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POSTGRADUATE INFORMATION

INTRODUCTION \ USEFUL CONTACTS \ REGISTRATION AS A MINEX CRC POSTGRADUATE STUDENT \ ENROLMENT AS A POSTGRADUATE STUDENT \ REQUIREMENTS AS A MINEX CRC POSTGRADUATE STUDENT \ FINANCIAL SUPPORT \ COMPLETION BONUS
Introduction

This booklet outlines PhD and Masters by Research projects that are being offered within MinEx CRC. These descriptions are intended to be a brief description of what the project will entail.

Any student interested in undertaking a project is encouraged to speak with the listed Primary Supervisor and any co- and industry-supervisors. Each project has an industry supervisor. For the purposes of the MinEx CRC Education and Training Program, industry supervisors are identified as employees within mining or exploration companies, service providers, geological surveys or government research organisations (e.g., CSIRO) that are listed supporters of MinEx CRC.

MinEx CRC is a research consortium that involves numerous industry, government and academic organisations across Australia and internationally. MinEx CRC is a 10-year program that started on 1st July, 2018. Research undertaken within MinEx CRC is aimed at addressing the declining discovery rates of major, new mineral deposits within Australia that are a significant contribution to the Australian export economy and that are needed to meet future metal demand. As there are few, if any, major new mineral deposits exposed at the Earth’s surface remaining to be found within Australia, exploration is moving into deeper terranes which is creating significant challenges and increasing deposit targeting risk and decreasing the cost effectiveness of mineral deposit discovery. As a result, explorers are moving away from Australia into less well explored countries. The decrease in exploration can be measured as Australia’s share of global mineral exploration has reduced from ~1/4 in the 1990s to ~1/8th today.

New sets of exploration tools and tool deployment are required to reverse this trend. Such tools need to recognise the fundamental importance of collecting quantity and high-quality data from subsurface environments, which requires drilling. MinEx CRC’s collective research is structured into three major programs that include:

• Developing more productive, safer and environmentally-friendly drilling methods to discover and drill-out deposits, including coiled tubing drilling technology. (Program 1)

• Developing new technologies for collecting data while drilling, bringing forward mine production. (Program 2)

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. (Program 3)

There are nine projects within these three programs. The projects described in this booklet fit into one of those nine projects.

MinEx CRC has a 10-year target to graduate 50 postgraduate students across the seven participating research institutions of University of South Australia, University of Adelaide, University of Newcastle, Curtin University, University of Western Australia, Australian National University and University of New South Wales.

Researchers across the institutions are involved in various programs and projects within MinEx CRC.

Useful Contacts

The following people can be approached with questions relating to the MinEx CRC Education and Training program and postgraduate projects.

DR CAROLINE TIDDY
MinEx CRC Education and Training Program Coordinator
Future Industries Institute, University of South Australia
Email: caroline.tiddy@unisa.edu.au
Phone: +61 (0) 8 8302 5272

PROFESSOR DAVID GILES
MinEx CRC Chief Scientific Officer
Future Industries Institute, University of South Australia
Email: david.giles@unisa.edu.au
Phone: +61 (0) 8 8303 7361

In addition to the above contacts, the primary supervisor listed the project description is a point of contact.
Registration as a MinEx CRC Postgraduate Student

MinEx CRC postgraduate student registration is independent of the university enrolment and is used for administration within MinEx CRC. All MinEx CRC registered postgraduate students are required to enrol in their degree through their host institution as per normal protocol.

Registration as a MinEx CRC postgraduate student is a simple, two-stage process done by completion of two proformas:

1. The project Primary Supervisor is required to organise approval from MinEx CRC for the proposed project. Details of an Industry Supervisor who will be active in co-supervising the project must be given. This form will give a brief description of the project and must include several signatures including the Primary Supervisor, Project Leader, Program Leader, Chief Scientific Officer and MinEx CRC Education and Training committee are required to ensure the project fits within the scope of MinEx CRC.

2. Recognition that the student has commenced the project. This form must be signed by the student and gives detailed information on obligations and requirements of MinEx CRC postgraduate students as well as project IP. Completion of this form triggers the student to be added to the MinEx CRC student register, which is done by the MinEx CRC Education and Training Committee.

Note that no assessment of thesis, grading or approval of degree is done by MinEx CRC. The degree is met when the University at which the student is enrolled declares so.

Enrolment as a Postgraduate Student

All prospective postgraduate students must enrol with their own university as per standard procedure. Students must therefore meet the requirements stipulated by the university to be enrolled in the degree (e.g., appropriate honours or Masters degree).

Requirements as a MinEx CRC Postgraduate Student

Detailed requirements and obligations for MinEx CRC students are given in the student commencement proforma. MinEx CRC students will be required to attend a small number of meetings such as MinEx CRC Annual Conferences and any researchers’ meetings. Participation in MinEx CRC student events is required. Students will be given opportunities to present their research to the MinEx CRC meetings and network with participants, affiliates and researchers.

Financial Support

Where agreed by MinEx CRC, postgraduate student projects may be financially supported by up to $20k per year for three years for a PhD project and two years for a Masters by Research project. The distribution of this funding is at the discretion of the Primary Supervisor of the project and may be used for student stipend, project operating expenditure or other expenditure that is related to the student project.

Completion Bonus

Upon qualification for the enrolled degree, registered MinEx CRC students will be eligible to receive a completion bonus of $3k for a completed PhD and $2k for a completed Masters by Research degree. The completion bonus is awarded once the student has received an official letter from their University stating they have qualified for the degree and are able to graduate. This will be received following thesis examination, correction and resubmission as required by the University.

Project Descriptions

The following pages give a brief description of postgraduate projects on offer within MinEx CRC. Host Universities include (note that projects will not always be offered in each institution):

- Australian National University
  - www.anu.edu.au
- Curtin University
  - www.curtin.edu.au
- The University of Adelaide
  - www.adelaide.edu.au
- The University of Newcastle
  - www.newcastle.edu.au
- UNSW
  - www.unsw.edu.au
- University of South Australia
  - www.unisa.edu.au
- The University of Western Australia
  - www.uwa.edu.au
THE FOLLOWING PAGES GIVE A BRIEF DESCRIPTION OF POSTGRADUATE PROJECTS ON OFFER WITHIN MINEX CRC.
**PHD PROJECT**
Curtin University

**PREREQUISITES AND INTERESTS**
Background in fluid mechanics, particularly compressible fluid flow.

**SUPERVISORS**
Dr Masood Mostofi
e: masood.mostofi@curtin.edu.au
t: +61 (0) 8 9266 4989

Co-supervisors:
Dr Yevhen Kovalyshen (CSIRO)
Dr Hongyang Zhang (Curtin University)

**PARTICIPATING ORGANISATIONS**
Curtin University
CSIRO

**RESEARCH PROJECT**
Drilling is an essential component of mineral exploration, and optimisation of drilling operation is the key towards effective exploration. In project 1 of MinEx CRC, the objective is to improve the drilling efficiency of rotary and percussive drilling.

This PhD project is focused on better understanding of the bit-rock interaction in percussive drilling. This project is an experimental study involving extensive drilling experiments with the goal of developing bit-rock interaction phenomenological models. The experiments will be performed in the lab using state of the art drilling facilities of Drilling Mechanics Group. In addition to the lab data, the project will benefit from the large volume of drilling data collected by the research team in Project 1 from the field.

In addition to be able to conduct percussive drilling experiments, the candidate is expected to have backgrounds in rock mechanics and signal processing to collect and interpret large volume of signals received from various sensors to quantify the link between rock properties, bit and the operating parameters.


Figure: Bilinear characteristic of the force/penetration response and its limited rate dependency, after Depouhon (2014).

**PHD PROJECT**
Curtin University

**PREREQUISITES AND INTERESTS**
Background in rock mechanics, data processing and experimental research.

**SUPERVISORS**
Dr Masood Mostofi
e: masood.mostofi@curtin.edu.au
t: +61 (0) 8 9266 4989

Co-supervisors:
Dr Thomas Richard (Curtin University)
Dr Yevhen Kovalyshen (CSIRO)

**PARTICIPATING ORGANISATIONS**
Curtin University
CSIRO

**RESEARCH PROJECT**
Drilling is an essential component of mineral exploration, and optimisation of drilling operation is the key towards effective exploration. In project 1 of MinEx CRC, the objective is to improve the drilling efficiency of rotary and percussive drilling.

RC drilling is one the effective methods of drilling and sampling in mineral exploration. One of the challenges of RC drilling is providing the downhole tool with sufficient hydraulic energy to deliver the mechanical energy for rock fragmentation. As the depth increases, and after passing the aquifer, the role of drilling fluid hydraulics becomes more and more important.

This project is aimed at better understanding of the two-phase flow of compressible fluids in RC drillstring and transportation of cuttings to surface. The project involves analytical and numerical modelling of compressible fluid hydraulics with goal of developing engineering models. In addition to the modelling, the work entails laboratory and field work to validate the engineering models developed to characterise the compressible fluid flow.

The ideal candidate has strong background in fluid mechanics especially for compressible fluids, and has previous experimental research background. Signal processing and basic programming is also an advantage.


Figure: Cutting velocity measurement using high speed video camera.
MINEX CRC PROJECT 3:  
Real-time downhole assay

PHD PROJECT  
University of South Australia

PREREQUISITES AND INTERESTS  
The potential candidate will have an interest in geology, geochemistry, mineralogy, analytics and experimental research

SUPERVISORS  
Dr Caroline Tiddy  
e: caroline.tiddy@unisa.edu.au  
t: +61 8 8302 5272

Co-supervisors  
Dr Ben van der Hoek (University of South Australia)  
Dr Steven Tassios (CSIRO)  
Dr Yulia Uvarova (CSIRO)

RESEARCH PROJECT  
This project will contribute to a broader effort within MinEx CRC to develop sensors that can be used for real-time analysis at the bottom of a drill hole (downhole assay). The project will focus on the adaptation of Laser Induced Breakdown Spectroscopy (LIBS) for analysis on a moving target and within media other than air (e.g. within water). Such technology is currently used on the Mars Rover system where analysis is done at a distance of up to 7m from the target, however has not been adapted to an aggressive downhole environment.

The project will require a series of experiments that investigate optimisation of the current LIBS technology with truthing done through geochemical and mineralogical analysis. The outcomes of the project may also have further implications on non-drilling exploration- and mining-based applications, e.g. real-time analysis of a decline mine wall or face-mapping.

PARTICIPATING ORGANISATIONS  
University of South Australia  
CSIRO

MINEX CRC PROJECT 4:  
Petrophysical logging while drilling

PHD OR MASTERS PROJECT  
Curtin University

PREREQUISITES AND INTERESTS  
Minimum is Honours and Masters Level - Engineering, Physics, or Geophysics or equivalent.

SUPERVISORS  
A/ Prof. Brett Harris  
e: b.harris@curtin.edu.au  
t: +61 8 9266 3089

Co-supervisors  
Dr Andrew Pethick (Curtin University)  
Industry supervisor to be selected from participating companies based on the final project details

RESEARCH PROJECT  
Sensor are being developed capable of providing delivery of geophysical data in real time during drilling. Multiple data sets stream from devices set in or above the bottom-hole assembly will be immediately available. This project concerns development of new methods and software for real time update or refinement of subsurface geological models during drilling. It will require a passion for advanced computing, geophysics and geology. The ultimate destination for the research outputs would be to assist new geo-steering for the Minerals industry.
GEOPHYSICAL SENSOR SYSTEMS FOR LOGGING WHILE DRILLING IN THE MINERAL INDUSTRY

MINEX CRC PROJECT 4:
Petrophysical logging while drilling

PHD OR MASTERS PROJECT
Curtin University

PREREQUISITES AND INTERESTS
Honours and Masters Students in Engineering, physics, or geophysics.

SUPERVISORS
Dr Michael Carson
e: Michael.carson@curtin.edu.au
t: +61 8 9266 4973

Co-supervisors
Dr Hoang Nguyen and Dr Brett Harris (Curtin University)
Industry supervisor to be selected from participating companies based on the final project details

PARTICIPATING ORGANISATIONS
Curtin University

RESEARCH PROJECT
MinEx CRC is developing innovative logging while drilling (LWD) technologies for the mineral industry. For example new real time sensing is required for the revolutionary minerals coil tubing drill rigs. This proposed project will focus on development, miniaturizations and testing of a range of logging while drilling geophysical sensor systems. The candidate should have a passion for geophysics, electronics, instrumentation and creating innovative devices for real world applications.

FULL-WAVEFORM INVERSION

MINEX CRC PROJECT 5:
Seismic in the drilling workflow

PHD PROJECT
Curtin University

PREREQUISITES AND INTERESTS
Potential candidate should have at least Masters or Honours degree in one of: Geophysics, Physics or Engineering. The candidate should have also experience in programming.

SUPERVISORS
Professor Andrej Bona
e: a.bona@curtin.edu.au
t: +61 8 9266 7194

Co-supervisors
A/Prof. Roman Pevzner (Curtin University)
Dr Greg Turner (HiSeis)

PARTICIPATING ORGANISATIONS
Curtin University
HiSeis

RESEARCH PROJECT
As part of MinEx CRC, we are developing methods that can make seismic imaging and characterisation of the subsurface a more viable tool for mineral exploration and mine development. One of the methods that we want to utilise more is Full Waveform Inversion (FWI). This project will investigate possibilities of utilising FWI algorithms for mineral exploration.
IMPROVEMENT OF DISTRIBUTED ACOUSTIC SENSING DATA PROCESSING

MINEX CRC PROJECT 5: Seismic in the drilling workflow

PHD PROJECT
Curtin University

PREREQUISITES AND INTERESTS
Potential candidate should have at least Masters or Honours degree in one of: Geophysics, Physics or Engineering. The candidate should have good background in signal processing and also experience in programming.

SUPERVISORS
Professor Andrej Bona
E: a.bona@curtin.edu.au
T: +61 8 9266 7194

Co-supervisors
A/Prof. Roman Pevzner (Curtin University)

PARTICIPATING ORGANISATIONS
Curtin University

RESEARCH PROJECT
As part of MinEx CRC, we are developing methods that can make seismic imaging and characterisation of the subsurface a more viable tool for mineral exploration and mine development. One of the novel tools that we want to utilise is Distributed Acoustic Sensing (DAS) that uses optical fibres as seismic sensors. DAS is a very rapidly developing field; there are still significant improvements in the acquired data quality possible, also by using advanced signal processing of the raw measurements.

The focus of the proposed PhD project is to develop a suite of processing methods with the aim to improve the seismic data produced by DAS.

PASSIVE SEISMIC METHODS FOR MINERAL EXPLORATION

MINEX CRC PROJECT 5: Seismic in the drilling workflow

PHD PROJECT
Curtin University

PREREQUISITES AND INTERESTS
Potential candidate should have at least Masters or Honours degree in one of: Geophysics, Physics or Engineering. The candidate should have some experience in programming.

SUPERVISORS
Professor Andrej Bona
E: a.bona@curtin.edu.au
T: +61 8 9266 7194

Co-supervisors
A/Prof. Milovan Urosevic (Curtin University)
Ashley Grant (BHP)

PARTICIPATING ORGANISATIONS
Curtin University, BHP

RESEARCH PROJECT
As part of MinEx CRC, we are developing methods that can make seismic imaging and characterisation of the subsurface a more viable tool for mineral exploration and mine development. One approach to reduce the cost of seismic is the utilisation of ambient seismic energy for the imaging. This project will focus on development of seismic imaging methods utilising ambient sources of seismic waves, which can include man-made sources such as drilling and mining activities.
**OPTIMAL DRILLING SCHEMES IN UNCERTAIN TERRANES**

**MINEX CRC PROJECT 6:**
Automated 3D Geological Modelling

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**PHD PROJECT**
University of Western Australia

**PREREQUISITES AND INTERESTS**
Good programming skills and a strong background in a natural science, preferably geoscience.

**SUPERVISORS**
Professor Mark Jessell  
e: Mark.Jessell@uwa.edu.au  
t: +61 428 082 004

Co-supervisors  
Dr Mark Lindsay (University of Western Australia)  
Industry Supervisor: TBC

**PARTICIPATING ORGANISATIONS**

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**RESEARCH PROJECT**
Working with an industry-supplied drill hole databases, this project will investigate the optimal density and distribution of drilling needed to extract meaningful geological models in different geological scenarios. This will involve the analysis of previously developed 3D models and simplified test models to better understand how different drilling strategies may be able to simultaneously maximise information from cover sequences and basement geology.

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**DATA FUSION METHODOLOGIES FOR GEOLOGY-GEOPHYSICS INVERSION**

**MINEX CRC PROJECT 6:**
Automated 3D Geological Modelling

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**PHD PROJECT**
University of Western Australia

**PREREQUISITES AND INTERESTS**
Good programming skills and a strong background in a natural science, preferably geoscience.

**SUPERVISORS**
Professor Mark Jessell  
e: Mark.Jessell@uwa.edu.au  
t: +61 428 082 004

Co-supervisors  
Dr Mark Lindsay and Jeremie Giraud (University of Western Australia),  
Industry Supervisor: TBC

**PARTICIPATING ORGANISATIONS**

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**RESEARCH PROJECT**
Fusion of geological modelling and constrained geophysical inversion through geology-geophysics inversion: methodological development and application case study. The project will be focusing on the development and application of a technology capable of modelling geological and geophysical data simultaneously. The goal of the project is to fuse geological modelling approaches that translate geological measurements into geological potential fields with constrained geophysical inversion to provide a unified modelling framework.
3D PROSPECTIVITY ANALYSIS
WITH UNCERTAINTY ANALYSIS

MINEX CRC PROJECT 6:
Automated 3D Geological Modelling

PHD PROJECT
University of Western Australia

PREREQUISITES AND INTERESTS
Good programming skills and a strong background in a natural science, preferably geoscience

SUPERVISORS
Dr Mark Lindsay
e: Mark.Lindsay@uwa.edu.au
t: +61 8 6488 5805
Co-supervisors
Professor Mark Jessell
(University of Western Australia)
Industry supervisor: TBC

PARTICIPATING ORGANISATIONS

RESEARCH PROJECT
Development and application of uncertainty propagation from data to prediction in 3D as applied to prospectivity analysis. This will be a multiscale approach that will find prospecitive alteration characteristics from drillcore, then extrapolate these to larger scales to better inform prospect-to-camp-scale predictive analyses.

Geostatistical techniques will be used and/or developed to identify trends in data that may represent 3D mineralisation vectors, and then used to constrain analyses. Uncertainties related to measurement error and data gaps will be determined to provide an evaluation of prediction robustness.

MINEX CRC POSTGRADUATE PROJECTS

TOPOLOGY OF GEOLOGY IN 1D & 2D AS A GEOMODELLING CONSTRAINT

MINEX CRC PROJECT 6:
Automated 3D Geological Modelling

PHD PROJECT
University of Western Australia

PREREQUISITES AND INTERESTS
Good programming skills and a strong background in a natural science, preferably geoscience

SUPERVISORS
Professor Mark Jessell
e: Mark.Jessell@uwa.edu.au
t: +61 428 082 004
Co-supervisors
Dr Mark Lindsay
(University of Western Australia)
Industry Supervisor: TBC

PARTICIPATING ORGANISATIONS

RESEARCH PROJECT
Topological constraints such as fault relationships, stratigraphy and magmatic intrusions form vital inputs to 3D geological modelling. Topology often defines the accepted tectonic scenario ascribed to a region, however are not always well-understood or constrained. Due to sparse and uncertain geological observations, multiple topologies are often possible for a given region, though we only ever consider the one thought to the most plausible. This project will investigate the use of the spatial and temporal topology of borehole and map data as constraints for 3D geological modelling to explore the full-extent of geological possibility from our geoscientific datasets.
**PHD PROJECT**
University of Adelaide

**PREREQUISITES AND INTERESTS**
Interests in isotope geology, ore deposits, basin exploration and analytical instrumentation.

**SUPERVISORS**
Dr. Juraj Farkas  
e: juraj.farkas@adelaide.edu.au  
t: +61 8 8313 5519

Co-supervisors
Prof. Alan Collins, Dr. Sarah Gilbert (University of Adelaide), Dr. Sam Spinks, Dr. Marcus Kunzmann (CSIRO), Dr. Chris Edgoose (NTGS), Prof. Tony Dosseto (University of Wollongong)

**PARTICIPATING ORGANISATIONS**

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**RESEARCH PROJECT**
The highly mineralized Yalgoo–Singleton greenstone belt (western Yilgarn Craton) has recently become data-rich since 1:100k digital mapping by GSWA. In particular, there is a stratigraphic and structural framework in place, augmented by complete geophysical coverage, and enhanced datasets for geochronology and geochemistry.

This has provided a backbone for further 3D understanding and input into a coarse 1:1M scale 3D model, and investigate a range of mineralisation styles in 3D (Au, VHMS base-metals, Fe-ore, ultramafic-hosted Cu-PGE and intrusion-related W-Mo).

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**ISOTOPE TRACING OF METAL SOURCES AND ORE FORMING PROCESSES IN THE MCArTHUR WITH UNCERTAINTY ANALYSIS**

**MINEX CRC PROJECT 8:**
Geological Architecture and Evolution

**PHD PROJECT**
University of Western Australia

**PREREQUISITES AND INTERESTS**
Good programming skills and a strong background in a natural science, preferably geoscience

**SUPERVISORS**
Dr Mark Lindsay  
e: Mark.Lindsay@uwa.edu.au  
t: +61 8 6488 5805

Co-supervisors
Professor Mark Jessell (University of Western Australia), Dr Tim Ivanic (Geological Survey of Western Australia)

**PARTICIPATING ORGANISATIONS**

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**RESEARCH PROJECT**
The highly mineralized Yalgoo–Singleton greenstone belt (western Yilgarn Craton) has recently become data-rich since 1:100k digital mapping by GSWA. In particular, there is a stratigraphic and structural framework in place, augmented by complete geophysical coverage, and enhanced datasets for geochronology and geochemistry.

This has provided a backbone for further 3D understanding and input into a coarse 1:1M scale 3D model, and investigate a range of mineralisation styles in 3D (Au, VHMS base-metals, Fe-ore, ultramafic-hosted Cu-PGE and intrusion-related W-Mo).

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**Using the Loop Platform**

**MINEX CRC PROJECT 6:** Automated 3D Geological Modelling

**RESEARCH PROJECT**
The highly mineralized Yalgoo–Singleton greenstone belt (western Yilgarn Terrane, Yilgarn Craton) has recently become data-rich since 1:100k digital mapping by GSWA. In particular, there is a stratigraphic and structural framework in place, augmented by complete geophysical coverage, and enhanced datasets for geochronology and geochemistry.

This has provided a backbone for further 3D understanding and input into a coarse 1:1M scale 3D model, and investigate a range of mineralisation styles in 3D (Au, VHMS base-metals, Fe-ore, ultramafic-hosted Cu-PGE and intrusion-related W-Mo).

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**MINEX CRC PROJECT 7:** Processes in the McArthur

**RESEARCH PROJECT**
Proterozoic mineral systems in Australia, such as the McArthur Basin in NT and Mount Isa Inlier in Queensland, host some of the largest sediment-hosted base metal deposits in the world. These accumulations of Pb, Zn, Cu and Ag are hosted in ~1.65 billion years old carbonaceous black shales, where the ore formation process is believed to be linked to complex interactions between mineralising fluids, host rocks, and ‘redox traps’ facilitating formation of base-metal sulphides. Although the general mechanisms for the formation of sediment-hosted deposits are relatively well understood, the specific conditions (redox, pH, temperature) and sources of metals for McArthur Basin hosted base metal deposits (HYC, Teena and Reward), remain relatively poorly constrained, thus impacting their future exploration and prospectivity.

Classical models invoke exhalative processes supplying hot and reducing fluids (carrying both metals and reduced H2S) leading to syndepositional formation of sulphide ores at the sediment-water interface. Alternatively, the ores might be linked to a migration of oxidised fluids carrying dissolved SO4- species, which once reduced to H2S (at ‘redox traps’) will lead to precipitation of Pb-Zn-Cu sulphides, where the metals can be thus locally sourced and not supplied by the fluids. Finally, the sediment-hosted ores can be also products of later hydrothermal replacement and remobilisation within sedimentary rocks, thus not requiring external sources of metals and/or sulphur.

To address these questions and better constrain (i) the sources of metals and (ii) local redox conditions during mineralisation, this project will employ novel isotope proxies and analytical techniques. Specifically, isotope tracers of redox sensitive metals (δ65Cu, δ66Zn, δ53Cr proxies) combined with S isotopes (δ34S) will be analysed in (i) host sedimentary rocks, (ii) associated volcanic rocks, and (iii) ore bodies in the McArthur Basin areas. Overall, this project will test the potential of novel isotope tracers for “vectoring” of base metal sources and their geochemical pathways in the McArthur Basin’s mineral system, and an overlying sedimentary cover, thus providing a proof of concept for future applications of metal isotope tracers for exploration purposes.
MINEX CRC PROJECT 8: Geological Architecture and Evolution

PHD PROJECT
University of Adelaide

PREREQUISITES AND INTERESTS
Interests in isotope geology, ore deposits, basin exploration and analytical instrumentation. A 2.1 or first class Honours degree or Masters in Earth Sciences or Chemistry.

SUPERVISORS
Dr. Juraj Farkas
e: juraj.farkas@adelaide.edu.au   t: +61 8 8313 5519

Co-supervisors
Prof. Alan Collins, Dr. Sarah Gilbert (University of Adelaide), Dr. Catherine Spaggiari (GDSA), Dr. Sam Spinks, Dr. Yulia Ivurova (CSIRO), Prof. Tony Dosseto (University of Wollongong)

PARTICIPATING ORGANISATIONS
University of Adelaide

MINEX CRC PROJECT 8: Geological Architecture and Evolution

PHD PROJECT
University of Adelaide

PREREQUISITES AND INTERESTS
Interests in isotope geology, ore deposits, basin exploration and analytical instrumentation. A 2.1 or first class Honours degree or Masters in Earth Sciences or Chemistry.

SUPERVISORS
Dr. Juraj Farkas
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Co-supervisors
Prof. David Chittleborough, Prof. Alan Collins (University of Adelaide), Dr. Nathan Reid, Dr. Sam Spinks, Dr. Robert Thorne (CSIRO), Dr. Anna Petts, Dr. Adrian Fabris (GSSA), Prof. Tony Dosseto (University of Wollongong)

PARTICIPATING ORGANISATIONS
University of Adelaide

RESEARCH PROJECT
Understanding the cover and how to effectively explore through it is complicated by many factors that contribute to masking changes in subsurface lithologies (matric, felsic, carbonates/shales) that may host ore deposits. Apart from conventional element-concentration surveys of soils, which often provide inconclusive results, one potential tool to address these issues is via novel metal isotope tracers. There is evidence that the latter can be used to infer different lithologies and mineralised systems based on the isotope analysis of selected metals in cover. These isotope proxies (e.g. Ca, Mg, Sr, Cu, Zn, Cr) can be sampled in various Earth’s surface reservoirs (soils, waters, vegetation, termite mounds) to better understand what may be preserved through weathering, and not greatly affected by local and/or regional biological/hydrological processes operating near surface.

This project aims to perform a regional study corresponding to NGI (National Drilling Initiative) areas of interest, by investigating how metal isotope fractionate from key rock types during biogeochemical weathering. We expect that this will aid the identification of specific isotope indices and/or geochemical parameters that may be preserved through in-situ weathering and potentially transported into cover and its specific near-surface reservoirs (soils, groundwater, vegetation, termite mounds). In particular, the project will investigate (i) Cr, Cu, Zn isotopes from mafic/ultramafic terrains (Harris Greenstone Belt, South Australia), (ii) Li, Sr, U isotopes from weathered pegmatite/granite systems (Western Australia-based), and (iii) alkaline earth elements (Ca, Mg, Sr) and redox metal isotopes (Cr, Cu, Zn) from carbonate/shale lithologies (Cobar region). This project thus proposes a focused investigation on several key sites/areas where legacy cores of the key lithologies are available, and can be followed up by surface sampling. Overall, this project aims to identify main fractionation mechanisms for metal isotopes during weathering, transport and biological uptake, which in turn is critical for future application of these isotopes to identify subsurface lithologies and associated ore deposits in various host-rocks via the analysis of cover.
**NOVEL LASER-BASED GEOCHRONOLOGICAL TECHNIQUES**

**FOR DATING SEDIMENTARY SYSTEMS WITH APPLICATION TO MINERAL AND HYDROCARBON EXPLORATION**

**MINEX CRC PROJECT 8:**

**Geological Architecture and Evolution**

**PHD PROJECT**
University of Adelaide

**PREREQUISITES AND INTERESTS**
Interests in geochronology, geochemistry, isotope geology and basin analysis. A 2.1 or first class Honours degree or Masters in Earth Sciences.

**SUPERVISORS**
Prof. Alan Collins
e: alan.collins@adelaide.edu.au
t: +61 8 8313 3174

Co-supervisors
- Dr. Juraj Farkas, University of Adelaide
- Dr. Sarah Gilbert (University of Adelaide)
- Dr. Anthony Reid (Geological Survey of SA)
- Dr. Geoff Fraser (Geoscience Australia)

**RESEARCH PROJECT**
Correlating Proterozoic sedimentary rocks undercover is essential to develop 3D stratigraphic models for a basin. Obtaining absolute ages is vital to set up a chronostratigraphic sequence stratigraphy. Yet, these are not straightforward things to do in Proterozoic rocks where palaeontology is only of limited help. In this project, which is part of the National Drilling Initiative of the MinEx CRC, the student will develop a new laser-based technique where shales and glauconites will be analysed for their Rb-Sr and K-Ca isotopes using a reaction-cell inductively coupled plasma mass spectrometer (so-called LA-QQQ-ICPMS). The isotope systematics of whole-rock shales, illites separated from the shales and glauconites from sandstones will be studied using this micro-analytical technique and micro-mineralogically and chemically characterised. As well as age information, chemical information about the fluid sources in which the rocks and minerals were deposited/recrystallised will be collected to link the age data with petrological data from the rocks in question. The resulting ages will be interpreted in terms of the role of detrital components, diagenetic and low temperature recrystallization, and thermal resetting, in order to understand the full meaning of these ‘ages’ and develop methodologies for absolute dating of these mineral and hydrocarbon hosting sedimentary systems.

**PARTICIPATING ORGANISATIONS**
- THE UNIVERSITY OF ADELAIDE
- Australian Government Geoscience Australia

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**GEOCHEMICAL FOOTPRINTS OF MINERALISATION IN THE CRYOGENIAN-EDIACARAN STUART SHELF**

**MINEX CRC PROJECT 8:**

**Geological Architecture and Evolution**

**PHD PROJECT**
University of Adelaide

**PREREQUISITES AND INTERESTS**
Interests in isotope geology, ore deposits, basin exploration and analytical instrumentation. A 2.1 or first class Honours degree or Masters in Earth Sciences.

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Co-supervisors
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**PARTICIPATING ORGANISATIONS**
- THE UNIVERSITY OF ADELAIDE
- Australian Government Geoscience Australia

**RESEARCH PROJECT**
The Stuart Shelf of South Australia is a sequence of Cryogenian-Ediacaran sandstones, carbonates and shales that underlie the iron oxide, copper, gold, uranium deposits of the Gawler Craton. Recent research has demonstrated that hydrothermal fluids redistributed mineralisation within the Olympic Dam ore body, coeval with, and after, deposition of the Stuart Shelf sediments. Other new research demonstrates that bottom water redox proxies, such as P, Mo and Mo/Al and Fe/Al ratios vary significantly in the Stuart Shelf sedimentary rocks due to a proposed stepped Neoproterozoic Oxygenation Event related to global glaciation at this time. As such, the sequence forms an ideal laboratory for understanding the metal distribution and deposition within variable redox-state of Neoproterozoic waters. In addition, the project will establish a background geochemical framework to use as a template on which geochemical anomalies due to distal chemical tracers of hydrothermal plumes fluxing material from the basement into the overlying sedimentary sequence.

This PhD project proposes to develop and undertake an extensive whole-rock and mineral (e.g. rutile, apatite) geochemical study of the Stuart Shelf of South Australia to map the spatial and temporal evolution of basin water chemistry and hydrothermal system distal footprints to, a) investigate the timing of basin-water oxygenation through the later Neoproterozoic; b) examine the extent of the sedimentary-hosted mineralisation in the basin; c) distinguish and map distal footprints of hydrothermal remobilisation of basement-based mineral systems (which may involve novel metal isotopes such as Cu); and; d) apply the techniques developed to new MinEx CRC drilling in the east-Tennant Creek region.
PHD PROJECT
University of Adelaide

PREREQUISITES
A 2.1 or first class Honours degree or Masters in Earth Sciences, with interests in isotope geology, ore deposits, basin exploration and analytical instrumentation.

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PARTICIPATING ORGANISATIONS

RESEARCH PROJECT
The Officer Basin is a Neoproterozoic intracratonic basin with a total sedimentary thickness of up to 8 km that straddles the West Australian and South Australian border. The basin infill is a mixed carbonate, silty and sandy siliciclastic, and evaporitic succession dominated by shallow marine to coastal deposition. It crops out and subcrops through a very remote part of the country and buries parts of the Musgrave Province, the Albany–Fraser Orogen, the NW Gawler and the NE Yilgarn Cratons.

This project will focus on the sedimentary geochemistry of the basin in three modules that will tackle: The provenance of detrital rocks within the basin. To do this the geochemistry and age of detrital minerals will be investigated. These include U–Pb, Hf, trace elements in zircon, apatite, and rutile as well as Rb–Sr, 40Ar–39Ar and trace elements in mica. In addition, Nd isotopes in shale and 87Sr–86Sr and 88Sr–86Sr variations in carbonates.

Chemostratigraphic correlation and absolute age constraints on the stratigraphy. This will be undertaken by developing C, N and Sr isotope profiles through shales and carbonates within the basin. In addition, absolute age constraints will be determined through the novel Rb–Sr and K–Ca LA-QQQ-ICP-MS technique of dating shales (±glauconite), which is being pioneered by MinEx CRC researchers.

Basin water geochemistry using proxies for salinity (e.g. B/Ca, Sr/Ba and C/S) and palaeo-redox (e.g. Mo, V, U, Fe speciation, and stable Cr isotopes) will be investigated to examine the chemical evolution of the basin, its redox structure, during times of controversial planetary oxidation levels.

In addition to unravelling the stratigraphy and chemical evolution of the basin through this incredible time of Earth evolution, this project will investigate potential redox traps and distal footprints of sedimentary-hosted mineral deposits as well as the hydrocarbon source-rock potential and maturation.

RESEARCH PROJECT
The greater McArthur Basin is a vast sedimentary system that spans from Queensland to Western Australia and covers much of northern Australia. The separate sedimentary packages within the basin contain vast Palaeoproterozoic sedimentary-hosted mineralisation and both Palaeoproterozoic and Mesoproterozoic hydrocarbon deposits. The present architecture of the basin is being worked out using geophysical techniques, and the past depositional systems are being revealed with new research into provenance analysis through the basins. Yet, the thermal and burial history of the basin and, in particular, the surrounding basement provinces (Murphy inlier, Pine Creek Orogen, Tanami, Arunta Province) is largely unknown.

This project seeks to understand the post-depositional thermal history of the greater McArthur Basin and its surrounding basement to understand the time-component in the development of the structural architecture of this vast expanse of northern Australia and link this to the compartmentalisation of the greater McArthur Basin and the exhumation of the region.
GEOCHEMICAL SIGNATURE OF ZIRCON IN RELATION TO MINERAL SYSTEMS

MINEX CRC PROJECT 8:
Geological Architecture and Evolution

PHD PROJECT
University of South Australia

PREREQUISITES AND INTERESTS
A 2.1 or first class Honours degree or Masters in Earth Sciences with interests in geochemistry and mineral systems

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RESEARCH PROJECT
The challenge for mineral exploration is to meet increasing global metal demand by making new discoveries. This challenge is amplified by decreasing rates of deposit discovery, as ore deposits once exposed at the Earth’s surface are being depleted. This has shifted the exploration frontier into progressively deeper terranes at increased cost and risk, increasing the need for indirect indicators of mineralisation.

Resistate mineral phases (e.g. monazite, rutile) demonstrably preserve unique geochemical signatures that can be directly related to mineralisation, and have the potential to be incorporated into sedimentary cover without undergoing alteration. Once characterised, these signatures have the potential to be used to identify buried mineralisation. This project aims to develop geochemical criteria for exploration using zircon chemistry. Mineral and whole rock geochemical data will be collected on zircon grains known to be associated with a mineralised system to identify unique chemical signatures that may be associated with various commodities, and understand their relationship with geological processes and provenance. This will be combined with assessment of the palaeogeography and landscape processes active at the time of deposition of sedimentary cover to understand the potential effect of weathering and transport and how the geochemical footprint of underlying mineralisation can be increased through the cover.

Figure: Cathodoluminescence Images of zircon grains from the Donington Suite at Punt Hill, Gawler Craton, South Australia.

THERMOCHRONOLOGICAL AND GEOCHEMICAL FOOTPRINTS OF FLUID ALTERATION, RECORDED IN APATITE

MINEX CRC PROJECT 8:
Geological Architecture and Evolution

PHD PROJECT
University of Adelaide

PREREQUISITES AND INTERESTS
Interests in isotope geology, ore deposits, basin exploration and analytical instrumentation. A 2.1 or first class Honours degree or Masters in Earth Sciences.

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RESEARCH PROJECT
This project aims to date and map distal footprints of fluid alteration/metasomatism using a multi-method thermochronological and geochemical approach. Apatites (and other accessory minerals) will be separated from basement rocks within central Australia (both under cover through the MinEx CRC national drilling program and from outcrops) and ‘double-dated’ using the fission track and U-Pb methods. Simultaneous acquisition of trace element concentrations during U-Pb isotope measurements, will provide a data-set that provides information on mid to low-temperature (<450°C) post-magmatic metamorphism / metasomatism as well as exhumation (cooling below <120°C). Resulting alteration and exhumation maps will jointly evaluate mineralisation prospects (see example below for the metal-rich Uzbek Tian Shan). This project is funded via the MinEx CRC and will suit a student with interest in mineral exploration.

Figure: young apatite U-Pb anomalies coincide with the extent of orogenic Au mineralisation. Deposits in the east have been eroded by subsequent deformation as mapped by fission track data (not on figure).
CRATON BOUNDARIES AND THEIR MAFIC MAGMAS

MINEX CRC PROJECT 8:
Geological Architecture and Evolution

PHD PROJECT
University of South Australia

PREREQUISITES AND INTERESTS
A 2.1 or first class Honours degree or Masters in Earth Sciences or related discipline, with interests in isotope geology, petrology and mineral exploration.

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PARTICIPATING ORGANISATIONS
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RESEARCH PROJECT
The western Gawler Craton, South Australia, represents the interface between an Archean craton and a 5000km long Mesoproterozoic orogen that is interpreted to record the final amalgamation of Proterozoic Australia. It is also highly prospective and has variously been explored for iron oxide-copper-gold (IOCG) deposits, due to its proximity and analogous geology to the world-class Olympic IOCG province, and nickel, due to interpreted similarities to the Thompson Nickel Belt in Canada. The region is host to multiple Mesoproterozoic, ultra-mafic to mafic intrusions that approximate the lithospheric boundary between Archean and Paleo- to Mesoproterozoic crust and are anomalous in Ni and Cr. This suite of rocks is yet to be fully geochemically characterised but is the current focus of active exploration programs. This project will use geochemistry, isotope geochemistry, petrology and geochronology to constrain the crustal evolution of the western Gawler Craton with a primary focus on understanding the mafic igneous systems in the region and the tectonic architecture of the craton margin. The project will benefit from access to a series of recent exploration drillholes that have been made available to the Geological Survey of South Australia. The project will aim to develop analytical and geological protocols that enable effective terrane boundary mapping and maximise the information available to explorers undertaking greenfields exploration in mafic – ultra-mafic igneous systems.

Figure: Cathodeluminescence images of zircon grains from the Donington Suite at Punt Hill, Gawler Craton, South Australia.

MINEX CRC PROJECT 8:
Geological Architecture and Evolution

PHD PROJECT
Curtin University

PREREQUISITES
A 2.1 or first class Honours degree or Masters in Earth Sciences, with interests in isotope geology, mineral exploration analytical instrumentation.

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PARTICIPATING ORGANISATIONS
Curtin University

RESEARCH PROJECT
The recognition that crustal fluids play a key role in the transporting mass within the crust and the generation of large-scale geophysical anomalies highlights the importance of linking fluid flow events to tectonometamorphic and structural events. The aim of this project is to use texturally controlled geochemical and isotopic data to investigate the source and timing of fluids in major crustal structures. To achieve this aim we will focus on the trace element geochemistry and isotopic composition of accessory minerals, such as monazite and titanite, associated with fluid flow. Linking the textual and trace element geochemical characteristics of accessory minerals to the growth of major minerals, such as garnet, has enabled the elucidation of metamorphic evolutions to be achieved. In this project it is envisaged that we will use similar techniques to examine the fluid characteristics through the coupling of the geochronological data from the accessory minerals with trace, REE and isotopic compositions of major (garnet) and accessory minerals such as titanite and monazite (Sm-Nd). This will allow the isotopic compositions of fluids to be tied to the geochronological and metamorphic data generated.

Figures: (left to right) Sheared aluminous metapelite; EPMA map of monazite in a shear zone; U-Pb Concordia from LASS analysis of monazite.

IN ACCESSORY MINERALS USING MULTIPLE ISOTOPIC SYSTEMS

TRACING FLUIDS IN SHEAR ZONES
**PB-LOSS MAPPING:**
**A NEW TOOL TO TRACK FLUID MOBILITY IN SPACE AND TIME**

**MINEX CRC PROJECT 8:**
Geological Architecture and Evolution

**PHD PROJECT**
Curtin University

**PREREQUISITES**
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**PARTICIPATING ORGANISATIONS**
Curtin University
Geological Survey of Western Australia
Australian Government

**RESEARCH PROJECT**
Zircon is a ubiquitous refractory mineral that contains uranium (U) and lead (Pb). Zircon U–Pb geochronology has become a keystone tool across Earth science, arguably providing the gold standard in resolving deep geological time as the U-Pb isotopic system has multiple chronometers including 238U/206Pb, 235U/207Pb and 207Pb/206Pb systems. Frequently the U-Pb zircon age reflects the timing of magmatic crystallization. However, under certain circumstances radiogenic Pb can be lost from the zircon crystal rendering the crystallization age determination incorrect. However the systematics of the Pb loss process can leave characteristic patterns in U-Pb isotope space. This pattern in isotope space is highly informative yet it is seldom interrogated to its full extent and can be modelled to best evaluate the timing of radiogenic-Pb loss. The timing of Pb loss may reflect the influence of reactive fluids which may be important in metallogenesis. This work will evaluate the timing of radiogenic-Pb mobility across Australia leveraging the huge amount of data currently available with an aim to determine if there is both a spatial and temporal association between Pb mobility and other geological processes including for example mineralization, fault density, dyke emplacement etc. The spatial relationship between the time of Pb mobility may provide a new tool to date otherwise difficult to date events as this approach has the potential to see through cover to underlying geological events that may have driven radiogenic-Pb mobility.

**EXPLORATION FOR HIGH-TEMPERATURE EXTENSIONAL SYSTEMS IN THE WILLYAMA SUPERGROUP**

**MINEX CRC PROJECT 8:**
Nature of basement and cover and interfaces

**PHD PROJECT**
University of Adelaide

**PREREQUISITES**
A First Class or 2A Honours degree or Masters in Earth Sciences, with interests in isotope geology, tectonics, structural geology, petrology, mineral exploration and analytical instrumentation.

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**PARTICIPATING ORGANISATIONS**
The University of Adelaide
Government of South Australia
Department for Energy and Mining
NSW Government

**RESEARCH PROJECT**
The Curnamona Province in southeastern Australia is host to the super giant Broken Hill Pb-Zn ore deposit which sits within the 1715 to ~ 1630 Ma Willyama Supergroup. The Willyama Supergroup contains persistent metal anomalism and its deposition was punctuated by magnatism that appears to have been derived from the sedimentary units themselves as well as externally.

Although the Willyama Supergroup has been exceptionally well mapped lithologically and structurally, and has extensive geochronological constraints, the tectonic regime leading up to shortening during the ~ 1610-1570 Ma Olorian Orogeny is still not well understood. Recent models have suggested that large-scale extensional systems may have operated prior to shortening, exposing different structural/metamorphic and stratigraphic levels across quasi-stratigraphic parallel detachments. These detachment systems if they exist, may have played an important role in facilitating metal and fluid movement. These hypothetical detachment systems also have a played a role in exhuming syn-sedimentary magmatic rocks derived from melting of deeper stratigraphic levels as the basin developed.

This PhD project will use cutting edge petrological and geochemical methods coupled with targeted structural mapping of stratigraphic/structural boundaries to determine if large-scale detachment systems exist within the Willyama Supergroup. If these detachment systems do exist, they may have provided structural corridors for fluid and metal transport and controlled the development of the contractional structures during the subsequent Olorian Orogeny.
The Gawler Craton in southern Australia contains a collage of lithospheric fragments that range in age from Mesoarchaean (~3150 Ma) to early Mesoproterozoic (~1500 Ma in age) that comprise igneous and sedimentary rocks and their metamorphosed equivalents. This collage is transected by a vast network of shear zones that record numerous activation and reactivation events, creating a complex tectonic system that exposes crust of different levels and different ages. The shear zone and their precursor regional metamorphic systems also dissect parts of the eastern and central Gawler mineral systems, leading to exposures of mineralisation and alteration at a variety of depths, giving access to different expressions of the mineral system. Compared to the more extensively explored and studied eastern Gawler Craton, the western and central parts of the craton are much less well known, creating significant barriers for mineral explorers.

The aims of this project are to:

1. Use metamorphic and petrochronology tools to determine the timing and physical conditions of regional metamorphism in the central Gawler Craton as a means to understand the early Mesoproterozoic tectonic regime.
2. Determine the timing of formation and reactivation of lithospheric scale shear zones in the central and western Gawler Craton.
3. Use geochemical and isotopic methods to identify reservoirs involved in the development of IOCG systems as expressed in comparatively deeply exposed high-temperature examples of the mineral system.
PHD PROJECT
University of Newcastle

PREREQUISITES AND INTERESTS
BSc Honours (1st or 2A) or Masters in Geoscience, with (geo)chemistry as a major/minor. Field, sampling, laboratory and data analysis skills.

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PARTICIPATING ORGANISATIONS

RESEARCH PROJECT
Hydrogeochemistry is becoming widely recognised as a great sample method for detection of ore minerals and different geological units under cover. As groundwater interacts with basement geology and mineralised rocks, it creates and carries a geochemical signature that may be much greater in size than that found with other geochemical sampling media, as water is more mobile than the surrounding minerals. This project would use analytes from water bore sampling to map signatures of basement geology in overlying basins, and detect distal footprints of mineral systems. Hydrogeochemical data will be collected from water bores in each of the National Drilling Initiative (NDI) areas in NSW, commencing in the Cobar region in 2019, and continuing thereafter in the Mundi, Forbes and Dubbo areas. The geology and potential mineral systems of the NDI areas allow hydrogeochemistry to be applied to Proterozoic to Devonian basement rocks, and a variety of mineral systems from magmatic to orogenic. There is also potential to expand the scope of this project to other NDI areas nationally. (2019 start).

PHD PROJECT
University of Adelaide

PREREQUISITES AND INTERESTS
BSc Honours (1st or 2A) or Masters in Geoscience, with biology as a major/minor. Core sampling, laboratory and data analysis skills.

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PARTICIPATING ORGANISATIONS

RESEARCH PROJECT
Each of the National Drilling Initiative (NDI) areas in NSW are covered by Cenozoic and Mesozoic sequences, as well as Devonian-Carboniferous-Permian sequences in some areas. Historically, these cover sequences have not been the focus of mineral exploration, so little work has been done to constrain their age. Elsewhere in NSW and Australia, palynology and other biostratigraphic techniques have been successfully used to constrain the age, and sedimentary facies results to propose the depositional environment of these sequences (e.g. Mesozoic Eromanga and Surat basins, Devonian Darling Basin). As well as furthering our understanding of the geodynamic setting and timing of these sequences, the data will provide a useful calibration for studies involving isotopic geochronology. Each of the NDI areas has legacy drilling material that should be suitable for analysis, and the WB Clarke Geoscience Centre in Londonderry has available separation and microscopy facilities. Although focussed in NSW, the project will work collaboratively with the Geological Survey of South Australia, and possibly other jurisdictions, by focussing on geological provinces (e.g. the Eromanga Basin covers four states/territories). (2019 or 2020 start).
PHD PROJECT
University of Newcastle

PREREQUISITES AND INTERESTS
BSc Honours (1st or 2A) or Masters in Geoscience, with geophysics or (geo)chemistry as a major/minor, Field, laboratory (mineral separation and LA ICPMS) and data analysis skills.

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PARTICIPATING ORGANISATIONS

RESEARCH PROJECT
The focus of the Dubbo National Drilling Initiative (NDI) area is the mapping of the Ordovician to early Silurian Macquarie Igneous Province (MIP) under younger (Silurian-Devonian, Permian, Triassic and Quaternary) cover sequences, as the MIP is prospective for porphyry Cu-Au mineralisation (e.g. Cadia, North Parkes). This multi-disciplinary project will include the use of geophysics, geochronology, lithogeochemistry and mineral chemistry fertility indices to better understand the MIP and potential mineralisation. The study will focus on MIP rocks exposed and intersected in legacy drilling in and adjacent to the Dubbo NDI area, and investigate signatures of the MIP in younger cover sequences. The project will also determine the nature, age and thickness of cover sequences using geophysics, legacy drilling and 3D modelling to develop a 4D geodynamic history of the area. The project will help to focus planned the NDI drilling scheduled in the region for 2026. (2019 or 2020 start).

MINEX CRC PROJECT 8:
Geological Architecture and Evolution

4D GEODYNAMIC HISTORY OF THE GREATER DUBBO AREA

INTEGRATING AEM AND HYDROGEOCHEMISTRY: IMPLICATIONS FOR WATER RESOURCES

PHD PROJECT
University of Newcastle

PREREQUISITES AND INTERESTS
BSc Honours (1st or 2A) or Masters in Geoscience, with geophysics and (geo)chemistry as a major/minor. 3D modelling and data analysis skills.

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TBC – CSIRO and / or Geoscience Australia
TBC – NSW Department of Industry (Water)

PARTICIPATING ORGANISATIONS

RESEARCH PROJECT
Airborne-electromagnetic (AEM) data acquisition and hydrogeochemical analysis of water bores will be conducted across all National Drilling Initiative (NDI) areas in NSW. As well as being used to map cover thickness and shallow basement geology features, AEM data can be applied to identify potential groundwater sources and provide basic information on salinity (that affects conductivity). This project will examine different techniques for optimising AEM inversion for identification of groundwater aquifers within younger cover sequences, palaeochannels and identification of potentially fractured rock aquifers. As the NDI areas include part of the Lachlan River, AEM will help map groundwater within the floodplain systems. The project will acquire and use physical properties from legacy exploration drilling, water bores and new NDI drilling to enhance AEM inversion. 3D mapping of groundwater zones from the AEM data will be integrated with results of hydrogeochemical analyses to model the chemistry and age of groundwater, examine recharge zones and study water flow. (2020 start).
PHD PROJECT
University of South Australia

PREREQUISITES AND INTERESTS
BSc Honours (1st or 2A) or Masters in Geoscience, with (geo)chemistry as a major/minor. Core sampling, field, laboratory and data analysis skills.

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PARTICIPATING ORGANISATIONS
NSW Government
University of South Australia

RESEARCH PROJECT
Work by the Geological Survey of NSW (GSNSW) to date has identified the scavenging of detrital minerals in parts of the Cobar Basin into base-metal mineral systems. This project would further this work across the Cobar Basin and into the North Cobar and South Cobar National Drilling Initiative (NDI) areas, as well as examine mineral-water reactions. The early basin fill is dominated by sediments derived from basement Ordovician quartz-rich turbidites and S-type granites that were exhumed and eroded into the basin. The project would use mineral chemistry and geochronology to examine the provenance of detrital minerals (e.g. zircon, ilmenite, biotite) in the basin sedimentary rocks, and relate them to the minerals associated with mineralisation in the basin (e.g. titanite and scheelite). The project will use new data collected from NDI drilling (planned for 2022-2023), in conjunction with legacy data, geochronology, isotopic analysis and geochemistry.

RESEARCH PROJECT
Recent GSNSW work in the Cobar Basin has identified phases of mineralisation associated with basin opening and magmatism, with subsequent inversion of the basin. The project will use a petroleum-systems approach to map the architecture of the Cobar Basin by determining the geodynamic history (e.g. thermal and deformation history, sedimentary facies and provenance). The project will use new data collected from National Drilling Initiative (NDI) drilling (planned for 2022-2023), in conjunction with legacy data, geochronology, isotopic analysis and geochemistry, to produce a 3D map of the greater Cobar Basin, highlighting key interfaces, reactive zones (e.g. carbonate, redox), fluid flow pathways (e.g. permeability), and heat (e.g. thermal maturity). (2022 start).

MINEX CRC PROJECT 8:
Geological Architecture and Evolution

MINEX CRC POSTGRADUATE PROJECTS

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**MINEX CRC PROJECT 8:**

**Geological Architecture and Evolution**

**PHD PROJECT**
University of Newcastle

**PREREQUISITES AND INTERESTS**
BSc Honours (1st or 2A) or Masters in Geoscience, with geophysics or (geo)chemistry as a major/minor. Core sampling, field, laboratory and data analysis skills.

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**PARTICIPATING ORGANISATIONS**

**RESEARCH PROJECT**
The geology of the Mundi National Drilling Initiative (NDI) area includes interpreted basement Palaeo-Proterozoic rocks of the Willyama Supergroup and a ~1590 magmatic event (Mundi-type granites). They are covered by multiple sequences of younger rocks including Neoproterozoic sedimentary rocks, and Palaeozoic-Mesozoic-Cenozoic sequences. This project will use new data collected from NDI drilling (planned for 2024) in conjunction with legacy data, geochronology, geochemistry, geophysical interpretation and 3D modelling of key interfaces, to propose a 4D geodynamic history for the area. Lithogeochemical investigations will aid identification of basement geology and mineralisation signatures in cover sequences. As the project area abuts the South Australian-NSW border, this project is envisaged to be a collaboration between the Geological Survey of NSW and the Geological Survey of South Australia. (2024 start).

**MINEX CRC PROJECT 8:**

**Geological Architecture and Evolution**

**PHD PROJECT**
University of Newcastle

**PREREQUISITES AND INTERESTS**
BSc Honours (1st or 2A) or Masters in Geoscience, with geophysics or (geo)chemistry as a major/minor. Core sampling, field, laboratory and data analysis skills.

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Dr Bob Musgrave (GSNSW and University of Newcastle)

**PARTICIPATING ORGANISATIONS**

**RESEARCH PROJECT**
The geology of the focus Forbes National Drilling Initiative (NDI) area is mostly interpreted from geophysics and sparse drilling due to unconsolidated Quaternary and consolidated Mesozoic to Devonian cover sequences. The area has potential for porphyry Cu-Au mineral systems relating to the Ordovician to early Silurian Macquarie Igneous Province (MIP), and Silurian to Devonian mineral systems related to basin opening and associated magmatism, with subsequent inversion. This multidisciplinary project will generate a 4D geodynamic history of the greater Forbes NDI area, including sedimentation and thermal history during periods of extension, kinematics of deformational events, and the nature, age and thickness of cover sequences. The project will use new data collected from NDI drilling (planned for 2025), in conjunction with legacy data, geochronology, geochemistry, geophysical interpretation and 3D modelling. Lithogeochemical investigations will aid identification of basement geology and mineralisation signatures in cover sequences. (2025 start).
REGIONAL BIOGEOCHEMICAL MAPPING (AND ASSOCIATED REGOLITH STUDIES) OF THE COBAR BASIN FOR MINERAL EXPLORATION AT REGIONAL TO LOCAL SCALES

MINEX CRC PROJECT 9: Targeting mineral systems in covered terranes

PHD PROJECT
University of New South Wales

PREREQUISITES AND INTERESTS
The project requires skills in mineral deposits (VMS, structurally-hosted, epithermal), exploration geochemistry and chemical analysis. Some background in biology would be useful but not essential.

SUPERVISORS
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Co-supervisors
Dr Ian Graham and A/Prof Steve Bonser (University of New South Wales)
Dr Neil Rutherford (Rutherford Mineral Resource Consultants)
Dr Phil Gilmore (GSNSW)
Dr John Greenfield (GSNSW)

RESEARCH PROJECT
The selection of sampling media in regional geochemical exploration programs, especially in areas of cover, involves balancing various factors. These include the availability of the media, the strength and consistency of geochemical patterns that can be spatially related to the effects of mineralisation and cost. This study will examine the use of biogeochemistry (specifically cypress pine needles) as a primary sampling media at both a regional and local scale. Apart from direct geochemical indications of buried mineralisation, the results will contribute to understanding of the processes involved in element dispersion in various landform-regolith setting, and from various deposit styles, in the region. The project will integrate with the planned MinEx CRC drilling and geophysical studies planned for the Cobar Basin and collation and analysis of existing geochemical datasets from the region.

PARTICIPATING ORGANISATIONS

BASEMENT INTERPRETATION & NEW CU-AU EXPLORATION MODELS - PEAK & DENISON DOMAIN

COMPANY SPONSORED PROJECT
Geological Architecture and Evolution

PHD PROJECT
University of South Australia

PREREQUISITES AND INTERESTS
Sound knowledge of airmag interpretation techniques, structural geology, alteration geochemistry, geochronology and exploration models

SUPERVISORS
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CO-SUPERVISORS
Dr Antonio Belperio (Minotaur Exploration)
Additional co-supervisors TBC

RESEARCH PROJECT
The Peake & Denison Domain at the north-eastern extremity of the Gawler Craton is a poorly known fragmented basement region under complete cover. Widespread regional IOCG style alteration and areas of extreme magnetic anomalism together with limited dating suggest this terrace is more akin to Cloncurry rather than the Gawler Craton. A postgraduate student would work with Minotaur geologists in deciphering basement geology, tectonics, alteration characteristics and Cu-Au mineral potential. It is envisaged the student will make use of historic drill core, new aeromagnetic data, magnetic modelling and latest geochemical, geochronological and petrophysical data extraction from drill core to build a new structural and time-constrained lithotectonic model that will then be used to generate appropriate new exploration models. The region is also ideal for a Coiled Drilling Rig campaign of undercover investigative sampling to provide a targeted grid of new basement samples under cover. A 3-D cube of magnetic sources provides a third dimension into the basement. The student would assist in area and target selection for such a proposal, and utilise the samples once collected as an important new data set additional to historic drillcore. The student is also expected to make major new contribution to evolving exploration and mineralisation models for this poorly known area, and potentially test their ideas in an undercover Paleo-MesoProterozoic exploration setting.

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Figure: Cathodeluminescence images of zircon grains from the Donington Suite at Punt Hill, Gawler Craton, South Australia.
Location:
Australian Resources Research Centre (ARRC)
26 Dick Perry Avenue
Kensington WA, 6151 Australia

minexcrc.com.au/contact