE TAXONOMIC VALIDITY OF THE GIANT EXTINCT MARSUPIAL *NOTOTHERIUM* (DIPROTODONTIDAE) AND ITS RELATIONSHIP TO *ZYGOMATURUS*
2	Darwinaji Subarkah	CONSTRAINTS ON DEPOSITIONAL ENVIRONMENT, GEOCHRONOLOGY AND TECTONIC GEOGRAPHY OF THE GREATER MCARTHUR BASIN
3	Jacinta S. Greer	READING THE TEA-TREE LEAVES: *MELALEUCA QUINQUENERVIA* LEAVES AS A PALAEO-CLIMATE PROXY
4	Asika Dharmarathna	HOLOCENE CLIMATE VARIABILITY IN SOUTH-EASTERN AUSTRALIA; AN INTEGRATED ISOTOPE DATA AND MODELLING APPROACH AT LAKE SURPRISE, VICTORIA
5	Kalimna Roe-Simons	METHANE FLUX DETERMINATION IN AN URBAN WETLAND VIA EDDIE COVARIANCE
6	Nathan Teder	DO CANYONS INFLUENCE ORCA AGGREGATION IN THE WESTERN GREAT AUSTRALIAN BIGHT
7	Alicia Pollett	THERMAL DRIVERS OF MEDIUM PRESSURE–HIGH TEMPERATURE METAMORPHISM WITHIN A INTRACONTINENTAL RIFT
8	Celina Sanso	COMPOSITIONALLY-BASED MODELS OF THERMAL CONDUCTIVITY OF IGNEOUS AND METAMORPHIC ROCKS
9	Michael Curtis	IGNEOUS IMPACT ON CARNARVON PETROLEUM SYSTEMS
10	Teagan Romyn	FELSIC METASTABILITY DURING CONTINENTAL SUBDUCTION
11	Adrienne Brotodewo	GEOCHEMICAL DISCRIMINATION OF IGNEOUS ZIRCON ASSOCIATED WITH IRON OXIDE COPPER-GOLD ALTERATION

PRIZES

Prizes for Best Poster and Best Oral Presentation will be awarded at GESSS-SA 2019.

A prize for Best Geophysics Presentation has also been generously donated by ASEG.

DIAMOND PARTNER

Minotaur Exploration Ltd (ASX:MEP) is an Adelaide-based ASX-listed mineral exploration company – a dedicated copper-gold explorer with a focus on Iron Oxide Copper-Gold (IOCG) style targets and Iron Sulphide (ISCG) variants. Our research is directed to locating 'blind' deposits masked by cover rocks, relying on a variety of geophysical techniques across selected geological terranes to 'see' through the cover and generate targets for drill testing.

The more expensive drill test phase is often undertaken in conjunction with a farm-in partner to ameliorate risk and expenditure. Regions of focus within Australia for copper-gold mineralisation include the Cloncurry terrane of western Queensland and South Australia's Gawler Craton. Minotaur is currently in the midst of a period of intense exploration drill testing activity in the Cloncurry region, as well as greenfield target generation in the Gawler Craton.

Minotaur also holds development-ready resources of industrial minerals – kaolin, halloysite, gypsum and magnetite. Research into new technology applications for the natural nanotube halloysite is now being translated into new commercialisation opportunities.

Minotaur has encouraged and assisted numerous geology and geophysics students through work experience and vacation employment placement, and has maintained a small graduate employment program over its +20 year life in Adelaide. Through its discovery of Prominent Hill in 2001, Minotaur has directly contributed to growth and prosperity of Australia.

DIAMOND PARTNER

The strategic intent of the Department for Energy and Mining is to deliver affordable, reliable and secure energy supplies in a transitioning national energy market while responsibly unlocking the value and opportunities of our mineral and energy resources. DEM's Energy Resources Division manages the State's petroleum resources as the lead agency facilitating ecologically sustainable petroleum exploration and development. Its operations cover the full cycle – investment attraction through provision of geoscientific data, regulation through policy and legislation, and optimisation of royalty income streams.

DIAMOND PARTNER

A proudly Australian company, Santos is a leading supplier of natural gas, a fuel for the future providing cleaner energy to improve the lives of people in Australia and Asia.

Santos aims to be Australia's leading domestic gas supplier and a leading Asia-Pacific LNG supplier.

For more than 60 years, Santos has been working in partnership with local communities to safely and sustainably develop Australia's natural gas resources.

Santos' strategy is centred on five core long-life natural gas and LNG assets (Northern Australia, Queensland and New South Wales, Western Australia, the Cooper Basin and Papua New Guinea) with the business positioned for growth across the portfolio.

With one of the largest exploration and production acreages in Australia, a significant and growing footprint in Papua New Guinea and a strategic infrastructure position, Santos is well positioned to benefit from the growing global demand for energy.

As a low cost, reliable and high performance business, Santos is proud to deliver the economic and environmental benefits of natural gas to homes and businesses throughout Australia and Asia.

DIAMOND PARTNER

OZ Minerals aspires to be a modern mining company and the best place to work! What that means is, we focus on developing our ability to adapt to the ever-changing environment and harness the innovative ideas of our teams to unlock value for people we are responsible to – our stakeholders.

We own and operate the copper-gold mine at Prominent Hill, the Antas mine in Brazil, are developing one of Australia's largest copper-gold resources at Carrapateena, and have assets in Brazil. We also have a pipeline of earn-in agreements with experienced exploration companies in Australia and internationally, and are focused on creating a pipeline of opportunities.

At OZ Minerals, we won't stand still or just follow the crowd, we think and act differently. As part of our team, you will work with great people and be challenged to learn, discover and grow.

We have a diverse range of people in a range of roles. We want people who are proud to work as part of a diverse and inclusive workforce – this includes diversity of thinking to challenge the status quo.

SAPPHIRE PARTNER

The ASEG brings together a diverse mix of more than a thousand active earth science professional and student members from Australia and around the world through our publications, technical conferences, exhibitions and workshops, the ASEG Research Foundation, the monthly technical and social events hosted in each of our major cities and, in recent years, our programs for young professionals and students.

Founded in 1970, the Australian Society of Exploration Geophysicists (ASEG) is a learned society of professional earth scientists specializing in the practical application of the principles of physics, mathematics and geology to solve real life problems in a complex and changing world. Our Society meetings and publications have a strong focus on the latest application of leading edge exploration geophysics in the minerals and petroleum exploration sectors as well as in the investigation of near -surface earth problems including the search for groundwater resources.

Our membership across all levels contributes to our premier ASEG publications which provide a forum for innovative and ground-breaking exploration geoscience applied research. The ASEG produces two major bi-monthly publications: our eminent journal, Exploration Geophysics, is a forum for scientific papers from our members and from our partner and affiliate societies. The ASEG also publishes Preview, our flagship magazine, covering the latest news, people and events in the field of exploration geophysics and geoscience. Student membership is always free!

SAPPHIRE PARTNER

Beach is an active supporter of Universities and student chapters, through corporate sponsorships, graduate programmes, hiring of young staff and support through our professional staff in associations such as PESA, AAPG and ASEG. Beach has also taken up two positions on the Advisory Board to the Australian School of Petroleum at the University of Adelaide and has direct involvement in helping to shape that school and its future for the next generation of students. Beach also routinely hosts local Adelaide-based students to undertake Honours projects, providing them with projects, data, materials, supervision and exciting industry projects to work on. This also includes having students posted to our office and working directly with the asset teams. This is the kind of hands-on experience that is beneficial to students for career development and to help them decide what career paths they might like to take. Over the last few years Beach has also hired many students once they have finished their undergraduate courses – these young professionals are moving up into more senior roles working in the Exploration and Production sector. Beach also sends staff to support and attend geological field trips and courses to encourage engagement between Beach staff, students and their academic supervisors.

TOPAZ PARTNER

The Petroleum Exploration Society of Australia (PESA) is a national organisation representing the interests of all professionals and practitioners in the upstream petroleum industry.

The purpose and objectives of the Society are as follows:-

1) To promote professional and technical excellence in the upstream petroleum industry throughout Australia. This is fostered by providing forums to communicate technical innovations and lessons learnt to individuals on a national basis;

2) To present views and facilitate discussion of technical and professional matters pertinent to the upstream petroleum industry;

3) To foster and provide continuing education for the benefit of PESA members and students progressing towards a career choice;

4) To nurture the spirit of research on matters pertinent to PESA members and their upstream petroleum industry colleagues; and

5) To maintain a high standard of professional conduct on the part of its members.

TOPAZ PARTNER

The University of South Australia's Future Industries Institute (FII) was established with a new research culture in mind – one deeply engaged with industry, with the end goal of building economic growth through relevant innovation and industry partnership underpinned by research excellence. Our goal is to support a creative and engaged culture and to help develop a *sustainable* ecosystem in which innovation and complex, *growth-focused* industries thrive.
The mineral and energy resources sector is a focus area of activity within FII. We take advantage of FII's cross disciplinary structure (earth sciences, minerals processing, engineering, materials science, environmental science), extensive analytical infrastructure and industry-facing mindset to offer a unique perspective on the challenges facing the sector. This creates a vibrant research environment with opportunities for Masters and PhD projects that will directly impact on the industries of tomorrow.

TOPAZ PARTNER

MinEx CRC (Mineral Exploration Cooperative Research Centre) is a consortium of Industry, Government and Research Organisations that combine to form the world's largest mineral exploration research collaboration. MinEx CRC will address the technical challenges of finding and developing new mineral deposits by:

• Developing more productive, safer and environmentally-friendly drilling methods to discover and drill-out deposits, including coiled tubing drilling technology.

• Developing new technologies for collecting data while drilling, bringing forward mine production.

• Implementation of a National Drilling Initiative (NDI) – a world-first collaboration of Geological Surveys, researchers and industry that will undertake drilling in under-explored areas of potential mineral wealth in Australia.

MinEx CRC offers the opportunity for Masters and PhD students to engage in well-funded, industry-engaged, cutting edge research projects in a variety of geoscience and engineering fields.

More information can be found at www.minexcrc.com.au or by contacting Dr Caroline Tiddy (Chair of MinEx CRC Education and Training Committee) at Caroline.Tiddy@unisa.edu.au.

TOPAZ PARTNER

The Australian Sedimentology Group is a Specialist Group of the Geological Society of Australia, in the process of revival! Our goal is to increase interaction and activity in the sedimentology community in Australia, and in particular to support students and ECRs. Research and travel grants will be announced soon, with plans for low-cost workshops and field trips in 2020. It would be great to have your involvement! For further info, please join our Facebook group AusSedGroupGSA or email australian.sedimentologists@gmail.com.

ABSTRACT VOLUME

Alphabetical Order

Geological Society of Australia
Earth Sciences Student Symposium, South Australia
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UTILIZING BIO-LEACH MICROBES FOR THE SEPARATION OF SULFIDE MINERALS

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Sulfide minerals are often found in complex, mixed ores and are commonly separated via froth flotation. Froth flotation uses toxic reagents such as xanthates and cyanides which are detrimental to the environment [1,2].

Bio-flotation is potentially a greener, more sustainable alternative to sulfide ore beneficiation, replacing the toxic reagents with biological alternatives including bacteria, which occur naturally at mine sites, and their metabolites. *Leptospirillum ferrooxidans* (*L.f*) and *Acidothiobacillus ferrooxidans* (*A.f*) are acidophilic chemolithoautotrophs, with an ability to derive energy through the oxidation of Fe and/or S at the mineral surface and produce extracellular polymeric substances (EPS) to aid in attachment to the mineral surface [3]. Previous work has shown that bacterial cells and their EPS have the ability to alter the surface chemistry, changing the hydrophobicity of the mineral particles.

Optimisation of this technique can be achieved through understanding the microbe-mineral interactions and the surface chemistry of the mineral particles. Herein, the microbe-mineral interaction has been investigated through Scanning Electron Microscopy (SEM), confirming an indirect contact mechanism for both *L.f* and *A.f* microbes. Bio-flotation tests indicate the presence of cells decreases separation efficiency, while exposure to EPS supernatant can enhance separation. Photoemission Electron Microscopy (PEEM) and X-ray Photoelectron Spectroscopy (XPS) were used to investigate the surface chemistry changes of the mineral particles. PEEM and XPS results show changes to the iron and carbon species at different exposure conditions. An increase of iron oxides (iron-oxyhydroxides) and carbon species (COOH) are observed with increasing exposure. The increase of these species suggests an increase in organic matter on the sample, which increases hydrophilicity.

Key words:

Bio-flotation, separation, pyrite, chalcopyrite

References:

[1] Napier-Munn, T. and B.A. Wills, *Wills' mineral processing technology: an introduction to the practical aspects of ore treatment and mineral recovery*. 2011: Butterworth-Heinemann.

[2] Blowes, D., et al., *The geochemistry of acid mine drainage.* Treatise on geochemistry, 2003. **9**: p. 149-204.

[3] Vilinska, A. and K.H. Rao, *Leptosririllum ferrooxidans-sulfide mineral interactions with reference to bioflotation and bioflocculation.* Transactions of Nonferrous Metals Society of China, 2008. **18**(6): p. 1403-1409.

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PALEOCENE FOSSILS FROM THE TAKATIKA GRIT, CHATHAM ISLAND, ADD TO THE GROWING DIVERSITY OF THE EARLIEST PENGUINS (AVES, SPHENISCIFORMES)

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Numerous isolated and associated skeletal remains recovered *in situ* from the late early to middle Paleocene Takatika Grit of Chatham Island, New Zealand [1], represent some of the oldest known penguin fossils (Aves, Sphenisciformes). Among these remains we recognise a new medium-sized taxon and another significantly larger form. The new penguins, as well as all other known Paleocene penguins, are analysed using an updated and revised phylogenetic matrix based on morphological and molecular characters and interpreted as among the most primitive of known sphenisciforms, in a close relation to species such as *Waimanu*—consistent with their age. While sharing a number of characteristics with these earliest wing-propelled divers, the medium-sized form records the oldest occurrence of the characteristic penguin tarsometatarsus morphology in a non-giant sphenisciform. These ancient Chatham Island representatives add to a growing number and increased morphological diversity of Paleocene penguins [e.g. 2] suggesting an origin for the group in the New Zealand region, and provide additional evidence for that origin sometime before the Paleocene. The implication proposes that stem penguins and their sister group, the Procellariiformes, both originated in the Late Cretaceous [3] and the former, at least, rapidly diversified as nonvolant piscivores in the southern oceans following the end-Cretaceous mass extinction.

Key words:

Palaeontology, waterbirds, phylogenetics, New Zealand, Rēkohu, K/Pg mass extinction

References:

[1] Hollis, C.J., Stickley, C.E., Bijl, P.K., Schiøler, P., Clowes, C.D., Li, X. and Campbell, H. (2017) Alcheringa: An Australasian Journal of Palaeontology, 41: 383–396.
[2] Mayr, G., De Pietri, V.L., Love, L., Mannering, A.A. and Scofield, R.P. (2018) Journal of Vertebrate Paleontology, 37: e1398169 (1398161–1398119).
[3] Mayr, G., De Pietri, V.L. and Scofield, R.P (2017) The Science of Nature, 104: 1–6.

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ARE THE PEAKE AND DENISON RANGES THE MISSING LINK BETWEEN THE GAWLER CRATON AND THE MT ISA PROVINCE? CORRELATIONS IN THE TIMING AND STYLE OF ALTERATION WITH IMPLICATIONS FOR CONTINENTAL RECONSTRUCTIONS AND IOCG EXPLORATION

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Proterozoic continental reconstructions seek to understand the arrangement of the continents and are commonly argued to be valuable for the purposes of exploration targeting at the terrane-scale. However, reconstruction models are almost always based on correlating lithologies or similar-aged magmatic or tectonic events and rarely draw upon hydrothermal or mineralising events as piercing points. We present correlations between alteration in the Peake and Denison Ranges in the north-eastern Gawler Craton and alteration systems associated with extensive mineralisation in the Eastern Fold Belt of the Mount Isa Province. Titanite U–Pb geochronology obtained via Laser Ablation–Inductively Coupled Plasma–Mass Spectrometry (LA–ICP–MS) from calc-silicate alteration in the Peake and Denison Ranges reveal multiple ages between c. 1515 – 1470 Ma. These ages are younger than known ages of alteration or mineralisation associated with the c. 1595–1575 Ma Hiltaba–Gawler Range Volcanics (GRV) event in the Gawler Craton, but do coincide with the timing and style of alteration and mineralisation associated with the c. 1530–1490 Ma Williams & Naraku batholiths in the Eastern Fold Belt. Previous reconstruction models have argued for lithospheric continuity between the eastern Gawler Craton and the Mount Isa Province, and the timing of hydrothermal alteration in the Peake and Denison Ranges lends support to those models. Whether the hydrothermal system in the Peake and Denison region represents a linked but temporal shift in the locus of potential mineralising processes in the eastern Gawler Craton, or is a separate system, is unclear. However, timing and style of Peake and Denison alteration are coeval with, and identical to, phases of Iron-oxide–Copper–Gold (IOCG) mineralisation in the Isan Eastern Fold Belt, making the Peake and Denison Ranges region highly prospective for further mineralisation.

Key words:

Gawler Craton, Mount Isa, IOCG, mineralisation, U–Pb geochronology, titanite.

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GEOCHEMICAL DISCRIMINATION OF IGNEOUS ZIRCON ASSOCIATED WITH IRON OXIDE COPPER-GOLD ALTERATION

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Zircon is commonly used to study petrogenesis and evolution of rocks due to its robustness during surficial, metamorphic and igneous processes, as well as its affinity for rare earth elements (REE), U and Th. Recently, research has focused on understanding and characterising the geochemical composition of zircon as it has a large influence over the trace and REE budget seen in whole rock geochemical data. However, this has been met with many challenges as REE and trace element compositions can be highly variable in zircon from the same lithological unit, and within a single grain itself. Despite this, zircon has successfully been used to discriminate between igneous, metamorphic and sedimentary source rocks [1] and can preserve a geochemical signature that can be related to mineralisation [2], indicating the potential use for zircon in mineral exploration.

In this study, new zircon geochemical data has been collected from igneous suites in the Gawler Craton, South Australia. The morphology of zircon has been used to understand changes in environment during and post-crystallisation. LA-ICP-MS data was collected to assess the trace and rare earth element distribution within zircon grains. Discriminatory characteristics between igneous units have been developed and indicate that the chemistry of zircon in samples associated with IOCG alteration show a different chemistry to 'background' samples. These distinct geochemical characteristics recognised in zircon will form the basis of developing criteria for using zircon as a pathfinder mineral in future work within this project.

Key words:

zircon, geochemistry, Gawler Craton, accessory mineral, Hiltaba Suite, magmatism

References:

[1] Belousova, E., Griffin, W., O'reilly, S. Y., and Fisher, N. (2002) Contributions to Mineralogy and Petrology, 143(5), 602–622
[2] Lu, Y-J., Loucks, RR., Fiorentini, M., McCuaig, TC., Evans, NJ., Yang, Z-M., Hou, Z-Q., Kirkland, CL., Parra-Avila, LA and Kobussen, A., (2016) Society of Economic Geologists, Inc. Special Publication 19, pp. 329–347

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CAMBRIAN ECLOGITE-FACIES METAMORPHISM IN THE CENTRAL TRANSANTARCTIC MOUNTAINS, EAST ANTARCTICA: EXTENDING THE RECORD OF EARLY PALAEOZOIC HIGH-PRESSURE METAMORPHISM ALONG THE EASTERN GONDWANAN MARGIN

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The Miller Range in the central Transantarctic Mountains comprises Mesoarchean and Palaeoproterozoic crust that was incorporated into the Ross Orogen during metamorphism and deformation along the eastern Gondwanan margin. In the central Transantarctic Mountains, boudinaged mafic domains are hosted within upper-amphibolite- to granulite-facies mylonitic rocks that were deformed during the Ross Orogeny. The mafic rocks preserve evidence of a precursor eclogite-facies assemblage containing garnet, omphacite, pargasite, quartz, rutile and either H_2O or melt. Phase equilibria forward modelling and Zr-in-rutile thermometry indicates the eclogite assemblage records peak pressure-temperature conditions of 15.5–17 kbar and 690–750 °C. Clinopyroxene-plagioclase symplectite, plagioclase coronae rimming garnet, hornblende, ilmenite and orthopyroxene overprint the high-pressure assemblage. Compositions and modal proportions of retrograde garnet, orthopyroxene and hornblende suggest near isothermal exhumation to conditions of 8–10 kbar and 660–840 °C, followed by a long-lived mid-crustal residence time. In-situ LA–ICP–MS U–Pb dating of zircon and rutile yields concordant ages of 535.9 ± 14 Ma and 536 ± 20 Ma, respectively. The Cambrian-aged zircons show an absent—weakly negative Eu anomaly signature and flat heavy-rare earth element (HREE) distributions, typical of zircons crystallised in the absence of plagioclase and presence of garnet, diagnostic of eclogite-facies conditions. The Cambrian-aged zircon population contrasts with older highly discordant Palaeoproterozoic zircons that have negative Eu anomalies and are HREE enriched. These zircons are interpreted to be protolithic, consistent with existing geochronology from the region. The Cambrian-aged zircon and rutile are inferred to represent the timing of eclogite-facies metamorphism associated with Ross orogenesis. The early Palaeozoic eastern Gondwanan margin contains a diverse array of eclogite precursors that document contrasting geodynamic styles. Eclogites in northern Victoria Land and central Tasmania record comparatively high thermal gradient metamorphism and rapid exhumation within their continental crust hosts, whereas the oceanic eclogites in the southern New England Fold Belt record refrigerated, long-lived metamorphism. The Miller Range eclogite-facies rocks appear to have been derived from shallow subduction of ancient continental crust, after which they stalled at thermally elevated mid-crustal depths prior to their final exhumation. The discovery of Cambrian-aged eclogite-facies rocks in the Miller Range expands the spatial footprint of high-pressure metamorphism during the Ross Orogeny along the early Palaeozoic eastern Gondwanan margin.

Key words:

High-pressure metamorphism, Cambrian, East-Gondwanan margin

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IGNEOUS IMPACT ON CARNARVON PETROLEUM SYSTEMS

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Igneous rocks in the in the Carnarvon Basin are a product of the rifting of Greater India from NW Australia during the breakup of Gondwana in the Cretaceous, c.135 Ma. Huge volumes of mafic magma were intruded along the Cuvier margin. There was also extrusive volcanism, and the eruption of flood basalts. In the Carnarvon Basin, petroleum has formed and accumulated in close association with these igneous systems: Woodside's Toro field was discovered in reservoir directly beneath a volcano and its associated volcaniclastic sediments. Despite this success, our current knowledge of the distribution of igneous rocks in the basin, particularly intrusions, is severely limited and outdated. The most recent regional work on the igneous rocks in the basin was completed in the 1990s, when two broad zones containing intrusions were defined across the Exmouth Plateau using regional magnetic data (1). There has, since then, been no regional, integrated study of the Carnarvon igneous system.

Using modern 3D seismic reflection data across the basin, I have begun to interpret intrusive sills and dykes on an individual basis, defining the extent of magmatism at a much higher resolution than was possible with 90s magnetic data, and to assess the influence of this magmatism on the regional petroleum system. I have interpreted detailed intrusion outlines across the Carnarvon Basin on open file 2D & 3D seismic reflection surveys. Intrusive igneous rocks are present between the Coverack 3D seismic reflection survey in the south of the Exmouth Sub-basin and the Centaur 3D survey in the north-western Exmouth Plateau. I have constrained the timing of magmatism through well correlation of stratigraphy on-lapping structures created by injection of magma beneath, and of stratigraphy on which cooling-related vent structures are identified. I have also identified six Carnarvon Basin exploration wells that penetrate igneous material and have compiled their well log data to show the unique petrophysical properties of igneous rocks, often misinterpreted by logging geologists.

Key words:

petroleum, intrusions, basin analysis, seismic interpretation, volcanoes

References:

(1) Frey, Ø., Planke, S., Symonds, P. A. & Heeremans, M. (1998) Marine Geophysical Researches, 20, 293-311.

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HOLOCENE CLIMATE VARIABILITY IN SOUTH-EASTERN AUSTRALIA; AN INTEGRATED ISOTOPE DATA AND MODELLING APPROACH AT LAKE SURPRISE, VICTORIA

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This project aims to build up a highly resolved late Holocene paleoclimate record based on qualitative and quantitative measures from a lacustrine sediment core taken from Lake Surprise, a volcanic crater lake in south east Australia. This study will be based on the hypothesis of closed lake basins at lower latitudes are hydrologically sensitive to the balance of precipitation and evaporation and lake sediments develop a continuous record of regional climate change, their response to climate drivers and local hydrology [1]. However, most of these processes in the southern hemisphere remain questionable due to poor attention on quantitative approach [2]. In this study, high resolution stable isotope records of C, N and O will be established using endogenic carbonates and cellulose in the sediment profile over the last 2500 years. These results will be calibrated using isotope hydrological proxy models in order to correlate and quantify regional climate trends. However, the proposed research will add a novel component, namely the integration of sediment geochemistry and seasonal depositional rate using modern precipitation and sedimentation data of the region. Data and results from the modern monitoring program will be coupled with historic precipitation variability, in order to provide robust relationships among regional climate drivers, on the effect of climate change in the region.

Key words:

Holocene, stable isotope, isotope hydrological proxy system model

References:

[1] Leng, M. J., & Marshall, J. D. (2004). Palaeoclimate interpretation of stable isotope data from lake sediment archives. *Quaternary Science Reviews*, *23*(7-8), 811-831.

[2] Tyler, J. J., Mills, K., Barr, C., Sniderman, J. K., Gell, P. A., & Karoly, D. J. (2015). Identifying coherent patterns of environmental change between multiple, multivariate records: an application to four 1000-year diatom records from Victoria, Australia. *Quaternary Science Reviews*, *119*, 94-105.

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THE LATE QUATERNARY SQUAMATES FROM CATHEDRAL CAVE, WELLINGTON, NEW SOUTH WALES

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Australian caves have rich and complex fossil deposits that are important in understanding past ecosystems and their change over time [1]. The Wellington Caves deposits (~4 Ma [2]) in central western New South Wales have a rich history of palaeontological study that spans over 180 years. Cathedral Cave was the first cave to be geologically mapped and was one of the first instances of palaeontological study in Australia [2]. Flinders University started their excavation of Cathedral Cave in February of 2016 and the excavation is still ongoing. Very few records of the changes in the abundances of fossil squamates (modern snakes and lizards) over time in a continuous record in a single assemblage have been collected and studied; creating such a record was a principal aim of this project.

There was not enough data to suggest a clear trend in faunal or climate change. There were some interesting observations regarding the composition of the fossil fauna compared to the squamates surrounding the Wellington district today. A large, extinct skink, *Tiliqua laticephala*, is the only *Tiliqua* found in the deposit; there is no fossil *T. rugosa* (Shingleback lizard) or *T. scincoides* (Eastern Blue-tongue lizard), both extant in the Wellington Caves area today. This indicates that the distribution of *Tiliqua* spp. has changed over time. There is a species of *Liopholis* in layers 10 to 13 that is distinguishable from the local *Liopholis whitii*. The species is similar to *Liopholis inornata*, possibly indicating a period of aridity. However, the comparative work necessary has not been done. While this project did not reveal a clear correlation in squamate composition with changes in climate, we can conclude that the squamate fauna has changed over time.

Key words:

Palaeontology, Australia, palaeoecology, reptiles, Wellington Caves

References:

[1] Webb, J, Grimes, K and Osborne, A, 2003, 'Black holes: caves in the Australian landscape,' *Beneath the Surface: A Natural History of Australian Caves*, pp. 1-52.
[2] Osborne, R, 1991, 'Red earth and bones: the history of cave sediment studies in New South Wales, Australia,' *Earth Sciences History*, vol. 10, no. 1, pp. 13-28.

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READING THE TEA-TREE LEAVES: *MELALEUCA QUINQUENERVIA* LEAVES AS A PALAEOCLIMATE PROXY

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The analysis of organic material preserved in sedimentary records is a useful tool in reconstructing past climatic conditions. The carbon isotope ratios ($\delta^{13}C$) calculated from measurement of plant tissues have been known for some time to reflect local climate variables corresponding to the period of plant growth. The preservation of *Melaleuca quinquenervia* leaves in lake sediments on Minjerribah (North Stradbroke Island) dating to the mid-Holocene presents the opportunity to produce species-specific stable isotope-based records of precipitation.

Here, we test the potential for *M. quinquenervia* to be used as a palaeoclimate proxy by examining the preservation of the bulk leaf $\delta^{13}C$ over time. Due to the varying rates of degradation of the different chemical constituents of plant matter, it is possible for $\delta^{13}C$ ratios to be altered by early diagenetic processes before, or during, the incorporation of leaves into the sediment. Therefore, modern studies are needed to establish what factors influence the discrimination derived precipitation record. Focusing on the *M. quinquenervia* growing at Swallow Lagoon on Minjerribah, we studied the changes to the bulk leaf $\delta^{13}C$ ratios of exposed leaves over an eighteen-month field study. By bisecting each leaf used in this study, we were able to compare the experimentally degraded leaves directly to their corresponding control halves. We observed that decay causes an approximate decrease of 1 ‰ in $\delta^{13}C$, as the leaves become more ^{13}C depleted relative to the control leaf halves that were dried immediately. Understanding exactly how early diagenesis changes the stable isotope composition of *M. quinquenervia* leaf material over time allows us to adjust for the offset between modern and sub-fossil bulk leaf $\delta^{13}C$ and advances the potential to use this species as a reliable climate proxy in the future.

Key words:

palaeoecology, leaf litter, decay, carbon isotope discrimination, freshwater lake

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ARSENIC INFLUENCE ON THE DISTRIBUTION AND MODES OF OCCURRENCE OF GOLD DURING THE FLUID-PYRITE INTERACTION

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Both invisible and visible gold are commonly associated with arsenian pyrite from epithermal gold deposits, but there is little knowledge about the effect of arsenic on the distribution and modes of occurrence of gold in pyrite during fluid-rock interactions in epithermal systems. Here we present a detailed study using a combination of scanning electron microscopy, electron probe micro-analyser, laser ablation-inductively coupled plasma -mass spectrometry, X-ray diffraction, laser Raman spectroscopy, electron backscatter diffraction, transmission electron microscopy, megapixel synchrotron X-ray fluorescence and atom probe tomography to identify the distribution and modes of occurrence of Au in arsenian pyrite, characterize the structure of host pyrite and interpret Au behaviours during the hydrothermal replacement of pyrite by As-rich ore-forming fluids. Results show that invisible Au was enriched as a homogeneous solid solution in the As-rich domains of arsenian pyrite. As-induced lattice defects by substitutions of As for both Fe and S provide space for occupation of invisible gold in pyrite. In contrast, visible Au was hosted in either grain boundaries or fissures in As-deficient interiors of pyrite. This study shows that extensive hydrothermal alteration at the fluid-pyrite interface promotes Au ions to take part in the build-up of As-rich products as homogeneous solid solutions with As-assisted incorporation, but Au ions also diffused along grain boundaries and fissures into the interiors of early pyrite where slower hydrothermal replacement would promote Au ions to preferentially crystallize as a secondary phase. The systematic composition and textual observations in this study provide new insights into the mechanisms responsible for the formation of different modes of occurrence of Au, enabling further understanding of the Au mineralization process.

Key words:

invisible gold, arsenian pyrite, fluid-rock interaction

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A UNIQUE ARTICULATED FOSSIL SHEDS LIGHT ON THE TAXONOMY OF TWO PLEISTOCENE SPECIES OF GIANT KANGAROO FROM THE GENUS *PROTEMNODON*

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Prior to the extinction of the genus around 40 000 years ago, kangaroos of the genus *Protemnodon* Owen, 1873 (Marsupialia: Macropodidae) were common members of mammalian herbivore assemblages across Australia and New Guinea. Of these, the mixed-feeding and grazing species *Protemnodon brehus* and *P. roechus*, found in open woodland and forest deposits from the Australian Pleistocene, were some of the largest kangaroos ever at between ~120 kg and ~170 kg. These two taxa are poorly delimited, with morphological descriptions relying heavily on variable dental characteristics, leaving significant grey-areas and lacking postcranial descriptions despite a wealth of postcranial material. Although *P. brehus* is described as smaller than *P. roechus* and differing in certain features of the cheek teeth, preliminary data from this study have suggested that these taxa may represent a single spatiotemporally widespread species. This study will utilise visualisation of craniodental and postcranial measurement data, morphological descriptions and geometric morphometric analyses of taxonomically significant areas, taken from a large sample of *P. roechus* and *P. brehus*, to test the taxonomic definitions of these taxa. An articulated fossil specimen in this study, that of a mother *Protemnodon brehus* with a joey preserved while still held within the pouch, presents the rare opportunity to be certain of the sex of a fossil marsupial. With this unique fossil it will be possible to visualise the degree of sexual dimorphism in size in *Protemnodon brehus*. It is possible that, given the significant size sexual dimorphism among medium- to large-sized extant kangaroo species, the perceived difference in size between *P. brehus* and *P. roechus* is an artefact of sexual dimorphism within a single species.

Key words:

palaeontology, Macropodidae, Lake Callabonna, sexual dimorphism, systematics

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THE STATE-OF-PLAY OF GEOCHRONOLOGY AND PROVENANCE IN THE NEO-PROTEROZOIC ADELAIDE RIFT COMPLEX

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The Adelaide Rift Complex was initially a rift basin in South Australia that formed resultant of Rodinia's breakup and subsequent evolution of the Australian passive margin of the Pacific basin. It holds a globally significant and exceptionally well-preserved Neoproterozoic–early Cambrian succession. Much work has been done over the last century delineating the lithostratigraphy and sedimentology of this vast basin. The rift complex contains evidence for major changes in Earth's systems, yet, the rocks are poorly dated, and the sediment provenance, and link with tectonic evolution, is remarkably poorly known.

This work provides a centralised database of the currently available and previously unpublished detrital zircon geochronology for the Neoproterozoic of the Adelaide Rift Complex, highlighting where the available data is from, and the stratigraphic and spatial gaps in our knowledge. By subjecting the U–Pb detrital zircon data to data analytical techniques, we provide a first-look overview of the change in provenance and subsequently (generalised) palaeo-tectonogeography that this suggests during the Neoproterozoic. These data show a change from dominantly local sources in the middle Tonian, to dominantly far-field sources as the rift-basin develops over time. The Cryogenian icesheets punctuate this with an ephemeral return to more local sources from nearby rift shoulders. This effect is particularly apparent during the Sturtian Glaciation than in the younger Marinoan Glaciation. In the Ediacaran, we see an increasingly stronger influence of younger (<700 Ma) detrital zircons from an enigmatic source that we interpret to be from southern (i.e. Antarctic) sources. We also note that we see a slight shift in the late Mesoproterozoic age peaks, from ca. 1170 Ma to ca. 1090 Ma, with a corresponding decrease in older ca. 1600 Ma detritus. This work forms the basis of continuing work to improve our understanding of the geochronology, provenance and palaeo-tectonogeography of the Adelaide Rift Complex.

Key words:

Adelaide Rift Complex, U–Pb geochronology, palaeogeography

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RECONSTRUCTION OF *GENYORNIS NEWTONI* CRANIA AND SEMICIRCULAR CANALS FOR PALAEOECOLOGICAL AND PHYLOGENETIC INFERENCE

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The dromornithids (Aves, Dromornithidae) are an evolutionarily distinct although extinct clade of large, flightless birds, known from the Australian Neogene fossil record [1,2,3]. *Genyornis newtoni* is the youngest of the dromornithids, first described by Stirling and Zeitz in 1896 [4] from fossil remains collected at Lake Callabonna, South Australia. Lake Callabonna is one of four playa lakes, including Blanche, Gregory and Frome, situated around the northern and eastern margins of the Flinders rangers [5,6]. A complex drainage system links the lakes with multiple filling events of differing magnitudes occurring within the last glacial cycle. The region is currently arid to semi-arid, a stark difference to the abundance of life which would have occurred there 50,000 years ago [1].

Recent Lake Callabonna expeditions have produced sufficient *G. newtoni* cranial elements for realistic reconstruction of the skull morphology. This opens new opportunities for comparative morphological analysis among dromornithid taxa and for an extension of the data available for phylogenetic analyses. Despite previous research concluding the semicircular canal of birds to be phylogenetically informative [7,8,9], analysis of this structure is lacking. Therefore, a comparative analysis of this structure in *G. newtoni* would provide further morphological characters to contribute to phylogenetic analyses. The addition of potentially phylogenetically important characters developed through an extensive and conclusive review of the morphology of *G. newtoni* is likely to assist in resolving the placement of dromornithids and other key lineages within Galloanserae. The morphology of the semicircular canal is closely linked to the method of locomotion and slight variation in shape and size can have implications for how the head was held [10,11,12]. Such research will provide opportunities for palaeoecological inferences for both *G. newtoni* and other dromornithids.

Key words:

Dromornithid, *Genyornis newtoni*, phylogenetics, semicircular canals, Lake Callabonna

References:

[1] Murray, P.F. and Vickers-Rich, P. (2004) Magnificent mihirungs: the colossal flightless birds of the Australian dreamtime. USA, Indiana University Press.
[2] Park, T and Fitzgerald, E.M.G. (2010) Alcheringa: An Australian Journal of Palaeontology 36(3):419-422.
[3] Worthy, T.H., Handley, W.D., Archer, M., Hand, S.J. (2016) Journal of Vertebrate Palaeontology 36(3): e1031345
[4] Stirling, E.C. and Zeitz, A.H.C. (1986) Transactions and Proceedings and Report of the Royal Society of South Australia. W. Howchin. Adelaide, Rigby, W C: 171-211.
[5] DeVogel, S.B., Stephen, B., Magee, J.W., Manley, W.F. and Miller, G.H. (2004) Palaeogeography, Palaeoclimatology, Palaeoecology 204(1-2): 1-13.
[6] Sipla, J. (2007) Unpublished PhD thesis, Stony Brook University, New York.
[7] Milner, A.C., Walsh, S.A. (2009) Zoological Journal of the Linnean Society 155(1): 198-219.
[8] Walsh, S.A. Barrett, P.M. et al. (2009) Proceedings of the Royal Society B: Biological Sciences 276(1660): 1355-1360.
[9] Degrange, F.J., Tambussi, C.P. et al. (2015) Journal of Vertebrate Paleontology 35(2): e912656.
[10] Muller, M. (1999) Journal of Theoretical Biology 198(3) 405-437.
[11] Georgi, J.A. (2008) Unpublished PhD thesis, Stony Brook University, New York.

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THERMAL DRIVERS OF MEDIUM PRESSURE–HIGH TEMPERATURE METAMORPHISM WITHIN AN INTRACONTINENTAL RIFT

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Medium pressure-high temperature (MP-HT) metamorphism is generally accepted to be driven by crustal thickening within compressional tectonic regimes. Despite this consensus, the Harts Range Group located in central Australia provides evidence for MP-HT metamorphism occurring as a result of burial in a deep intracontinental rift. Detrital zircon studies of metasediments within the Harts Range and surrounding sedimentary sequences indicate the Harts Range Group represent the metamorphosed equivalents of the sedimentary successions located in neighbouring sedimentary basins. Although the metamorphic character of this region has been characterised, the thermal character of each of the individual sequences that infilled the rift are yet to be examined. The exhumation and preservation of metamorphosed components of the Harts Range Group, along with the proximity of these metasediments to their sequence equivalents, provide a unique opportunity to examine the thermal character of components that infilled the rift. Measurements indicate the heat production rate of the sequences that infilled the rift are low relative to neighbouring central Australian terranes that are characterised by enrichment of heat producing elements. However, the thickness of the rift-fill (~25 km) still provide significant thermal blanketing. Scenarios of sediment infill characteristics and mantle heat flow have been modelled to evaluate the thermal dynamics required to produce MP-HT conditions at the base of the rift. Our results confirm the combination of high basal heat flows blanketed by thick sedimentary cover plausibly could have generated the MP-HT conditions experienced at the base of this Hart Range Group.

Key words:

heat production, mantle heat flow, airborne radiometrics, gamma ray spectrometry, Harts Range, MP-HT metamorphism

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RECONSTRUCTING THE LATE PLEISTOCENE CLIMATE SEQUENCE AT ALEXANDRA CAVE, NARACOORTE, USING SINGLE-GRAIN OPTICALLY STIMULATED LUMINESCENCE DATING AND PALAEOENVIRONMENTAL PROXIES

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The drivers of the Australia-wide megafaunal extinction during the late Pleistocene remain poorly resolved. Hypotheses include individual or synergistic combinations of climate fluctuations, human impacts through hunting or habitat alteration by landscape burning. Moreover, the relationship between extinction dynamics and long term glacial - interglacial timescales is not yet understood. Using a series of complementary geochronology, palaeoecological and geochemical techniques on a sedimentary sequence in Alexandra Cave, Naracoorte, this study provides improved reconstructions of past climates in south-east South Australia around the time of megafaunal extinction. Ten luminescence dating samples constrain the age of the sedimentary sequence to 17.7—106.3 ka. Palaeoenvironmental reconstructions undertaken using charcoal, carbon isotopes and geochemical analysis reveal high fire frequency and precipitation during Marine Isotope Stage (MIS) 5, while MIS 4 and the Last Glacial Maximum were arid, with low fire frequency. MIS 3 was wet, with little fluctuation in the environment, with the exception of a change in biomass burning at 36 – 50 ka. These findings suggest that climate change likely played a minor role in the demise of megafauna locally, whereas changes in fire regime could have acted as a more significant driver or consequence of megafaunal extinction.

Key words:

Luminescence dating, charcoal, pollen, *Sporormiella*, megafaunal extinction, Naracoorte Caves

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METHANE FLUX DETERMINATION IN AN URBAN WETLAND VIA EDDIE CO-VARIANCE

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Methane (CH_4) is the second most potent greenhouse gas in the atmosphere after carbon dioxide [1]. Demand for more urban green spaces, such as wetlands, as a way to combat climate change and improve biodiversity is increasing. However, there is limited literature on the impacts of climate change on these artificial systems, as well as the potential contributions that these wetlands might make to climate change. Wetlands as a greenhouse gas source or sink are poorly defined due to the wide variety of wetland ecosystem and the challenges involved in long term monitoring of these gases. New robust technology for measuring methane concentration over long durations is now available in the form of eddy covariance flux towers [2]. This study is designed to add to the carbon budget evidence for the city of Adelaide. Methane fluxes in the artificially constructed Urrbrae Wetlands were measured continually over three months using an eddy covariance flux tower. Mean methane flux (FCH_4) of the wetland was found to be 0.2603 ± 0.1865 $\mu mol.m^{-2}.s^{-1}$ which is a factor of 10 higher than other literature values. There is no statistically significant difference between mean night and daytime FCH_4. Linear correlations between FCH_4 and air temperature, air pressure and wind speed were observed. A peak in the early afternoon occurred diurnally, which coincided with the mean maximum daily temperature. No weekly/monthly patterns were observed for the duration of the study. We conclude that artificial urban wetlands are potentially a significant source of atmospheric methane which requires further investigation.

Key words:

methane, greenhouse gas, Eddy Covariance, urban wetlands, climate, flux

References:

[1] IPCC. (2014). Climate Change 2014: Synthesis Report; Chapter Observed Changes and their Causes. In IPCC.

[2] Burba, G. (2005). Eddy Covariance Method – for Scientific, Industrial, Agricultural, and Regulatory Applications. Lincoln, Nebraska: LI-COR Biosciences.

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FELSIC METASTABILITY DURING CONTINENTAL SUBDUCTION

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Ultrahigh pressure (UHP) metamorphic terranes are typically comprised of a bulk felsic component with intercalated mafic rocks. The former generally fail to preserve UHP mineral assemblages, thus hindering accurate tectonic reconstructions [1,2]. Norway's Western Gneiss Complex (WGC) is an extensively studied UHP metamorphic terrane comprised of ~95% amphibolitic felsic gneiss that hosts mafic eclogite facies and minor metapelitic volumes [3]. It has undergone three orogenic events, the first two of which we argue created a sparsely reactive rock system in the volumetrically dominant felsic gneisses. Most studies examine the mafic eclogites recording >125km burial during the Caledonian Orogeny ca. ~430-385 Ma [4], but the underlying reasons for variable reactivity in the WGC remain unclear. The southern ultrahigh-P domain in the comparatively unstudied Sognefjord region contains mafic eclogite facies assemblages recording metamorphic conditions of ~2-2.2 GPa and 650-700°C. The site provides an ideal location for examining felsic crust metastability during continental subduction. Preliminary structural mapping suggests a complex pattern of evolving rock reactivity and identified four deformation events. D1/S1 created a biotite-defined foliation overgrown by garnet+clinopyroxene+phengite coronae in 'low-strain' eclogitic rocks. D2/S2 'high-strain eclogites' continued to deform during the Caledonian while the D1/S1 eclogites failed to react. Caledonian D2/S2 eclogite is overprinted by initially diatexitic shear zones (D3/S3) that evolve into solid-state deformation zones (D4/S4) at 100m+ scales. The metamorphic effect on mafic eclogite is to convert them to biotite-hornblende-plagioclase amphibolite schists. The lack of garnet in these retrogressed rocks suggests that pressures were less than 1.0 GPa by this time.

Key words:

UHP metamorphism, subduction, metastability, Western Gneiss Complex, petrology

References:

[1] Wain, A., Waters, D., Jephcoat, A. and Olijynk, H. (2000) European Journal of Mineralogy 12: 667-687

[2] Peterman, E.M., Hacker, B.R. and Baxter E.F. (2009) European Journal of Mineralogy 21(6): 1096-1118.

[3] Skar O. and Pedersen R.B. (2003) Journal of the Geological Society 160: 935-946.

[4] Hacker B.R., Andersen T.B., Johnston S., Kylander-Clark A.R.C., Peterman E.M., Walsh E.O. & Young D. (2010) Tectonophysics 480: 149-171.

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COMPOSITIONALLY-BASED MODELS OF THERMAL CONDUCTIVITY OF IGNEOUS AND METAMORPHIC ROCKS

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Thermal conductivity (*k*) is essential for determining heat flow within the Earth, which is necessary for geothermal investigations, accurately modelling tectonic and volcanic processes, and predicting petroleum maturation. Currently, *k* can be measured on hand samples, however, it can be impracticable to make regional models due to time and expense required. In this study, we create a compositionally-based model to predict *k* within the crust. We measured *k* on 340 igneous and 168 metamorphic rocks using an optical conductivity scanner. Density and p-wave velocity are calculated through models, and density is also measured using Archimedes' principle. The data are supplemented with 122 previously published measurements. Each of the samples have their major element geochemistry and modal mineralogy. The results for the igneous samples show that *k* varies between 2 to 3 W m^{-1} K^{-1}. From this, the geometric model produces a consistent best fit and that the primary control on *k* is SiO_2. The preliminary data for the metamorphic samples show the range for *k* is between 2 to 5 W m^{-1} K^{-1} and it is predicted that the main control for these values is SiO_2 and Al_2O_3, as well as the anisotropy factor. These results show that, on average, metamorphic rocks have a higher *k* than igneous rocks. The compositional model for igneous rocks is relatively successful at predicting *k* from sample mineralogy and major element composition (< 10%). Therefore, it is hypothesised that the model for metamorphic rocks should also be successful. With this new model, *k* can be predicted without having to make a direct measurement, which significantly improves estimates of crustal temperatures where the crustal composition can be reasonably determined. Future studies should include pressure and temperature effects on *k* so that the model can be more reliably extended to a greater range of physical conditions.

Key words:

Thermal conductivity, igneous, metamorphic, composition, anisotropy, mixing models

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CONSTRAINTS ON DEPOSITIONAL ENVIRONMENT, GEOCHRONOLOGY AND TECTONIC GEOGRAPHY OF THE GREATER MCARTHUR BASIN

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The informally named greater McArthur Basin is a regionally extensive Proterozoic 'super basin' system located across northern Australia. The region hosts large and proven hydrocarbon reservoirs as well as high grade mineralisation. The deposition system is divided into 'packages'; rocks of similar lithology, age and stratigraphic position. Although studies have begun to constrain intra-basin correlation, tectonic setting and depositional environments of the enclosing Wilton and Glyde Packages, very little is known about the Favenc Package. In this study, we present new, high resolution geochemical isotopic data (rare earth, trace and majors elements) as proxies for the palaeoenvironment and redox conditions of the Mount Rigg Carbonates. Cerium anomalies, Y/Ho and Zn/Fe ratios of carbonate-rich facies show evidence for restrictive and anoxic basin-wide conditions through the deposition of the Dook Creek, Limmen and Mainorou Formations. Furthermore, rare earth elements and yttrium (REY) distribution patterns of these carbonates also reflected a lacustrine environment. In addition, new U–Pb, Hf and REE data of detrital zircons within the Favenc and Wilton Packages are also presented to investigate correlation and provenance of stratigraphically similar groups. Using the youngest concordant grain, the Dook Creek Formation is interpreted to have a maximum depositional age of 1614 ± 78 Ma. ƐHf(t) values of the unit ranges between -28.09 to 18.89. Findings in this study were then incorporated together to develop a tectonic and deposition model for the Mesoproterozoic greater McArthur Basin.

Key words:

Greater McArthur Basin, geochemistry, geochronology, tectonics, palaeoenvironment

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CYCLING OF ECLOGITE WITHIN A SERPENTINITE FILLED SUBDUCTION CHANNEL

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Translating burial and exhumation histories from the petrological and geochronological evolution of high-pressure assemblages in subduction channels is key to understanding subduction channel processes. Convective return flow, either serpentinite or sediment hosted, has been suggested as a potential mechanism to retrieve rocks from significant depths and exhume them to the surface. Numerical modelling predicts that during this convective flow oceanic crust can be cycled within a serpentinite-filled subduction channel, experiencing multiple burial cycles. Geochronological and petrological evidence for such cycling during subduction is preserved in lawsonite eclogite from serpentinite mélange in the Southern New England Orogen, in eastern Australia. U–Pb titanite and Ar–Ar/ Rb–Sr phengite geochronology, supported by mineral equilibria forward modelling and mineral zoning patterns, suggest a second cycle of burial within the subduction channel in the Cambro–Ordovician. The initial subduction of the eclogite at ca. 490 Ma formed HREE- and Mn-rich garnet cores and porphyroblastic lawsonite at approximate *P–T* conditions of at least 2.9 GPa and 600 °C. Partial exhumation to approximately 1.9 GPa and 500 degrees is recorded by garnet dissolution and retrograde chlorite and glaucophane. Reburial of the eclogite resulted in growth of new comparatively Mg-rich garnet rims, growth of new prograde-zoned phengite and recrystallization of titanite at *P–T* conditions of approximately 2.7 GPa and 590 °C. U–Pb titanite, and Ar–Ar and Rb–Sr phengite ages record recrystallization during this second event at ca. 450 Ma. This was followed by a second exhumation event, where chlorite and glaucophane partially replaced garnet and omphacite respectively, at approximately 2.2 GPa and 520 °C. These conditions fall along a cold approximate geotherm of 230 °C/GPa, supported by the preservation of pristine lawsonite throughout the burial and exhumation stages. Inferred changes in pressure suggest the lawsonite eclogite underwent depth cycling within the subduction channel, supported by geochronological data indicating that partial exhumation and reburial occurred over ca. 50 Ma.

Key words:

Eclogite, lawsonite, high-pressure, subduction, serpentinite, channel flow

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DO CANYONS INFLUENCE ORCA AGGREGATION IN THE WESTERN GREAT AUSTRALIAN BIGHT?

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The western Great Australian Bight is home to a seasonal hotspot for *Orcinus orca* (orcas or killer whales) aggregation, which occurs from November to March [1,2]. The reason why this aggregation occurs is attributed to a subsurface upwelling event is from data obtained from the Southern Voyager April 2006 voyage [3], however what causes that sub-surface upwelling event is unknown. A potential cause of subsurface upwelling events is through a canyon interacting with a current to condense flow in the region, and thus increasing the amount of prey in a small area. Supporting this idea is next to the orca hotspot is the Hood Canyon, a tributary of the Bremer Canyon with a structure that seems to support the idea of feeding the Flinders Current into a localised hotspot, with a more gentle slope change to the right of the outlet (average of 22.55°, and maxes at 55°) and a steeper northern wall (an average of 27.22° with a max of 81.5°).

To test if the Hood Canyon could condense the Flinders Current, a single layer hydrodynamic model was used create a velocity field using bathymetry from the Collaborative Australian Postgraduate Sea Training Alliance Network (CAPSTAN) and a decrease of sea level of 5 cm on the northern boundary driving flow. Neutrally buoyant passive Lagrangian particles are then released on the western boundary, and measured to see if they interact with the canyon. Doing this with a westwards current, representing the Flinders Current, resulted in 92% of particles transecting the Bremer Canyon between 34.5705° to 35.0434° ending up within the area that corresponds with the orca hotspot.

Key words:

oceanography, canyon, current, modelling, orcas, upwelling

References:

[1] Wellard, R., Lightbody, K., Fouda, L., Blewitt, M., Riggs, D. & Erbe, C. 2016. 'Killer whale (*Orcinus orca*) predation on beaked whales (*Mesoplodon* spp.) in the Bremer Sub-Basin, Western Australia'. PloS one, 11.

[2] Meeuwig, J., Turner, J. & Bouchet, P. 2016. Bremer Canyon Science Report.

[3] Pattiaratchi, C. 2007. 'Understanding areas of high productivity within the South-west Marine Region'. National Oceans Office Report.

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MIOCENE ORIGINS AND PLIO-PLEISTOCENE GIGANTISM IN THE AUSTRALASIAN BLUETONGUED LIZARDS (SQUAMATA: SCINCIDAE)

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The charismatic blue-tongue lizards of the genus *Tiliqua* are amongst the largest skinks in the world today. This study uses fossils from around Australia to examine how and when this group managed to grow so large, how their body shapes became so diverse and explores how a pygmy species appeared amongst giants. Discrete and continuous morphological characters, combined with molecular data, were analysed with both parsimony and tip-dated Bayesian methods. Three fossil *Tiliqua* species were added to these analyses, *Tiliqua pusilla*, a tiny middle-Miocene taxon; *Tiliqua wilkinsonorum*, a large Pliocene taxon; and *Tiliqua frangens*, an extinct Pleistocene 'megafaunal' shingleback. The resulting tip-dated total-evidence phylogeny suggests that the most rapid morphological evolution in the social skinks, in the Oligo-Miocene, produced the highly distinctive body forms typical of *Tiliqua*, and the clade *Cyclodomorphus*. Within *Tiliqua*, phyletic gigantism began after the middle Miocene, and peaked in the Plio-Pleistocene with two giant taxa. There are also examples of: autapomorphic nanism which produced the endangered pygmy *Tiliqua adelaidensis*, sister taxon to one of the largest extant skinks, *T. rugosa*; and phyletic nanism, a trend in decreasing body size which produced the clade inclusive of the small *Cyclodomorphus branchialis*. Knowledge of how and when these body size changes occurred would not have been possible without a total-evidence phylogeny of this group. This investigation has uncovered another exception to Cope's rule that bodies grow larger through evolutionary time and has highlighted the morphological diversity of Australia's previously underrepresented fossil reptiles.

Key words:

Palaeontology, reptiles, phylogenetics, Bayesian, late Cenozoic, megafauna

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CRUSTAL HOTSPOT METAMORPHISM POWERED BY ANOMALOUS HIGH HEAT PRODUCING Th–U CONCENTRATIONS

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High geothermal gradient metamorphism characterised by cordierite-bearing prograde amphibolite facies mineral assemblages requires thermally energetic environments which represent significant excursions from normal continental thermal conditions. For this reason, heat advected from magmas generated at depth are typically considered necessary to create a high geothermal gradient environment, and therefore, metamorphism should be spatially and temporally associated with magmatism with elevated thermal conditions being transient. While this will likely remain the governing paradigm, we present evidence from the Arkaroola region of the northern Flinders Ranges, South Australia, where high geothermal gradient mineral assemblages are not obviously spatially or temporally associated with magmatism. Our study focusses on cordierite-bearing schists from within the lower Adelaidean stratigraphy of the Adelaide Rift Complex. These strata directly overlie the Mount Painter Inlier, a basement inlier comprised of Mesoproterozoic metasediments and granitic rocks which display some of the world's most anomalous enrichments in heat producing elements (Th, U and K). This study presents results from in-situ U–Pb monazite geochronology combined with phase equilibria modelling to argue that the rocks of the lower Adelaidean began undergoing prograde metamorphism at c. 580 Ma, much earlier than previously thought, significantly pre-dating the onset of the regional Delamerian Orogeny at c. 520 Ma. Phase equilibria modelling indicates that metamorphism took place under highly perturbed geothermal gradient conditions in excess of 180 °C/kbar (> 48 °C/km) and was highly sensitive to burial depth within the basin. We interpret the Arkaroola region to be an example of a basin-hosted metamorphic system thermally driven by endogenous heat production.

Key words: Metamorphism, heat production, geothermal energy, monazite geochronology, phase equilibria modelling

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DESCENDING INTO THE "SNOWBALL": IMPROVING INTERPRETATIONS OF TONIAN AND CRYOGENIAN PALAEOENVIRONMENTS WITH DETAILED SEDIMENTOLOGY

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The Neoproterozoic Era (1000 to 541 Ma) represents a period of significant physiochemical change in Earth history. It involved variations in oceanic and atmospheric oxygenation, significant changes in the biosphere, tectonic reorganisation, and two episodes of major glaciation referred to as "Snowball Earth". Three periods comprise Neoproterozoic time: Tonian, Cryogenian and Ediacaran. The Tonian–Cryogenian transition marks the onset of the Sturtian glaciation, with these sediments recording major environmental shifts through distinct variations in lithology and isotope chemistry. Tonian-Cryogenian sediments accumulated in the Adelaide Rift Complex, South Australia, ca. 750 million years ago, and represent some of the most significant and well-exposed sections of this interval globally. Although this transition is geologically significant, it remains enigmatic due to a distinct lack of comprehensive, contemporary Tonian-Cryogenian research in South Australia. This gap is exacerbated by recent sedimentological analysis of complete Tonian-Cryogenian sections at other significant Neoproterozoic sites in Namibia, Scotland, Svalbard, and Canada.

We present a robust sedimentological analysis and palaeoenvironmental interpretation for a complete pre- to post-Sturtian glaciation succession in the northern Flinders Ranges, South Australia. Detailed descriptions of grain size, sedimentary structures, bedding thickness and palaeocurrent direction have been observed from a 5km, Tonian-Cryogenian section near Copley, South Australia. Our analysis reveals multiple regressive-transgressive cycles, recorded by shallow marine rippled and cross-stratified sandstones, very shallow water interbedded shales and stromatolitic carbonates, and interbedded laminated siltstones and carbonates. These shallow to deep water formations are unconformably overlain by a greywacke diamictite with quarzitic and dolomitic interbeds, which grades into a poorly laminated siltstone with sparse pebbles. We suggest that these facies reflect glaciomarine conditions during peak glaciation and at the onset of deglaciation. The post-glacial formation consists of laminated shales and carbonates, reflecting widespread transgression after the Sturtian glaciation. We present these analyses, focussing on the record of palaeoenvironments spanning pre- to post-Sturtian glaciation, and a comparison of our findings with equivalent sections globally to shed new light in our understanding of how the world descended into one of the most severe glaciations ever recorded.

Key words:

Sedimentology, Tonian, Cryogenian, Adelaide Rift Complex

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FACTORS GOVERNING MICROBIAL HETEROGENEITY AND TRICHLOROETHYLENE BIODEGRADATION IN A CHLOROCARBON CONTAMINATED AQUIFER

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Aquifers are geochemically complex environments which constitute the largest microbial reservoir in the biosphere [1; 2]. Within these systems, microbes play key roles in maintaining groundwater quality by recycling nutrients and degrading anthropogenic contaminants, making bioremediation an effective tool for groundwater remediation [2]. However, groundwater microbiology is largely governed by subsurface geology; thus, bioremediation efficacy would too be influenced by geology, placing importance on understanding the role of geology in governing subsurface microbial dynamics [3]. Here, we investigate the spatial abundance, taxonomy and interaction dynamics of prokaryotes and virus-like particles within a chlorocarbon contaminated aquifer in Beverley, South Australia via 16S rRNA sequencing, flow cytometry and multi-correlative network analysis. Our results show a dominance of putative nitrogen cycling taxa in groundwater and coupling of trichloroethylene biodegradation to nitrate reduction; we suggest nitrate reduction inhibits trichloroethylene biodegradation by scavenging electron donors which would otherwise be available for biological reductive dehalogenation. We demonstrate that the Beverley aquifer is biologically unproductive, inferred from the low virus to microbe ratios ranging from 0 to 0.9. The aquifer was also microbially heterogeneous, with vertical partitioning of the microbial community over a localised aquitard, heterogeneity of bacterial composition and prokaryotic and virus-like particle abundances within tens of metres laterally. Obligate halogen-respiring *Dehalococcoidia* represented 4.9% average abundance, indicating that ongoing biodegradation of halogenated contaminants, such as trichloroethylene, was occurring. These results emphasise the dynamic nature of groundwater and the necessity for considering aquifer lithology, hydrology, and geochemistry when devising sampling regimes to accurately characterise microbial parameters in the subsurface. Our findings facilitate a deeper understanding of microbial ecology and population dynamics within contaminated groundwater. By understanding such dynamics, we can begin to investigate factors influencing the natural attenuation of chlorocarbon contaminants to further the development of effective remediation practices.

Key words:

Groundwater, microbial ecology, biogeochemistry, bioremediation, trichloroethylene, bacteria

References:

[1] Gleeson, T., Befus, K. M, Jasechko, S., Luijendijk, E. and Cardenas, M. B. (2016) The global volume and distribution of modern groundwater. *Nat. Geosci.* 9: 161-167.

[2] Griebler, C. and Lueders, T. (2009) Microbial biodiversity in groundwater ecosystems. *Freshwater Biol* 54: 649-677.

[3] Brockman, F. J. and Murray, C. J. (1997) Subsurface microbiological heterogeneity: current knowledge, descriptive approaches and applications. *FEMS Microbiol Ecol* 20: 231-247.

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THE REPLACEMENT REACTION OF CHALCOPYRITE BY COVELLITE UNDER HYDROTHERMAL CONDITIONS

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In the supergene layer, covellite (CuS) is commonly found and recognized as a secondary copper sulfide. Previous studies suggest that covellite is formed by a mineral replacement reaction from chalcopyrite ($CuFeS_2$) *in situ* [1]. There have been a limited number of studies conducted on the replacement of chalcopyrite with covellite and the reaction mechanisms are still not well-understood. Currently, the copper leaching of chalcopyrite is not very cost-effective because it is refractory compared to other copper sulfides. In this research we aim to understand the mechanisms and kinetics of the replacement reaction of chalcopyrite by covellite/chalcocite under hydrothermal conditions enabling an extrapolation of the reaction rate at low temperatures, typically in supergene environment. The results show the replacement reaction of chalcopyrite to covellite can be achieved under pH 1, 2 and 3 between 180 and 210°C. The replacement reaction rate increases as the pH value decreases. The outcome of this work is beneficial to the processing of copper sulfides in mining industry by aiding understanding of the reaction mechanisms of the replacement of chalcopyrite by covellite.

Key words:

Chalcopyrite, covellite, mineral replacement reaction, hydrothermal

References:

[1] Reich, M. and P.M. Vasconcelos, *Geological and economic significance of supergene metal deposits.* Elements, 2015. **11**(5): p. 305-310.

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Resolving the taxonomic validity of the giant extinct marsupial *Nototherium* (Diprotodontidae) and its relationship to *Zygomaturus*

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The megafaunal herbivores of the family Diprotodontidae were integral members of terrestrial ecosystems in Australia and New Guinea until the last-surviving and largest-ever diprotodontid, Diprotodon optatum, became extinct c. 40,000 years ago. Despite their iconic status as the largest-ever marsupials and the frequency with which their remains are encountered, key aspects of their systematics and evolutionary history remain poorly resolved. There is no clearer example of this than the taxonomic confusion surrounding the late Cenozoic genera Nototherium Owen 1845 and Zygomaturus Macleay 1858, which has persisted for more than 160 years. This is attributable to: 1) the highly fragmentary fossil material upon which the original two species of Nototherium were founded; 2) the destruction of the lectotype of N. inerme during World War II; and 3) marked similarities in the size and shape of the jaws and teeth of species referred to Nototherium and Zygomaturus. Most recently, this has led to Nototherium and its original two species, N. inerme and N. mitchelli, being relegated to nomina dubia. However, re-appraisal of the type material plus new material recently uncovered, including two crania, has shed light on the taxonomy and distinctiveness of Nototherium and provided evidence for its validity. Here I reassess the systematics and distribution of Nototherium and Zygomaturus and provide a preliminary diagnosis of the two most convergent and oft-confused species, Nototherium inerme/mitchelli and Zygomaturus trilobus.

Key words:

palaeontology, systematics, Australia, biogeography, osteology