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Earth Sciences Student Symposium – South Australia

PROGRAM AND ABSTRACT PROCEEDINGS 2023

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WELCOME TO GESSS-SA 2023

Welcome to the annual Geological Society of Australia Earth Sciences Student Symposium (GESSS-SA). We are pleased to have your company at Flinders University, in Bedford Park.

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, 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 Flinders University for their assistance in making this event possible.

Thank you for your participation and we hope you enjoy GESSS-SA 2023.

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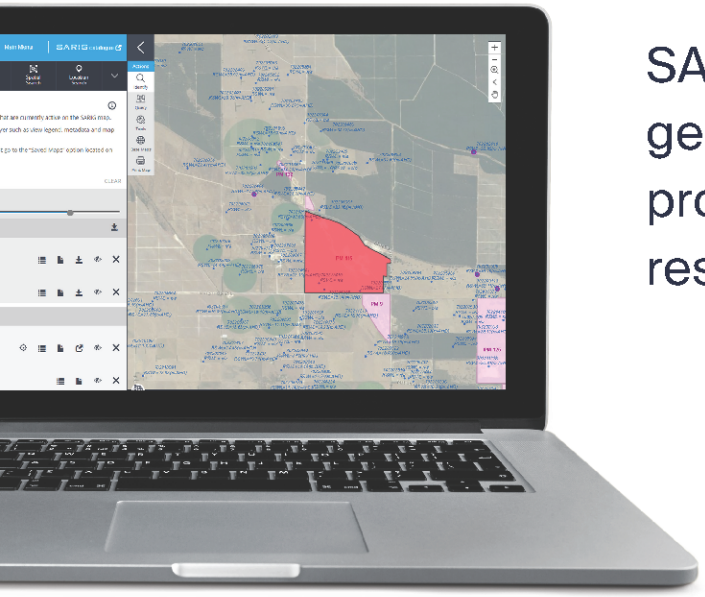

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TIME	PROCEEDINGS	
8:30 – 9:15	Registration	
9:15 – 9:25	Welcome	
9:25 – 9:30	Acknowledgement of Country	
TIME	**SESSION 1**	
9:30 – 10:00	**Dr. Rachelle Kernen** *Keynote*	The role of salt-sediment interaction for a clean energy future
10:00 – 10:15	**Elinor Alexander** *DEM*	Diamond Sponsor Talk
10:15 – 10:30	**Fraser Brown** *Flinders University*	The Brothers Islands: A late Pleistocene, predator-driven fossil assemblage from Coffin Bay (South Australia).
10:30 – 10:45	**Corinne Mensforth** *Flinders University*	Newly described anatomy of a Devonian stem-tetrapod fish illuminated by neutron tomography
10:45 – 11:00	**Jayden Squire** *University of Adelaide*	Australites bearing localities and collections in Southern Australia and their role in stratigraphy
11:00 – 11:30	**Morning Tea**	
TIME	**SESSION 2**	
11:30 – 12:00	**Dr. Sandra Villacorta** *Keynote*	Geoethics: A foundation for responsible geoscience practice
12:00 – 12:15	**Ivan Gutierrez Agramont** *UniSA*	Sensitivity analysis of data driven machine learning algorithms for laser induced breakdown spectroscopy (LIBS) data
12:15 – 12:30	**Vanessa Nowinski** *University of Adelaide*	East Asian monsoon response to abrupt global change during the last glacial period: Evidence from the sediments of Lake Suigetsu, Japan
12:30 – 12:45	**Darren Ray** *University of Adelaide*	Examining Australian and global climate teleconnections through causality and paleo-reanalysis
12:45 – 1:00	**Andres Sifuentes** *UniSA*	Exploring the nexus between technology's role and the drivers governing social license to operate (SLO) in the context of mineral exploration
1:00 – 2:00	**Lunch**	

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TIME	SESSION 3	
2:00 – 2:15	**Dr. Rob Fitzpatrick** *CSIRO*	Diamond Sponsor Talk
2:15 – 2:30	**Ferdinand Mayer-Ullmann** *University of Adelaide*	Thermal history of the East Antarctic margin: Campaign-style multi-method apatite geochronology study
2:30 – 2:45	**Cecilia Loyola** *University of Adelaide*	In situ Rb-Sr dating and REE patterns of Ediacaran glauconites and detrital feldspars from the Centralian Superbasin and the Flinders Ranges, Australia
2:45 – 3:00	**Luke Tylkowski** *UniSA*	Unravelling apatite chemistry: A foundation for orogenic gold exploration at Fosterville, Victoria
TIME	**POSTER SESSION**	
3:00 – 3:30	**Afternoon Tea/Poster Session**	
	Chryselle Mancenido *UniSA*	Enhanced rock characterization through machine learning-assisted fusion of hyperspectral and geochemical data
	Travis Batch *UniSA*	Developing a tool for ISCG exploration using REE-bearing phosphate chemistry
	Zara Woolston *University of Adelaide*	Laser based S isotope analysis of weathered 'super-heavy' Neoproterozoic sulphides and Rb–Sr dating of illite from Kapunda, South Australia
3:30 – 3:50	**Closing Remarks and Prize Announcement**	
3:50 – 4:30	**Flinders University Lab Tour**	
4:30 – 6:00	**Networking Drinks**	

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THE BROTHERS ISLANDS: A LATE PLEISTOCENE, PREDATOR-DRIVEN FOSSIL ASSEMBLAGE FROM COFFIN BAY (SOUTH AUSTRALIA).

Fraser G. Brown[1], Diana A. Fusco[1], Lee J. Arnold[2], Aaron B. Camens[1].

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Mammal populations in South Australia have suffered a drastic decline since European arrival. The Eyre Peninsula (EP) has been particularly adversely affected, seeing a near total collapse of its native mammal fauna. In a 2010 review of Holocene cave sites, McDowell and Medlin found [1] that just four of the twenty-five native mammals recorded in their sample persisted in the southern EP today, the rest being extirpated or driven extinct. The exact state of the region's ecology prior to European influence is poorly recorded, limiting future conservation efforts. The Brothers Islands, Coffin Bay, is one of just two known Pleistocene megafaunal deposits from the EP, although its fauna and taphonomy have never been documented. Between 2014–2023 we made several new collections at the site in order to better understand the past fauna of the lower EP and to compare it to other southern Australian Pleistocene sites.

The site's age, determined by single-grain optically stimulated luminescence (OSL) dating of quartz supports a rapid formation of the deposit during Marine Isotope Stage 5e. This rapid formation is interpreted as being too fast for traditional cave formation, implying a different karst structure. Fossil material from >30 mammal, reptile, bird and amphibian species support the notion of a complex ecosystem once existing in Coffin Bay. Species representation, biting traces and geological evidence indicate that mammalian and avian predators were the primary accumulatory mechanism in The Brothers deposit. Unpaired cut marks on a sthenurine kangaroo metatarsal initially attributed to humans are instead assigned to the carnassial premolars of the 'marsupial lion' Thylacoleo, shedding light on the difficulties of identifying human-megafaunal interaction in the Australian fossil record. A taxonomic habitat index (THI) is used to approximate climatic conditions on the EP during the last interglacial, the results suggesting an east-west temperate-arid association in South Australia.

Keywords:

Pleistocene, ichnology, taphonomy, palaeoecology

References:

[1] McDowell M.C. and Medlin G.C. (2010) Australian Mammalogy 32:87–93

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NEWLY DESCRIBED ANATOMY OF A DEVONIAN STEM-TETRAPOD FISH ILLUMINATED BY NEUTRON TOMOGRAPHY

Corinne L. Mensforth[1], Alice M. Clement[1] and John A. Long[1]

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One of the most significant events in vertebrate evolution was the fish-to-tetrapod transition, that also covered the water-to-land, fin-to-limb and gill-to-lung transitions. This event is observed in anatomical differences over several stem-tetrapod fishes and early tetrapod taxa during the Devonian and Carboniferous periods. These stem-tetrapod fishes are the common ancestors to all extant tetrapods including amphibians, reptiles, birds and mammals.
Koharalepis jarviki is a stem-tetrapod fish known only from its holotype that was discovered in Antarctica in 1971. It has been the subject of two studies to date, its initial description and some revisions based on X-ray tomography. The position of *Koharalepis* in the stem-tetrapod phylogenetic tree remains unclear due to a lack of data and is the subject of the current study. A new 3D scan dataset was produced on the ANSTO Dingo neutron beam that captured images of undescribed internal features. The dataset will be used to produce 3D models and descriptions of all novel anatomy. Preliminary results will be presented here with a focus on newly described features and the braincase's internal endocast.
These results will be used to generate a more accurate stem-tetrapod phylogenetic tree. The braincase and its internal endocast will also be examined and compared to other stem-tetrapod fishes to determine changes in neural anatomy over the water-to-land transition. This study will provide a greater understanding of the evolution of the stem-tetrapod fishes and the wider tetrapod lineage.

Key words:

Sarcopterygii, Tetrapodomorph, Canowindridae, Devonian, tomography, endocast, phylogenetic analyses, 3D modelling.

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AUSTRALITES BEARING LOCALITIES AND COLLECTIONS IN SOUTHERN AUSTRALIA AND THEIR ROLE IN STRATIGRAPHY

Jayden Squire[1], Tony Milnes[1]

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This study reviews the collection locality of australites from the large collection at the University of Adelaide and highlights the large literature gaps that exist in stratigraphy reviews, and published and accessible records of collection sites. Furthermore, Pleistocene geology of four key australite collection sites: Florieton, Mann/Woodroffe, Charlotte Waters, Port Campbell is reviewed to provided stratigraphic reference. This is the first published review of the australite stratigraphy of the Florieton, Charlotte Waters and Mann/Woodroffe australite sites. A large collection of australites are reviewed to present the common form and shape of the australites that are collected at each site. The stratigraphy is reviewed to develop a deposition time frame which is concluded to have occurred after the final deposition of the Blanchetown Clay and before the first deposition of the Pooraka formation or equivalent formations. It is summarized that the initial deposition of these australites was after the final deposition of the Blanchetown clay and before the initial deposition of the Pooraka formation, which is consistent with a deposition age that would fit the previously proposed 40Ar/39Ar age of 770± 20 ka.

Keywords:

Australites, Meteoritics, Tektites, Collections

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SENSITIVITY ANALYSIS OF DATA DRIVEN MACHINE LEARNING ALGORITHMS FOR LASER INDUCED BREAKDOWN SPECTROSCOPY (LIBS) DATA.

Ivan Gutierrez Agramont[1,2,3], Ben van der Hoek[1,3], Caroline Tiddy[1,3], Lequn Zhang[2,3], Neil Francis[2,3], Steven Tassios[3,4]

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This study presents a sensitivity analysis of Data-Driven Machine Learning (DDML) algorithms applied to Laser Induced Breakdown Spectroscopy (LIBS) data in the context of the development of a tool for rapid downhole geochemical analysis in a mineral exploration environment. LIBS is being used in the tool development as it offers a method for rapid elemental analysis of materials in harsh environments with no required sample preparation. However, a challenge with rapid data collection methods is that large volumes of data are produced, meaning automated methods to interpret the datasets generated are needed.

The focus here is on understanding the capability of DDML algorithms to predict elemental compositions from the spectra produced by LIBS. DDML regression models, including Lasso, Neural Network Regression, Decision Trees Regression, Random Forest Regression and Linear Regression, were trained using LIBS data collected from a set of known mixtures of MgO and NaCl. Sensitivity of the number and compositional representativity of training data were tested by using different mixtures ratios and different number of captures for training/validation as well as prediction for each algorithm, as these are known to be limiting steps in using DDML algorithms in analysis of LIBS (and other) datasets. Values predicted from the DDML models were evaluated against laboratory analysis (i.e., measured versus actual) for each mixture, and statistical methods and learning curves were used to highlight model-specific biases and variance patterns.

Preliminary results indicate varying degrees of prediction accuracy among the models. When using an 'ideal' training dataset (i.e., excessive number of captures with maximum compositional representativity), the Ridge Regression and Decision Tree Regressor had the best performance with an R^2 for Mg of 0.9603 and 0.9415 respectively for validation. After those algorithms were used for prediction with unseen data (data not used in the training/validation process), the R^2 for Mg using Ridge Regression is 0.9666 and Decision Tree is 0.9501. When the same algorithm is used for prediction using a single LIBS spectrum of unseen data, the result is a bit worse than the training/validation process with an R^2 for Mg of 0.9640 for Ridge and 0.9399 for Decision Tree. However, when the data is smoothed by averaging the LIBS spectra for every 25 laser shots before prediction, the results are

improved. The same behaviour is observed for the Na under the same analysis. Further analysis was done based on number of data as well as impact of compositional representativity.

The outcomes of this study will be used to inform the efficacy of DDML algorithms for LIBS data interpretation, revealing their potential and areas of improvement for future applications.

Acknowledgements

The work has been supported by the Mineral Exploration Cooperative Research Centre who se activities are funded by the Australian Government's Cooperative Research Centre Progr am. This is MinEx CRC Document 2023/36

Key words:

LIBS, Machine Learning, DDML, AI, MinEx CRC, Data Analysis, Mineral Exploration, Geology

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EAST ASIAN MONSOON RESPONSE TO ABRUPT GLOBAL CHANGE DURING THE LAST GLACIAL PERIOD: EVIDENCE FROM THE SEDIMENTS OF LAKE SUIGETSU, JAPAN

Vanessa Nowinski[1], Alexander Francke[1,2], Jonathan J. Tyler[1], John Tibby[3], Jack Lacey[4], Melanie Leng[4], Takeshi Nakagawa[5]

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The East Asian Monsoon (EAM) impacts almost half of the world's population, however it's trajectory for the future remains largely unknown in light of current rapid climate change. This oral presentation will outline preliminary data with an aim to investigate the underlying mechanisms and long-term contributors to EAM variability. The project focuses on the precisely dated varved sediments of Lake Suigetsu, Japan, and the episodes of abrupt global change leading into the last glacial maximum. Building on previous and ongoing research, this study aims to analyse oxygen isotopes from siderite, as well as total organic carbon, biogenic silica and siderite concentrations from Lake Suigetsu's sediments to reconstruct climate and hydrological change from ~55,000 – 20,000 years before present. The data will be interrogated in the context of regional climate reconstructions. By improving the understanding of long-term drivers of the EAM, this study will contribute to improved estimates of future change in the region.

Key words:

Lake Suigetsu, East Asian Monsoon, palaeolimnology, climate reconstruction, oxygen isotopes, siderite

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EXAMINING AUSTRALIAN AND GLOBAL CLIMATE TELECONNECTIONS THROUGH CAUSALITY AND PALEO-REANALYSIS

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Understanding climate tele-connections and the role of natural forcings is vital for managing Australian hydroclimate variability through coming decades. Recently developed causality inference techniques offer opportunities to examine climate teleconnections across timescales. Results from the application of causal inference techniques to instrumental era and last millennium climate suggest complex lag responses and connections of tropical Pacific and southern hemispheric westerly winds to solar and volcanic forcings, impacting Australian hydroclimate.

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EXPLORING THE NEXUS BETWEEN TECHNOLOGY'S ROLE AND THE DRIVERS GOVERNING SOCIAL LICENSE TO OPERATE (SLO) IN THE CONTEXT OF MINERAL EXPLORATION

Andres Sifuentes[1,2], Caroline Tiddy[1,2], Adam Simpson[3], Vicki Waye[3], Jennifer McKay[3], Benjamin Zammit[4]

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Technology developments respond to the desires of society and industry for advancement, and both, society, and industry, have the power to make technological advances occur as they are interrelated by socio-economic and political factors. The decision-making process for granting or withholding the license projects where technology wants to be applied, is also affected by these aspects (as in the case of mineral exploration projects, for example).

A well-known example of technological change driven by industry and society is renewable technologies for climate change mitigation to attain 2050 Net-Zero Emission targets. Within the resources industry, technological changes include the MinEx CRC RoXplorer coil tubing drill rig and associated sensors for rapid data acquisition for application in mineral exploration which operates in an area close to population that interacts, indirectly at least, with this technology that can potentially impact social dynamics and the way human interactions occur. However, research and understanding of how technology could influence social dynamics and people's decision-making process in granting or withholding social license to operate is limited.

This presentation will outline my research project which focuses on the potential impact that development of new technology could have on social acceptance in the context of mineral exploration. This will be done by understanding if and how new mineral exploration technologies change perceptions of stakeholder groups such as local populations, Aboriginal peoples and grassroot organisations involved in the process of granting or withholding a social license to operate (SLO) for mineral exploration (also referred as social acceptance). An understanding of stakeholder perceptions will be gained through interviews and focus groups that will go through three stages of investigation: 1. Establishing stakeholder understanding and perceptions of mineral exploration; 2. Discussing emerging mineral exploration technologies, particularly MinEx CRC technologies; and 3. Formulating ideas of stakeholders' future expectations of mineral exploration and how new technologies may impact these activities.

Keywords:

Social License to Operate, SLO, Social Acceptance, Geoethics , Technology

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Thermal history of the East Antarctic margin: Campaign-style multi-method apatite geochronology study

Ferdinand Mayer-Ullmann[1], Stijn Glorie[1], Jacob Mulder[1], Martin Hand[1], Laura Morrissey[2], Sharmaine Verhaert[1], Jacqueline Halpin[3]

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East Antarctica records a complex thermal history in response to (1) tectonic events associated with supercontinent assembly and break-up; and (2) climatic processes such as Cenozoic glaciation. However, due to the current extensive ice-cover and poor accessibility of outcrops, large gaps remain in our understanding of the thermo-tectonic evolution of the East Antarctic margin. In particular, a cohesive picture of the magnitude and timing of upper crustal exhumation is yet to be deciphered.

With the aim to reveal new insights into the thermo-tectonic history of East Antarctica, we present a large new dataset of apatite fission track, U-Pb and Lu-Hf data, covering more than 90° of longitude along the East Antarctic margin. Preliminary Apatite high-temperature geochronometers reveal an image of the tectonic terrane configuration, showing conformity with established terrane boundaries that developed during Gondwana assembly. Samples west of the Bunger Hills predominately show Cambrian Apatite U-Pb and Lu-Hf ages, whilst to the East mostly 1.1-1.5 Ga ages are recorded.

First results from apatite fission track analysis indicate Late Carboniferous and Permo-Triassic cooling ages along the entire length of the margin. Thermal modelling indicates a continental-wide Permian cooling event followed by slow cooling through the Mesozoic. This implies that passive-margin cooling preceded Gondwana breakup, while continental separation did not lead to significant cooling.

The multi-method `campaign-style` approach highlights regional differences in the thermal response of the Indo- and Australo-Antarctic domains to the tectonic processes experienced along the passive margin.

Keywords:

East Antarctica, geochronology, thermochronology, passive margin, tectonics,

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IN SITU RB-SR DATING AND REE PATTERNS OF EDIACARAN GLAUCONITES AND DETRITAL FELDSPARS FROM THE CENTRALIAN SUPERBASIN AND THE FLINDERS RANGES, AUSTRALIA

Cecilia Vanina Loyola[1], Juraj Farkas[1], Charles Verdel[2], Sarah Gilbert [1], Lance Holmes[3], Stefan Löhr[4], Glenn Brock[4], Graham A. Shields[5], Christine Edgoose[2], Ahmad Redaa[1,6], Morgan L. Blades[1], Alan S. Collins[1], Caleb Bishop[7], Sarah Giles[8], Nicholas Christie-Blick[8], Peter Haines[9]

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[8]Columbia University, Department of Earth & Environmental Sciences, USA,

[9]Geological Survey of Western Australia

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In situ Rb-Sr dating of silicate minerals and sedimentary rocks uses a laser ablation (LA)-inductively coupled plasma tandem mass spectrometry with a collision/reaction cell (LA-ICP-MS/MS)[1]to measure the 87Rb and 87Sr isotope abundances. This novel dating method is based on well-established radioactive decay of 87Rb to 87Sr via a negative beta pathway (the emission of an electron), with a half-life of 49.61 ± 0.16 Ga[2].

Here we present results from samples deposited in the Centralian Superbasin, corresponding to glauconite bearing Ediacaran to Cambrian marine sedimentary rocks: Arumbera Sandstone (Amadeus Basin), Dey Dey (Officer Basin). We also analysed the Ediacaran Wonoka Formation (Flinders Ranges from South Australia). Prior to in-situ Rb-Sr dating, the samples were mapped using high-resolution SEM/EDS imaging and mineral mapping. The analysis of the glauconite from the Arumbera Sandstone returned an age of 441.4 ± 12.6 Ma. For the Dey Dey mudstone, the age of glauconite is 472.32 ± 7.57 Ma, and for glauconite from Wonoka Formation, the age is 491 ± 11.4 Ma. Although the ages are younger than expected stratigraphic ages (i.e., the latter ranging from ca. 580 to 520 Ma) they coincide with possible overprinting related to the Rodingan movement (~440 to 430 Ma) [3] and the Delamerian Orogeny (~500 to 480 Ma)[3].

In situ Rb-Sr dating and Rare Earth Elements (REE) analysis (via LA-ICP MS/MS) was undertaken also in detrital orthoclase grains from the Arumbera Sst. sample. Based upon Eu

anomalies, the orthoclase grains with a positive Eu-anomaly are detrital and older (1158±76 Ma), than orthoclase with negative Eu-anomalies which are much younger (556±65 Ma) and thus of likely authigenic origin and age.

Our study shows the potential of the in situ Rb-Sr technique for dating detrital and authigenic K- and Rb-rich mineral components (i.e., glauconite and orthoclase) in marine sedimentary rocks, and for constraining their post-depositional diagenetic overprinting or alteration histories.

Keywords:

Rb-Sr, REE, Flinders Ranges, glauconite, feldspar

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UNRAVELLING APATITE CHEMISTRY: A FOUNDATION FOR OROGENIC GOLD EXPLORATION AT FOSTERVILLE, VICTORIA

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Determining proximity to mineralisation is a challenge for exploration geologists and is particularly difficult in systems with small footprints, such as orogenic gold. The ability to assess ore deposit proximity using the chemistry of resistate mineral phases such as zircon, monazite and apatite, has been demonstrated in various mineralised systems [e.g.1-3]. Apatite is an attractive resistate phase as it is common in igneous (felsic to mafic), sedimentary and metamorphic rocks [4-5]. Apatite can precipitate from, or be altered by, hydrothermal fluids, to preserve distinct geochemical signatures related to a mineralising events [2,6-8]. In order to identify these distinct geochemical signatures, the background signature of apatite in unmineralised rocks has to be established.

We investigate the chemistry of detrital apatite grains within the Castlemaine Group sandstones in the Fosterville area of central Victoria, which hosts significant orogenic Au mineralisation. The trace element chemistry of the Fosterville detrital apatite grains is compared to published apatite chemical data from common lithologies (igneous and metamorphic) to classify grains and establish background chemical signatures. Trace element analysis has shown that most detrital grains have a signature similar to published data, however a small population of grains contain a unique signature that is possibly related to orogenic Au mineralisation.

Key words:

apatite, gold, mineralisation, Fosterville, Victoria, geochemistry, geochronology

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Geological Society of Australia
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ENHANCED ROCK CHARACTERIZATION THROUGH MACHINE LEARNING-ASSISTED FUSION OF HYPERSPECTRAL AND GEOCHEMICAL DATA

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Understanding the mineralogy and ore quantity is pivotal in mineral processing, influencing downstream operations like grinding and separation methods. Spectroscopic techniques are instrumental in qualitative and quantitative analyses of diverse materials, including minerals. However, traditional methods necessitate employing various spectroscopic techniques independently, tailored to specific informational needs, as no single technique comprehensively covers all minerals. This often leads to subjectivity and inefficiency due to reliance on human judgement. To address this, our study focuses on developing a methodology that integrates data from multiple sensor techniques (geochemical XRF and hyperspectral mineralogical data) using assisted machine learning for high fidelity characterization of drill cores. We anticipate this integration to surmount the limitations of individual techniques, enabling the characterization of complex mineral assemblages. Notably, both methods offer swift data collection, are non-destructive, and necessitate minimal sample preparation. Despite limited prior exploration, our research showcases the potential of data fusion and machine learning for drill core characterization. Proposed machine learning frameworks for mineral mapping have exhibited promising results. Moreover, data fusion has demonstrated effectiveness in enhancing prediction models.

Key words:

X-ray fluorescence, XRF, hyperspectral, HS, data fusion, machine learning, drill-cores

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DEVELOPING A TOOL FOR ISCG EXPLORATION USING REE-BEARING PHOSPHATE CHEMISTRY

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Mineral exploration is being forced into deeper regions below thick, usually barren, sedimentary cover sequences. New geochemical targeting tools, which use mineral chemistry from a variety of minerals, are being developed to aid exploration under cover, value-add to drill core and understand proximity to ore deposits.

In this project, the mineral chemistry of REE-bearing phosphate minerals (monazite, rhabdophane) from the Jericho and Kulthor ISCG deposits in the Cloncurry District, Queensland has been investigated. At Kulthor, hydrothermal REE-bearing phosphates associated with mineralisation are characterised by elevated light REE (except Ce) and S concentrations and depleted Ca, Th and U concentrations compared to samples with no association with mineralisation. Hydrothermal REE-phosphates associated with mineralisation at Jericho preserve elevated Ca, S and Eu, and depleted Th and U compared to barren metamorphic REE-phosphates. Rhabdophane, a hydrated, low temperature mineral with similar chemistry to monazite, is present in mineralised samples at Jericho, while monazite is the only REE-phosphate mineral present in barren metamorphic samples. Kulthor exclusively contains monazite as the REE-phosphate phase throughout the system.

Overall, the geochemical patterns of REE-bearing phosphate minerals from mineralised and barren samples at Jericho and Kulthor show potential to be used as indicators for proximity to mineralisation.

Key words:

Monazite, rhabdophane, mineral chemistry, ISCG, Cloncurry, Jericho, Kulthor

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LASER BASED S ISOTOPE ANALYSIS OF WEATHERED 'SUPER-HEAVY' NEOPROTEROZOIC SULPHIDES AND RB–SR DATING OF ILLITE FROM KAPUNDA, SOUTH AUSTRALIA

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Biogeochemical cycling of elements can be used to vector subsurface ore deposits via analysis of cover and the interactions across the soil-water-plant system. Tracing isotopic fraction of certain elements from their original depositional environment, through a range of alterations to in-situ weathering and creation of supergene zones. This study couples new sulphide in-situ S isotope data collected with in-situ Rb–Sr dating of illite. Kapunda is located 90 km north of Adelaide, South Australia, and is the oldest commercial copper mine in Australia. This sediment-hosted Cu deposit is hosted in carbonaceous siltstone host-rocks of the Neoproterozoic Tapley Hill Formation [1], in-situ weathering reaches depths of up to 100 metres and result in a Cu-rich supergene environment [2]. Lambert et al. [3] published S isotope data from sulphides at Kapunda displaying 'super-heavy' $\delta^{34}S$ (CDT) signatures of up to 40‰ in both syn-sedimentary and vein sulphides. Samples for this study were taken across 500 metres of core. SEM-MLA images of specific samples were used to identify sulphides for isotopic analysis and illite for Rb–Sr dating. These results indicated alteration of the Tapley Hill Formation at ca. 527 ± 44 Ma during the Delamerian Orogen. These 'super-heavy' sedimentary pyrite in the Tapley Hill Formation have $\delta^{34}S$ values that fall within globally reported marine pyrite $\delta^{34}S$ datasets recording a time interval between the Sturtian and Marinoan glaciations (ca. 715–650 Ma) [4]. Novel laser-based S isotope techniques on sulphides and sedimentary rocks [5] potentially highlight diagenetic redox conditions, fluid sources and weathering alteration of mineralisation via in-situ stable S isotopic analysis. Results reveal $\delta^{34}S$ samples taken from the Tapley Hill Formation at Kapunda within 12-50‰ for chalcopyrite and pyrite. These super-heavy sulphides show a shift to lower $\delta^{34}S$ signatures (~10‰ lower) particularly in chalcopyrite between unweathered and weathered zones of Tapley Hill Formation.

Key words:
Sulphides, S isotopes, Rb-Sr dating, regolith, Cu mineralisation, Tapley Hill Formation

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