# Geological Society of Australia

## Earth Sciences Student Symposium - South Australia

## PROGRAM AND ABSTRACT PROCEEDINGS 2021

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AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS 1917

Adelaide University AAPG Student Chapter

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# WELCOME TO GESSS-SA 2021

Welcome to the annual Geological Society of Australia Earth Sciences Student Symposium (GESSS-SA). We are pleased to have your company at the Sprigg Room, Mawson Building, University of Adelaide City Campus.

This event provides an opportunity for undergraduate and post-graduate students to present their research to the public and wider scientific community. This experience is valuable for students who wish to develop their communication skills, network with their peers and professional geoscientists as well as develop their early careers.

We are elated that our presenters this year are covering a wide range of topics including, palaeontology, archaeology, ecology, environmental sciences, igneous, sedimentary and metamorphic geology.

We sincerely thank our sponsors for their support in making this year's conference possible and we hope to continue these partnerships into the future. We would also like to thank the University of Adelaide for their assistance in making this event possible.

Thank you for your participation and we hope you enjoy GESSS-SA 2021.

GESSS-SA 2021 Committee

# GESSS-SA 2021 COMMITTEE

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In South Australia, we own and operate the copper-gold mine at Prominent Hill and the copper-gold mine at Carrapateena. We have a pipeline of earn-in agreements with experienced exploration companies in Australia and internationally. We also have an operating mine and a significant pipeline of development and exploration opportunities in the Carajás and Gurupi provinces in Brazil.

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Minotaur Exploration Ltd (ASX:MEP) is an Adelaide-based ASX-listed mineral exploration company whose business model is built on a three-tier platform through close exposure to minerals prospects and related technology applications. Minotaur's exploration portfolio is primarily vectored towards copper discovery. As demand grows supply shrinks and the impetus for explorers to uncover new copper endowed systems strengthens. Minotaur also explorers for gold, recognising its intrinsic value as faith in fiat currencies is tested.

Regions of focus within Australia for copper-gold mineralisation include the Cloncurry terrane of western Queensland and South Australia's Gawler Craton. Projects include Eloise (in Joint Venture with Oz Minerals), Pyramid Gold, Windsor VMS and Peake & Denison. Minotaur is a 25% contributing partner in the Great White Kaolin Joint Venture (GW JV), the proposed development of long-life kaolin-halloysite mining operation in South Australia. In many of these projects the more expensive drill test phase is often undertaken in conjunction with a farm-in partner to ameliorate risk and expenditure.

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, more recent discoveries in Cloncurry, and the imminent development of the Great White Kaolin Joint Venture on Eyre Peninsula, Minotaur has contributed significantly to the growth and prosperity of Australia.

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DEM's Mineral Resources Division is committed to developing the state's resource wealth to benefit South Australians. The Division drives forward growth and sustainable development of South Australia's minerals and energy assets within a world's best regulatory framework. The work supports the vision of growing the mineral sector's reputation as a leading resource investment destination, and encompasses leading-edge regulation, environmental assessment and royalty administration to provide good outcomes for the South Australian economy and community.

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# SPONSOR: AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS ADELAIDE UNIVERSITY STUDENT CHAPTER


Since its founding in 1917, the American Association of Petroleum Geologists has been a pillar of the worldwide scientific community. The original purpose of AAPG, to foster scientific research, to advance the science of geology, to promote technology, and to inspire high professional conduct.

The Adelaide University AAPG student chapter is an active social-academic group of petroleum geoscience and engineering students. Th chapter conducts a range of activities including technical talks, field trips and student-industry networking events.

# GESSS-SA 2021 PROGRAM

| TIME | PROCEEDINGS | |
|---|---|---|
| 8:30-9:00 | **Registration** | |
| 9:00-9:10 | Introduction and Welcome to Country | |
| 9:10-9:20 | Acknowledgement of Country | |
| **TIME** | **SESSION 1** | |
| 9:20-9:30 | **Dr. Antonio Belperio**, *Minotaur Exploration* | Diamond Sponsor Talk |
| 9:30-9:55 | **Dr. Ian Moffat**, *Flinders University* | Using Geophysical and Geochemical Methods in Archaeological Rock Shelters |
| 9:55-10:10 | **Richard Lewis**, *University of Adelaide* | The Hydroclimatic And Chronological Context Of Late Pleistocene Megafauna Extinction In North-Eastern Australia |
| 10:10-10:25 | **Fraser Brown**, *Flinders University* | Thylacoleo Carnifex (Owen): An Examination Of Assigned Bite Traces And Implications For Mode Of Predation. |
| 10:25-10:40 | **Vito Hernandez**, *Flinders University* | We Don't Live In A Bubble, And Neither Does The Site You Study: Geoarchaeology And The Challenges Of Southeast Asian Sites |
| 10:40-11:10 | **Morning Tea** | |
| **TIME** | **SESSION 2** | |
| 11:10-11:20 | **Ian Anderson**, *Oz Minerals* | Diamond Sponsor Talk |
| 11:20-11:35 | **Ashten Turner**, *University of Adelaide* | Preliminary Revision Of The Morphology Of Phyllozoon Hanseni From The Ediacaran Of South Australia. |
| 11:35-11:50 | **Tiah Bampton**, *University of Adelaide* | Palaeoecology Study Of Two Rodent Species (Genus Pseudomys) Using Stable Isotopic Analysis, Naracoorte Caves, South Australia |
| 11:50-12:05 | **Lucinda Duxbury**, *University of Adelaide* | Holocene Fire And Ecosystem Change On Kangaroo Island |
| 12:05-12:20 | **Flynn Cameron,** *University of Adelaide* | Topographic Reconstructions Of The East African Orogen |
| 12:20-13:20 | **Lunch** | |

# GESSS SA 2021 PROGRAM

| TIME | SESSION 3 | |
|---|---|---|
| 13:20-13:30 | **Dr. Kate Robertson**, *Geological Survey of South Australia* | Diamond Sponsor Talk |
| 13:30-13:45 | **Oliver Pring**, *University of Adelaide* | The Fractionation Of Copper Isotopes In Granitic And Mafic Intrusions: Mafic Enclaves In The Mannum Granite, A Case Study |
| 13:45-14:00 | **Travis Batch**, *University of South Australia* | Investigations Into The Geology Of The Tumut Trough, Lachlan Orogen, NSW |
| 14:00-14:15 | **Thomas Burke**, *University of Adelaide* | Gechronology Of Pallasite Meteorites: First In Situ Lu-Hf Ages And Pu Fission Track Methodology Refinements |
| 14:15-14:45 | **Afternoon Tea** | |
| **TIME** | **SESSION 4** | |
| 14:45-15:10 | **Dr. Lorna Strachan**, *University of Auckland* | How I Became A Marine Geologist; Career Challenges & Perspectives |
| 15:10-15:25 | **Samuel Rasch**, *University of Adelaide* | Dating And Characterising A Newly Discovered Sedimentary Basin In The East Tennant Region |
| 15:25-15:40 | **Angus Nixon**, *University of Adelaide* | Influence Of The Kalkarindji Large Igneous Province On The Mcarthur Basin Low-Temperature Evolution |
| 15:40-16:15 | **Poster Session** | |
| 16:15-16:50 | **Tate Museum Tour** | |
| 16:50-17:00 | **Closing Remarks and Prize Announcements** | |

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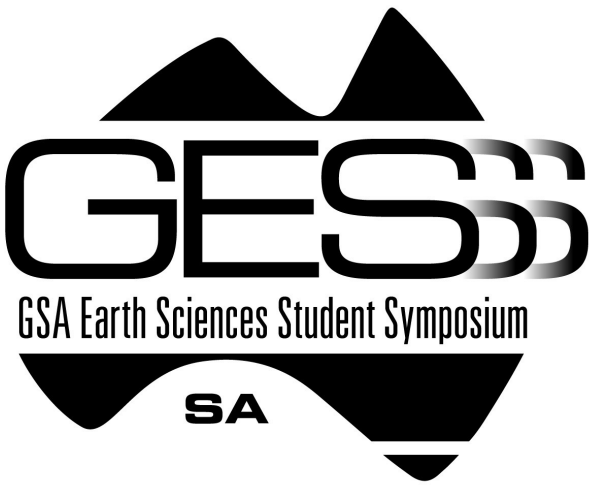
# Oral Presentation Abstract Volume 2021




# THE HYDROCLIMATIC AND CHRONOLOGICAL CONTEXT OF LATE PLEISTOCENE MEGAFAUNA EXTINCTION IN NORTH-EASTERN AUSTRALIA

**Richard J. Lewis[1], Lee J. Arnold[1], Scott Hocknull[2, 3], John Tibby[4], Martina Demuro[1], Rochelle Lawrence[2]**

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The lack of well dated palaeoenvironmental archives continues to fuel the late Pleistocene megafauna extinction debate for Sahul (Australian and New Guinea). Conventionally, palaeoenvironmental reconstructions and inferences of human- verses climate-mediated causes of megafauna extinction have relied on biological proxy data. However, a wealth of environmental information can also be inferred from abiotic data, including the type and mode of sediment deposition itself. We examine the timing and palaeoenvironmental significance of fossil-bearing sediment archives from South Walker Creek, tropical Queensland, and use a Bayesian modelling approach to compare the resulting chronometric datasets with a range of other Australian catchment records. Regional spatiotemporal patterns of hydrological activity is then inferred from this chronological framework and used to consider megafauna disappearance in the context of changing environmental conditions during the late Pleistocene. Results support a link between the last appearance of megafauna at South Walker Creek around 37.9 thousand years ago (ka) and a regional trend towards a more negative moisture balance during late Marine Isotope Stage 3 (MIS3). Limited fluvial and lacustrine deposition persist across several northern and central Australian catchments through late MIS3 and early- to mid-MIS2, including the Last Glacial Maximum – coincident with an absence of preserved fluvial deposition at South Walker Creek between 43.6 and 15.8 ka – before renewed fluvial deposition is recorded across various basins from late MIS2 onwards (~16 ka). The outcome of this analysis provides important insights into regional Australian palaeoenvironmental reconstructions during the late Pleistocene; revealing differences in catchment responses related to synoptic climate conditions during MIS3–1, and adding new constraints on megafauna extinction dynamics in the underrepresented tropical zone of Sahul.

**Key words:**

OSL dating, megafauna extinction, late Pleistocene, Australia, fluvial activity

# *THYLACOLEO CARNIFEX* (OWEN): AN EXAMINATION OF ASSIGNED BITE TRACES AND IMPLICATIONS FOR MODE OF PREDATION

**Fraser G. Brown[1], Aaron B. Camens[1]**

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*Thylacoleo carnifex* was a large marsupial carnivore native to the Australian mainland during the late Pleistocene. Its unusual anatomy and its interaction with the other equally enigmatic Australian megafauna have been the subject of much debate [1, 2]. Here, a sample of modified bones were examined with the goal of identifying the marks of *T. carnifex* and inferring predatory modes. A sample of 54 elements from 8 sources yielded 13-18 elements with perimortem *T. carnifex* traces. These elements exhibited some trends in prey selection with macropodoids being the overwhelming majority (~78-85%), and a smaller percentage of large diprotodontids. Certain trends were also found to suggest an anatomical focus; the axial skeleton contributed only one element, contrasting the distal bones of the limbs and the pes. The tarsometatarsal and radioulnar joints were targeted specifically, and the lack of musculature in these areas perhaps indicates an unusual form of prey capture or disarticulation whilst feeding. The small sample size limits conclusions in this respect, and the reliability of the taphonomic record as an unbiased source remains problematic.

**Key words:**

Megafauna, taphonomy, Ichnology, Thylacoleo carnifex, Pleistocene

**References:**

[1] Wells R.T., Camens A.B. (2018) 'New skeletal material sheds light on the palaeobiology of the Pleistocene marsupial carnivore, Thylacoleo carnifex' PLOS ONE 13(12):e0208020.
[2] Figueirido B., Martín-Serra A., Janis C.M. (2016) 'Ecomorphological determinations in the absence of living analogues: the predatory behaviour of the marsupial lion (Thylacoleo carnifex) as revealed by the elbow joint' Paleobiology 42(3):508–531.

# WE DON'T LIVE IN A BUBBLE, AND NEITHER DOES THE SITE YOU STUDY: GEOARCHAEOLOGY AND THE CHALLENGES OF SOUTHEAST ASIAN SITES

**Vito Hernandez[1]**

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This presentation is an overview of the natural and cultural circumstances that make archaeological work in Southeast Asia challenging, and the growing need for geoarchaeological methods to be applied to many of its sites. Current and previous research conducted in the region covering Pleistocene, Holocene and recent historical sites are used to illustrate these challenges, and discuss the importance of reflexivity when conducting geoarchaeological work in the region; emphasizing what Karl Butzer wrote in page 40 of his 1982 book *Archaeology as Human Ecology: Method and Theory for a Contextual Approach:* 'The purpose of geoarchaeology is not to implement an impressive battery of tests but to select those procedures that within the constraints of available financial and human resources will yield the results most critical to proper evaluation of a particular context'.

**Key words**

Geoarchaeology, Southeast Asia, archaeological stratigraphy, site preservation

# PRELIMINARY REVISION OF THE MORPHOLOGY OF PHYLLOZOON HANSENI FROM THE EDIACARAN OF SOUTH AUSTRALIA.

**Ashten M. Turner[1], Steven Delean[1] y Diego C. García-Bellido[1-2]**

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We have investigated the morphology of *Phyllozoon hanseni* Jenkins and Gehling, a frond-like fossil organism with glide reflection symmetry from the Ediacaran of the Flinders Ranges, South Australia. The focus of this study was to measure some basic physical parameters of these fossils to identify some distinguishing trends, to help build a picture of the functional morphology of *P. hanseni*, and then to reconcile this information in a palaeobiological context. The main findings are that specimen length displayed a non-normal, negatively skewed distribution, and that *P. hanseni* possesses two distinct ends. One dubbed here the 'spoon', is rounded in profile, with steep-angled positioning of thicker units and a rosebud-like appearance at the terminus, found to always begin on the left bank of the positive hyporelief. The other end, the 'knife', displays instead a gradual decrease in both unit width and length with positioning of units perpendicular to the body axis. The area between these two sections, with sub-parallel edges, is referred to as the 'trunk'. Specimen length was found to be positively associated with both unit number and specimen width. Additionally, the findings suggest a longitudinally asymmetrical growth pattern of increasing size and number of units, with serial addition of units at the knife terminus. The observed morphology of *P. hanseni* suggests as a lifestyle as a benthic, prostrate organism.

**Key words:**

Phyllozoon, Ediacara Biota, Flinders Ranges, glide symmetry, longitudinal asymmetry.

# PALAEOECOLOGY STUDY OF TWO RODENT SPECIES (GENUS *PSEUDOMYS*) USING STABLE ISOTOPIC ANALYSIS, NARACOORTE CAVES, SOUTH AUSTRALIA

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Understanding the dietary and habitat niche of past faunas is important for elucidating faunal community response to changes in climate and environment through time. Stable isotopic analysis of carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) obtained from fossil remains is a useful tool for interpreting palaeoecology of both extinct and extant fauna's [1]. Here we report on the first stable isotope study of Quaternary fossil vertebrates from the Naracoorte Caves World Heritage Area (NCWHA). We conducted $\delta^{18}O$ and $\delta^{13}C$ analyses on fossil teeth of two native rodent species (*Pseudomys auritus* and *P. australis)*, obtained from a palaeontological excavation in the third chamber of Blanche Cave (5U6). *P. auritus* became totally extinct shortly after European colonisation; probably in the 1850s. Consequently, little is known of its diet or habitat preference. We analysed $\delta^{13}C$ and $\delta^{18}O$ from the bioapatite of fossilised tooth material, using isotope ratio mass spectrometry. Isotopic signatures from $\delta^{13}C$ and $\delta^{18}O$ were used to reconstruct palaeodiet, drinking behaviour and habitat preferences for both species. These data were then compared with existing ecological records. The $\delta^{13}C$ data show that *P. auritus* was more of a dietary specialist when compared to *P. australis.* While the $\delta^{18}O$ indicate that the two species obtained their body water from a similar source. Our results suggest that the possible driver of extinction for *P. auritus* was the lack of its preferred diet due to habitat loss.

**Key words:**

Palaeoecology, stable isotopes, bioapatite, rodents, Naracoorte Caves

**References:**

[1] Crawford, K., McDonald, R. A. and Bearhop, S. (2018) Mammal Review, 38: 87-107

# HOLOCENE FIRE AND ECOSYSTEM CHANGE ON KANGAROO ISLAND

**Lucinda C. Duxbury[1,2,3], Jonathan J. Tyler[1,3], Linda H. Ambrecht[2], Alexander Francke[1], Haidee R. Cadd[4,8], W. Boone Law[6], Atun Zawadzki[7], David Child[7], Patricia Gadd[7], Geraldine Jacobsen[7], John Tibby[5], Kieren J. Mitchell[2,6]**

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Fire has long been an important part of Australian landscapes. However, anthropogenic climate heralds major shifts in fire regimes, negatively impacting ecosystems. These effects will worsen in coming years, but there remain difficulties with projecting fire regime trajectories and their environmental impacts, in part due to a lack of data on centennial to millennial timescales.

This study aims to address these uncertainties by returning to Lashmars Lagoon, Kangaroo Island, a site of pioneering palaeoenvironmental research that has been overlooked in recent decades. Kangaroo Island presents a fascinating case study, due to putative abandonment of the island by ancient Aboriginal populations ~ 2,500 years ago. As such, it represents a unique opportunity to study the impact of cessation of Aboriginal management practices on ecosystems prior to European invasion.

We collected a ~ 7.5 metre long sediment core from Lashmars Lagoon, which we expected, from the work of previous studies, to span the past 5,000 years. The analysis of these cores combines traditional and novel palaeoecological and geochemical proxies to infer fire, catchment and ecosystem variability, augmented by an age model based on Pb-210, Pu isotopic profiling and C-14 dating.

In this talk, I specifically discuss our preliminary age model, work integral to the interpretation of our other proxies. Our preliminary age model determined our core to span the past ~ 7,000 years, an adjustment to previous estimates. The model also integrates 15 Pb-210 dates from the uppermost 30 cm, verified by the establishment of a nuclear bomb-testing peak from Pu isotopic profiling. Overall, the age model indicates a constant rate of sedimentation approximately 1 mm/yr, a somewhat surprising result given the considerable variation in

sedimentology. Importantly, refining our age model improves certainty around the timing of the human exodus from Kangaroo Island and the resultant discontinuation of Indigenous fire management.

**Key words:**

Fire, ecosystems, lake sediments, age model, $^{210}$Pb, radiocarbon, plutonium isotopic profiling

# TOPOGRAPHIC RECONSTRUCTIONS OF THE EAST AFRICAN OROGEN

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Reconstructing the shape of Earth's surface in deep time has not been previously attempted. How topography changes through time is essential in understanding the controls on ancient Earth systems (e.g. climate, biology and atmosphere/hydrosphere chemistry). The Neoproterozoic to Cambrian East African Orogen amalgamated through an important time for Earth's climate. Here, I attempt the first reconstruction of the changing topography of the trans-Gondwanan mountain belt, as a first step in revealing the significance of the mountain belt on climate throughout this period. The topographic reconstruction was attempted by incorporating inverted metamorphic pressure–time (P– t) data into a compositional isostatic equilibrium equation. This was done to determine an approximate elevation of the mountain belt relative to the modern-day elevation. By georeferencing the P–t data to current geological provinces, and incorporating them into a full plate model, a paleo-geographic topographic reconstruction was developed through the final amalgamation sequence of Central Gondwana. Across the orogen there is a variability in the depths that the rocks were buried and ultimately the elevations the mountain belts reached above sea level. The Arabian Nubian Shield (accretionary orogenesis from ~750–600 Ma) produced elevations of up to ~3 km peak elevation, similar to average heights of the current day European Alps. In the Mozambique and India/Madagascar belts much higher elevations of up to ~8 km, are predicted from ~650 –530 Ma., elevations similar to the current day Himalayas.

In addition to developing a methodology to apply topography in deep time, a proof-of-concept study was undertaken to efficiently obtain relevant pressure-time data for future campaign-style topography reconstruction studies. This was done using garnets from a well characterised transect across Southern India, which dated using the novel laser Lu–Hf inductively coupled plasma reaction cell mass spectrometry (LA-ICP- MS/MS) technique. Quartz inclusions within these were then analysed using RAMAN spectroscopy to determine their trapping pressures. These produced results of up to ~12– 15 kbar at ages ~600 to 540 Ma (peak conditions) which agree with conventional pressure-time studies and demonstrate the potential of this workflow.

**Key words:**

Jebel Ja'alan, Topography, Reconstruction, Isostasy, Gondwana, Climate, East African Orogen, Garnet, Neoproterozoic.

# THE FRACTIONATION OF COPPER ISOTOPES IN GRANITIC AND MAFIC INTRUSIONS: MAFIC ENCLAVES IN THE MANNUM GRANITE, A CASE STUDY

**Oliver T. Pring[1], Lucy McGee[1], Justin Payne[2]**

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The transfer of material between mantle sourced magma and evolved magmatic rocks may provide a mechanism for the transportation of metals such as copper Cu to the crust. The Mannum Granite provides a case study as the A-type granite is synchronously accompanied by mafic enclaves, providing a mafic-felsic interface with differing degrees of mixing/mingling. This mafic-felsic interface shows different mechanism for transportation such as both transport of xenoliths, compositional riming (rapakivi feldspars) and change in overall bulk chemistry. Cu isotope analysis characterises Cu behaviour between the mafic enclaves and granite and shows whether any copper has been assimilated from country rock. Samples of both the granite and mafic enclaves were taken, with a focus of the granite-enclave boundary. This study used petrography, whole rock and mineral major and trace element chemistry and whole rock Cu isotopes analysis were used. Processes such as fractional crystallising and magma mixing/mingling provide mechanism for the transfer of material between the granite and the intruding mafic enclaves. There is evidence of the transfer of material in the hybridised zones, particularly the formation of rapakivi feldspars and xenocrysts from both phases. Rare earth element signatures show mineral growth has occurred prior and post injection of mafic magma into the Mannum granite and that magmatic transfer is most applicable to lithophile elements. Cu Isotope results show that $\delta^{65}Cu$ values generally increases with decreasing copper concertation and ranges from -0.12 to 2.34‰. The range of $\delta^{65}Cu$ values are in line with those reported in mantle derived rocks and follow Rayleigh fractionation curves. Cu isotopes analyse further our understanding of Cu isotope behaviour and can be applied to ore forming environments. Other stable transition metal isotopes could be paired with Cu isotopes, such as Zn and Fe to further examine the role of any redox reactions.

**Key words:**

Copper Isotopes, Mannum granite, rare earth elements, mafic enclaves, magma mingling/mixing

# INVESTIGATIONS INTO THE GEOLOGY OF THE TUMUT TROUGH, LACHLAN OROGEN, NSW

**Travis D. Batch[1], Ryan C. Dwyer[1], Robin Offler[1], Mark Eastlake[2], Alistair C. Hack[1]**

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The Tumut Trough is a poorly understood extensional setting that lies in the Lachlan Orogen (NSW). To understand the events that built the Tumut Trough, we present new U-Pb age data from several key igneous and metamorphic bodies, detailed geochemical data of key rock units, and whole rock Sm-Nd and zircon Lu-Hf isotopic data. The data indicates three distinct phases in the development of the Tumut Trough: basement material emplacement (cease at 465 Ma), trough infill (440 – 420 Ma) and post-infill granite intrusion (420 – 410 Ma). Ages are placed on the previously undated Killimicat Granite, Warrienbah granite (proposed name) and Snowball Metabasic Igneous Complex at 410.0 ± 1.5, 415.9 ± 2.6 and 427.8 ± 13.4 Ma respectively. Ages are updated for the poorly constrained Bogong Granite, Gocup Granite and Honeysuckle Beds (at 416.8 ± 1.5, 418.7 ± 1.5 and 429.1 ± 1.7 Ma respectively). The age for the Kimo Diorite is refined at 417.4 ± 1.3 Ma. The age of the Wermatong Metabasalt is inferred to be older than previously reported, as it is multiply deformed like the Bullawyarra Schist, the only multiply deformed rocks in the area. The Tumut Trough is geochemically compared to the Okinawa Trough, a developing backarc basin near Japan, with Nb/Yb and Th/Yb similar in both systems. Dadd's [1] suggestion of incipient backarc magmatism is supported, with rocks having an early backarc signature. The Lu-Hf isotopes of the Blowering Formation, Honeysuckle Beds and post-infill granites indicate a quicker progression from crustal influenced magmatism to juvenile magmatism than the wider Lachlan Orogen at ~400 Ma [2]. This is similar to the isotopic progression found in the Northern Lachlan Orogen/Southern Thomson Orogen [3], along strike of the Tumut Trough.

**Key words:**

Tumut Trough, U–Pb geochronology, geochemistry, Lu-Hf isotopes

**References:**

[1] Dadd, K. (1998) Australian Journal of Earth Sciences 45(1): 109-121
[2] Kemp, A., Hawkesworth, C., Collins, W., Gray, C. and Blevin, P (2009) Earth Science and Planetary Letters 284(3): 455-466
[3] Waltenberg, K., Bodorkos, S., Armstrong, R. and Fu, B (2018) Australian Journal of Earth Sciences 65(7-8): 1009-1034

# GECHRONOLOGY OF PALLASITE METEORITES: FIRST IN SITU LU-HF AGES AND PU FISSION TRACK METHODOLOGY REFINEMENTS

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Pallasite meteorites are stony-iron meteorites that are generally accepted to have originated from the core-mantle boundary of a planetesimal. With only 141 pallasite meteorites discovered on Earth, it is uncertain if they were sourced from a single planetary body, multiple planetoids, or have experienced the same thermal histories. Constraining absolute ages would aid our understanding of this, yet few have been determined. This is due to historical age methodologies involving time consuming, challenging analytical processes, resulting in whole-rock ages and complete sample destruction. This study develops an analytical workflow using micro-X-ray Fluorescence spectrometry (μ-XRF), Scanning Electron Microscopy (SEM), Electron Probe Micro-Analysis (EPMA) and Laser Ablation tandem Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS/MS) to identify and date phosphate minerals in pallasites. The main advantages of the approach are: (1) no destructive sample preparation requirements, (2) high spatial resolution, and (3) large quantities of data can be collected in a short time span. Using this workflow, the first *in situ* Lu–Hf ages and Pu fission track analyses for phosphate crystals in pallasites are presented. The Lu-Hf ages for Springwater (4564±91Ma) and Seymchan (4560±67Ma) pallasites are in good agreement with the timing of solar system formation. The presented Pu fission track data demonstrate the initial $^{244}Pu/^{238}U$ ratio used in published work (0.015) is flawed and a more appropriate minimum initial ratio of 0.019-0.029 was calculated for stanfieldite phosphates within Springwater, Sericho and NWA10023. These new methods have wide application to rapidly obtain age constraints for the formation and thermal evolution of not only pallasites, but potentially any phosphate-bearing meteorites, enabling new insights into the evolution of the solar system.

**Key words:**

Geochronology, Lu–Hf, Pu fission-track, planetesimal, merrillite, stanfieldite

# DATING AND CHARACTERISING A NEWLY DISCOVERED SEDIMENTARY BASIN IN THE EAST TENNANT REGION

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An unknown sedimentary sequence was discovered in the newly defined Brunette Downs Rift Corridor. The sequence is interpreted to lie within a half graben structure, beneath the Helen Springs Volcanics (297m) and extend to basement (724m). This study analyses these sediments to establish; when they were deposited, under what conditions, and from what source. The unknown sedimentary rocks were defined as Unit A through F, with a notable unconformity splitting units A and B. Maximum depositional ages were established above and below the unconformity, using U–Pb detrital zircon dating. These yielded ages of 902±34 Ma and 1649±37 Ma respectively, based on youngest concordant grain. In situ–laser ablation inductively coupled plasma reaction cell mass spectrometry (LA-ICP-MS/MS) Rb–Sr dating established a minimum depositional age of 1547±13 Ma for shales in the sequence below the unconformity. Initial $^{87}Sr/^{86}Sr$ values and rare earth element compositions of these shales suggest that this age dates diagenetic phases that grew in equilibrium with Mesoproterozoic sea water. Therefore, this age may effectively date deposition of this sedimentary package. NDI-BK10 sediments were compared to a database of surrounding sedimentary and igneous provinces. The age distribution of detrital zircon grains show that the unknown sediments are most similar to the lower McArthur Group (Glyde Package), or Bullita Group (Favenc Package). The shale Rb–Sr age of 1547 ± 13 Ma suggests that the Favenc Package is the most likely of these possibilities. The sandstones are likely sourced from the Aileron Province, possibly due to uplift related to the Chewings Event. La/Sm ratios from shales indicate that the source was primarily felsic, comparable to average upper continental crust (AUCC). Th/U ratios and Ce anomalies indicate that ocean waters were oxic/sub-oxic becoming more oxic during deposition.

**Key words:**

McArthur Basin, Northern Territory, Geochronology, U–Pb, Zircon, Rb–Sr, Shale, Carbonate, Glauconite, Geochemistry, Sedimentology

# INFLUENCE OF THE KALKARINDJI LARGE IGNEOUS PROVINCE ON THE MCARTHUR BASIN LOW-TEMPERATURE EVOLUTION

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The greater McArthur Basin of the North Australian Craton is one of the very few places on Earth where extensive hydrocarbons are preserved that were generated from Mesoproterozoic source rocks, prior to the development of extensive multicellular life [1]. Here we present new apatite fission track data from a combination of outcrop and sub-surface samples from the McArthur Basin in order to directly investigate the post-depositional thermal history of the basin, and implications for hydrocarbon maturation. Apatite fission track data suggest that the McArthur Basin experienced a basin-wide reheating event contemporaneous with the eruption of the Cambrian Kalkarindji Large Igneous Province in the North and West Australian cratons, during which thick (~500–100 m) basaltic flows blanketed the basin surface. New 1D thermal modelling supports a heat pulse lasting c. 10,000 years which greatly elevated temperatures in the upper ~1 km of the basin as a response to erupting of voluminous lava flows. This abrupt reheating at c. 510 Ma is consistent with a proposed timing of elevated hydrocarbon maturation, particularly in the Beetaloo Sub-basin [2], and provides a mechanism for petroleum generation throughout the basin. Subsequent regional cooling was slow and gradual, most likely facilitated by gentle erosion of overlying Georgina Basin sediments in the Devonian–Carboniferous with little major structural reactivation. This model provides a framework in which hydrocarbons sourced from organic carbon rich rocks from the Mesoproterozoic experienced thermal maturation much later in the Cambrian, and preservation of these hydrocarbons was aided by lack of widespread structural movement following this event.

**Key words:**

McArthur Basin; Beetaloo Sub-basin; thermal history; apatite fission track; Kalkarindji Large Igneous Province

**References:**

[1] Cox, G. M., Jarrett, A., Edwards, D., Crockford, P. W., Halverson, G. P., Collins, A. S., Poirier, A., Li, Z. X. (2016) Chemical Geology, 440: 101-114
[2] Taylor, D., Kontorovich, A. E., Larichev, A. I., & Glikson, M. (1994) The APPEA Journal, 34(1): 279-296

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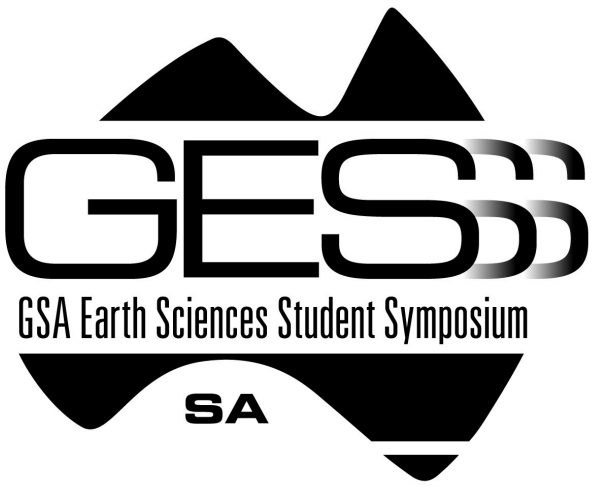


# THE TAPHONOMIC PROCESSES THAT LED TO THE PRESERVATION OF *Astroloma* MACROFOSSILS IN ROBERTSON CAVE, NARACOORTE

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Understanding the taphonomic processes that lead to the preservation of fossilised plant remains can highlight potential biases in the plant macrofossil record. Knowledge of these biases can allow scientists to account for factors such as over- and under-representation of certain species. For example, plants that produce large amounts of well-preserved litter that are abundant in the macrofossil record may not be a dominant species in the surficial vegetation cover, thus being over-represented. This bias can influence the accuracy of vegetation reconstruction and how we predict future vegetation-climate relationships based on ancient floral communities. The rarity of plant macrofossils makes understanding their taphonomy challenging, thus limited research has been conducted. Robertson Cave in Naracoorte Caves National Park is one such place where fossilised plant remains are plentiful. *Astroloma humifusum* and *Stenanthera conostephioides* (formerly known as *Astroloma conostephioides*) are two examples of species that are preserved as plant macrofossils within the sediment of Robertson Cave. The woody endocarps of both species are abundant and well preserved in the sediment, while their leaves and flowers are scarce. This indicates that animal dispersal is the likely agent for the endocarp of these particular species, and more specifically suggests birds as the primary disperser. However, it is still unclear how the endocarps have entered the sediment in such large quantities. Moreover, charcoalified material is present in the sediment, which begs the question of how charred endocarps accumulated in the cave as birds surely do not eat burnt fruit.

**Key words:**

Taphonomy, *Astroloma*, plant macrofossils, cave sediments, Naracoorte, cave

# CONSTRAINING EARTH SYSTEMS FOR ENERGY AND MINERAL EXPLORATION

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Sedimentary rocks are important archives for understanding how Earth systems have evolved through deep time. In particular, marine sedimentary rocks like mudstone and limestone can record the chemistries of ancient waters and atmosphere. How abundant and productive was life in the oceans? How much oxygen was in the air? They provide a glimpse into what the surface of our planet was like in the past.

More importantly, they also hold the key for large-scale energy and critical mineral exploration. Dead organic-rich material accumulates in the bottom of the seafloor, is put under intense heat and pressure during burial and forms hydrocarbons. This important source of fuel is responsible for more than 80% of the global energy consumption. In addition, metals like Cu, Pb and Zn are mobilised, concentrated and trapped in sediments under different oxygenation environments. Sediment hosted mineralisation accounts for half of the base metal deposits in the world. Specifically, 20% of all known Cu, >60% of Pb and >50% of Zn in our planet are found in sedimentary rocks. All of these commodities are essential for building a sustainable future.

This study involves the development of new methods as well as the application of established ones to assess the geochronology and geochemistry of Proterozoic basins across Australia. Novel in situ Rb–Sr as well as detrital zircon geochronology are used to provide a framework for the evolution of these sedimentary systems. Constraining the provenance source regions is the key to understanding the tectonic setting, weathering fluxes and nutrient input for these basins. Understanding the chemical conditions of the water column within these basins will also be integral in connecting how organic productivity controls the redox conditions of its surrounding environments and ultimately determine where critical minerals accumulate and concentrate in these complexes.

**Key words:**

geochemistry, geochronology, Proterozoic, tectonics, energy, critical minerals

# ESR AND OSL DATING OF FOSSIL DEPOSITS FROM THE NARACOORTE CAVE COMPLEX, SOUTH AUSTRALIA

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Comparisons of optically bleached quartz dating methods that can be applied to shared sedimentary samples offer optimal assessments of dating reliability over late to middle Pleistocene timescales; enabling stratigraphically constrained evaluations of dose rate or palaeodose complications that may otherwise be difficult to unravel in certain depositional settings. In spite of these advantages, paired evaluations of electron spin resonance (ESR) and optically stimulated luminescence (OSL) dating – the two most widely used quartz dating techniques in Quaternary studies – remain relatively uncommon. This study aims to assess the suitability of a combined ESR and OSL dating approach for resolving the chronologies of late-middle Pleistocene deposits within the Naracoorte Cave Complex (NCC) of South Australia. This karst system is known for its rich megafaunal deposits and sediment infill sequences spanning the last 550 ka, and is considered a key fossil locality for understanding the drivers of Australia-wide late Pleistocene megafaunal extinction. Establishing reliable chronologies on the NCC fossil-bearing deposits using quartz trapped charge dating techniques is critical since most NCC sites lie close to, or well-beyond, the radiocarbon dating range.

In this study, we apply ESR and OSL dating in tandem to a series of samples collected from three different NCC sites: Whalebone, Specimen and Alexandra cave. ESR quartz dating focuses on the multi-centre (MC) approach, which involves comparative evaluations of Al and Ti centre signals to provide insights into sample bleaching adequacy. The paired luminescence dating study focuses on single-OSL analysis, and includes examination of multi-grain averaging effects and dose saturation limits.

The comparative ESR-OSL dating results exhibit broad agreement for deposits spanning 50-150 ka, with either the Ti-H or Al centre ages overlapping with paired OSL ages at 2σ in nearly all cases. MC ESR evaluations (Al v Ti-Li v Ti-H age assessments) indicate incomplete resetting of the Al centre signal for a small number of samples. Two-thirds of samples exhibit

Ti-Li ages that are significantly older than corresponding Al centre ages, which is unexpected from a bleaching kinetics perspective and may indicate a broader reliability issue for Ti-Li $D_e$ evaluation with these particular samples. Our findings: (i) support the applicability of both palaeodosimetric dating methods in this depositional setting; (ii) highlight the merits of applying combined ESR-OSL analyses in tandem, and; (iii) provide one of the first reliable evaluations of quartz ESR MC dating for samples with natural dose ranges as low as only a few tens of Gy.

**Key words:**

Quartz ESR dating; Multi-centre approach, single-grain OSL dating; Naracoorte caves

# RESISTATE PHASES IN RELATION TO OROGENIC GOLD MINERALISATION IN CENTRAL VICTORIA

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Resistate phases (e.g. zircon, apatite, rutile) are stable minerals that are resistant to physical and chemical weathering [1]. Resistate minerals that preserve geochemical signatures related to mineralisation within cover sequences may be used to trace ore fluid chemical events, and therefore be used as a proximity indicator to such mineralisation [2]. Few studies of resistate phase trace element geochemistry related to orogenic gold mineralisation exist [e.g. 3].

This project aims to investigate how trace element signatures within resistate mineral phases may be used to assess proximity to orogenic gold mineralisation. The Lockington prospect within the Bendigo Zone of northern central Victoria will be used as a case study area. Orogenic gold mineralisation at Lockington is hosted within Ordovician turbidite sequences of the Castlemaine Group [4]. The basement rocks are overlain by Cenozoic Murray Basin cover sequences [5]. Preliminary petrological analysis of mineralised samples shows sulphide mineralisation (mainly pyrite and arsenopyrite) is associated with carbonate (siderite) and phyllic (sericite) alteration. Abundant resistate phases are preserved within the mineralised basement turbidites, including apatite and rutile with lesser concentrations of monazite and zircon.

The research to be undertaken in this project will include further petrology analysis of mineralised and barren sediments at Lockington and surrounding regions to understand the context of resistate phases within the mineralising system. Geochemical analysis of resistate phases will allow comparison of trace element chemistry within the phases from mineralised and barren samples and generation of geochemical exploration criteria. A similar approach will be taken to investigating whether geochemical signatures related to underlying mineralisation can be identified within the Murray Basin cover sediments. This approach may reveal an extended geochemical footprint of the mineralising system.

**Keywords:**

Orogenic, gold, Victoria, resistate, Lockington, apatite, Murray Basin

**References:**

[1] Dryden, Dryden (1946), Journal of Sedimentary Research, 46(3), 91-96
[2] Tiddy, Zivak, Hill, Giles, Hodgkison, Neumann & Brotodewo (2021) Minerals, 11(8), 809
[3] Agangi, Reddy, Plavsa, Fougerouse, Clark, Roberts & Johnson (2019) Ore Geology Reviews 106; 1-11
[4] Turner (2006) Lockington annual report on work to 31st December 2005. Gold Fields Australasia
[5] Brown & Stephenson (1991) Geology of the Murray Basin, southeastern Australia, Australian Government Publishing Service

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# FORMATION OF THE MOUNT NOVIT Zn-Pb-Ag DEPOSIT, NORTHERN AUSTRALIA: EVIDENCE FROM GEOLOGY, MULTI-MINERAL U-Pb GEOCHRONOLOGY AND SPHALERITE GEOCHEMISTRY.

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The Mount Novit Zn-Pb-Ag deposit is an accumulation of sub-economic mineralisation located approximately 20 km south of Mount Isa, Queensland. In contrast to the nearby Mount Isa, Hilton and George Fisher Zn-Pb-Ag deposits, mineralisation at Mount Novit is situated to the west of the regional-scale Mount Isa Fault and is hosted in Moondarra Siltstone as opposed to the Urquhart Shale. Lower-grade mineralisation (<1% Zn + Pb) primary replaces pre-existing dolomitic alteration and veining and consists of pyrrhotite and pyrite with minor sphalerite. Higher-grade Zn-Pb-Ag mineralisation (>5% Zn + Pb) occurs as matrix supported breccias that formed from the advanced replacement of the host shale by sphalerite and pyrrhotite with moderate galena, pyrite, and magnetite. In-situ U-Pb geochronology was completed on apatite and two textural varieties of monazite from Mount Novit. Fine-grained (<50 µm) subhedral to anhedral monazite located in highly foliated biotite alteration directly adjacent Zn-Pb-Ag mineralisation yields a mean weighted $^{207}Pb/^{206}Pb$ age of 1527 ± 18 Ma (MSWD = 1.06). This age is interpreted to represent the formation of biotite-rich alteration and synchronous $D_3$ deformation of the Isan Orogeny. Apatite located in the same fabric yields a lower intercept age of 1443 ± 29 Ma (MSWD = 1.3). This age is interpreted to represent the age of a major thrusting event along the Mount Isa Fault which resulted in the cooling of the Mount Novit area below ~375°C. Coarse-grained ore-stage monazite yields a mean weighted $^{207}Pb/^{206}Pb$ age of 1457 ± 10 Ma (MSWD = 0.28). The sphalerite geothermometer produced a mean formation temperature of 345 ± 52°C. The timing and temperature of ore-stage Zn-Pb-Ag mineralisation is consistent with both the age and cooling temperature of apatite presented in this study. Based on this evidence, it is suggested that Zn-Pb-Ag mineralisation at Mount Novit was emplaced during an episode of major thrusting along the Mount Isa Fault, with the precipitation of the ore driven largely by the cooling of the Mount Novit area below ~375°C.

**Key words:**

Mount Isa, Mount Novit, Zn-Pb-Ag Mineralisation, U-Pb Geochronology, SEDEX

# IDENTIFYING SNAKE FOSSILS FROM NARACOORTE CAVES

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Reptile fossils are abundant in the Quaternary deposits of the Naracoorte Caves in south-eastern South Australia but are largely undescribed. Once identified however, they can inform understanding of palaeoecology and aid in reconstruction of palaeoclimate from Naracoorte's recent past. Here we aim to identify two of these undescribed fossils, both elapid maxillae from Robertson and Victoria Fossil Cave respectively. Taxonomic affinity was determined by comparing the fossils to a sample of modern-day elapid species using visual comparisons to a sample of Computed Tomography (CT) scans and specimens from the South Australian Museum collections. On the second specimen three-dimensional geometric morphometrics was also employed. Using these techniques, the closest identification for Specimen 1 was *Pseudonaja textilis*, the Eastern Brown Snake. Specimen 2 was found to be very similar to *Austrelaps superbus*, the Lowland Copperhead, except for its number of teeth, meaning it could also potentially be a new, closely related species. This research into the use of geometric morphometrics has provided a good pilot study for new methods of identifying elapid snakes from their isolated maxillae, though would benefit from larger comparative samples to eliminate intraspecific variation.

**Key words:**

Palaeontology, Naracoorte caves, geometric morphometrics, elapids, Quaternary

# MAPPING SULPHIDE WEATHERING THROUGH REGOLITH AT KAPUNDA (SOUTH AUSTRALIA) USING A RAPID S ISOTOPE ANALYSIS

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Regolith covers ~80% of Australia and in some areas, this weathered regolith soil profile (i.e. cover) can be kilometres thick which provides challenges for mineral exploration of subsurface ore deposits. There are multiple methods to observe mineralisation through cover, and this project focuses upon the novel application of coupled Cu and S isotopes, where the latter will be analysed using a rapid and recently developed ICP MS/MS technique for determination of $\delta^{34}S$ values [1]. The study site, Kapunda, South Australia, is home to one of the oldest copper mines in Australia, and the depth of regolith ranges from 10s to 100s of metres. Based on previous research [2] this sedimentary-copper deposit is understood to have formed by involvement of metal-rich saline groundwaters inundating the carbonaceous siltstone host-rocks of the Tapley Hill Formation. Thus, producing a supergene environment facilitating the leaching of Cu and formation of sulphides. Samples of sulphides collected from dill core throughout the regolith profile have been analysed by a Scanning Electron Microscope (SEM) Mineral Liberation Analysis (MLA). Initial observations from mineral mapping confirmed abundant presence of potentially metamorphic biotite locally altered to chlorite, and enrichments in sulphides (mostly pyrite, chalcopyrite) associated with kaolinite clays concentrated around veins. Legacy data completed in this region [3] have shown that syn-sedimentary sulphides have a $\delta^{34}S$ signature of up to 40‰ (relative to CDT standard), with sulphides in veins exhibiting similar variability. The S isotope analysis ($\delta^{34}S$) targeting these sulphide rich zones will be the next step of the project to constrain representative S isotope signatures of distinctive sulphide endmembers or phases. Analysis and comparison of recent and legacy $\delta^{34}S$ values will be used to interpret the Cu-bearing sulphides at Kapunda, constraining their origin and interpret movement of metals within this supergene ore deposit.

**Key words:**

Regolith, supergene, sulphide, SEM MLA mineral mapping, $\delta^{34}S$ Isotope, Kapunda

**References:**

[1] Leyden, et al. (2021). "A simple and rapid ICP-MS/MS determination of sulfur isotope ratios (34S/32S) in complex natural waters: A new tool for tracing seawater intrusion in coastal systems." Talanta.
[2] Lambert, I. B., et al. (1980). "Genesis of upper proterozoic stratabound copper mineralisation, Kapunda, South Australia " Mineral. Deposita 15: 1-18.

# IDENTIFYING ATMOSPHERIC METHANE CAUSING PAST GREENHOUSE CLIMATES

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The Artinskian-Kungurian boundary, currently at 283.5 ± 0.6 Ma, is the only time within the Permian that does not have a GSSP spike. The boundary is associated with the transition from icehouse to greenhouse conditions and abundant coal seams worldwide. Previously studied coal seams show a negative carbon isotope excursion, the KCIE, but are poorly dated. This excursion is hypothesised to be the result of warming, causing destabilisation of methane clathrates globally. The Le Chiffre-1 core from the Cooper Basin is well dated and is the focus of this study. It shows the KCIE at ~281.8 Ma, which does not align with the current Artinskian-Kungurian boundary. Given the lack of defining features associated with the current boundary, the dated KCIE from this study could be suggested as a better way to define the boundary. This study is particularly relevant given the high likelihood that a similar methane clathrate destabilisation will be seen in the foreseeable future as a result of anthropogenic warming.

**Key words:**

GSSP, Permian, Artinskian-Kungurian boundary

# IN SITU LU HF GEOCHRONOLOGY BY LA-ICP-MS

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Lu-Hf geochronology is a powerful method to constrain the temporal evolution of geological systems. Traditional application of this dating method requires time-consuming chemical separation of the parent ($^{176}$Lu) and daughter ($^{176}$Hf) isotopes that is commonly accompanied by loss of textural context of the analysed minerals. In contrast, *In-situ* (laser-ablation based) Lu-Hf geochronology offers a number of advantages including rapid analysis with high spatial resolution, as well as control on textural relationships of the analysed mineral. However, laser-ablation based Lu-Hf geochronology has been hindered by isobaric interferences that have effectively masked reliable determination of $^{176}$Lu and $^{176}$Hf. We present a methodology that resolves these interferences using laser ablation tandem inductively coupled mass spectrometry (LA-ICP-MS/MS) and $NH_3$ gas to separate Hf from Lu. Further, we demonstrate the utility of this novel technique for determining accurate ages for calcite, apatite and garnet growth.

**Key words:**

Lu-Hf, geochronology, apatite, calcite, garnet