

School of Earth Sciences

Potential research projects offered for Level 4 (Honours) and Level 5 (Masters) students commencing in 2024

- Geology
- Geochemistry
- Geophysics
- Environmental and Marine Geoscience
- Hydrogeology
- Mineral Geoscience
- Energy Geoscience
- Numerical Modelling and Geodata Analytics

The projects outlined in this booklet are not necessarily all those available. Please feel free to talk to School supervisory staff about designing projects around your interests.



Geoscience Projects

This document describes projects suitable for students undertaking a 24pt research project as part of an Honours or coursework Masters degree. Some projects are also suitable for the larger thesis in the Master of Science by Thesis & Coursework

We encourage you to consider what geoscience research problems excite you and to choose a project topic that will motivate you to do your best work throughout the year. Your project may align with your career aspirations and/or be a topic that you are keen to explore. The aim of the 24pt project is to provide you with an opportunity to learn how research works and to develop your research skills.

The 24pt project is one of the **best ways** to demonstrate skills in problem-solving, communication (reading, writing and speaking), and completing a major task on time – *all key elements for employment in a wide range of careers including the resources industries and related government agencies*. It is also a pathway to higher degrees by research (MSc, MPhil, PhD) with students often discovering a passion for research through undertaking their Honours or Masters project!

This document does not summarise all available projects and you are welcome to speak with any staff in the School who supervise projects in the areas of interest to you. We recommend that you have a UWA supervisor and a general idea of your project *by the end of this year for both semester 1 and semester 2 commencements in 2024*. Do not leave organising a project until the first teaching week of 2023 or late July! Remember that many academic staff take leave through January.

Geoscience is a broad discipline that includes Geology, Geophysics, Geochemistry, Geobiology, Environmental Geoscience, Marine Geoscience, Antarctic Geoscience, Computation/Numerical Modelling and Geodata Analytics. The breadth of research activity in the School of Earth Sciences means that students have opportunities to undertake diverse research projects. Research may be focused on resolving questions related to fundamental Earth processes and Earth evolution and thus advancing important knowledge or have various levels of application to discovery, and/or extraction of specific resources including mineral deposits, groundwater and energy, and to management of coastal zones, water-dependent ecosystems, agricultural regions and mine sites.

You are welcome to contact staff directly (contact details are provided in the booklet) to discuss projects. If you are interested in an **MSc by thesis & coursework degree**, some of the projects outlined in this booklet can be extended into or set up as larger projects (e.g. 36pt projects). You are welcome to contact prospective supervisors to discuss as required.

Project:	Mapping workflows for subglacial geology: A data analytics approach
Majors or Masters:	Geology, IEMS, Geoscience, Computer Science or related
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au , Mareen Lösing mareen.loesing@uwa.edu.au and Lu Li, lu.li@research.uwa.edu.au
Description:	Knowledge of the geology beneath the Antarctic Ice Sheet is essential to understand ice-sheet bed conditions. Antarctic Geology is very poorly known with <2% outcrop and very few subglacial samples, with an understanding developed mainly from geophysical data. Human interpretations of these data are subjective and are difficult to validate. This project will seek the first implementation of an integrated analysis workflow, including automated image analysis and machine learning approaches to minimise interpreter biases to map the subglacial geology in parts of Antarctica.

Project:	Where does Australia end?
Majors or Masters:	Geology, Geoscience, IEMS, Marine Science or related
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au ; Naomi Tucker naomi.tucker@uwa.edu.au
Description:	This project will involve a ship-based science to understand and define Australia's southern margin. The project includes a 10-day cruise on the RV Investigator in March 2024 to collect new geophysical data and dredge samples from Australia's southern margin. Depending on data obtained the project will involve modelling of and/or analysis of samples to probe the nature of the crust and its origins.

Project:	Modelling past and future sediment productivity of ocean-terminating glaciers
Majors or Masters:	Geology, Geoscience, Marine Science, Computer Science, or related
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au
Description:	Novel graph-based modelling approaches provide the capacity to quantify the sediment productivity of glacier systems associated with dynamic subglacial hydrology. This project will investigate the past and projected future sediment productivity and detrital provenance of glaciers under changing climate. Results will inform multidisciplinary studies as part of the Australian Centre of Excellence in Antarctic Science. Modelling involves training in the use of Matlab and Python.

Project	Teeth geochemistry as a tracer of environmental pollution in the Perth metropolitan area and the rural communities from Goldfields of WA.
Majors or Masters:	Geology, Environmental Geoscience, Geochemistry
Supervisor:	Aleksey Sadekov, Aleksey.Sadekov@uwa.edu.au, 64884384 Christine Jeffries-Stokes (UWA Medical School, Rural Clinical School – Kalgoorlie)
Description:	Geochemistry of human teeth has been shown to provide critical information of habitat changes, migration of early human population and also environmental pollution in modern communities. For example, human teeth uptake heavy metals in the dentin and therefore teeth geochemistry can potentially quantify the exposure of residents to heavy metal pollution. This project will explore similarities and differences in teeth geochemistry of samples collected from residents of Perth metropolitan area and residents of communities across the Goldfields region of WA. The aim of the project is to characterise trace and heavy metal composition of teeth samples using Laser Ablation ICP mass spectrometry and link it to environmental conditions in each study region.

Project:	Deep sea carbonate sediments as a major sink/source of Rare Earth Elements (REEs) in the ocean.
Majors or Masters:	Geology, Geochemistry, Marine Geoscience
Supervisor:	Aleksey Sadekov, Aleksey.Sadekov@uwa.edu.au, 64884384 April Abbott (Coastal Carolina University)
Description:	Rare earth elements (REEs) signatures of planktonic foraminiferal shells in deep-sea sediments have been used extensively to reconstruct evolution of deep-water masses and their interactions with ocean carbon cycle and global climate (Osborne et al, 2017, Skinner et al, 2019). Concentrations of REEs in living planktonic foraminifera are around 2-3 orders of magnitude smaller than in shells extracted from deep-sea sediments, implying a diagenetic origin of REEs signatures in the latter. A commonly accepted hypothesis is that foraminiferal shells in sediments are coated with a thin layer of Fe-Mn oxides and/or organic matter leading to significant enrichment in REEs (Roberts et al, 2012; Haley et al, 204). This project will investigate the origin of this 'diagenetic coating' using high resolution Laser Ablation ICP mass spectrometry and electron microscopy of individual planktonic foraminiferal shells. This project will utilise materials collected during the 2020 research cruise of RV Falkor. This material was sampled using remotely operated underwater vehicles and therefore provide samples from uniquely preserved sediment-water interface which is critical for investigating REEs cycling in the ocean. The aim of the project is to link geochemistry of pore water in these sediments with REE geochemistry of foraminiferal shell coatings.

Project:	Interconnection of geochemistry and microbiome of corals shallow water as indicators of health and resilience of coral communities.
Majors or Masters:	Geology, Environmental Geoscience, Geochemistry, Marine Geoscience
Supervisor:	Aleksey Sadekov, Aleksey.Sadekov@uwa.edu.au, 64884384 Marco Coolen (Curtin University)
Description:	<p>Coral health is an essential factor for maintaining productive and sustainable reef ecosystems. The primary production within coral reefs supports approximately 25% of all known marine species and impacts over a billion people worldwide (Moberg and Folke, 1999). However, recent climate changes and their subsequent effects on coral health, such as coral bleaching, raise significant questions about the resilience of reef communities in the future (Hough-Guldberg et al., 2007).</p> <p>In this project, our aim is to explore the relationship between the geochemistry of Porites corals and their microbiome. These corals were collected from Ningaloo Reef, WA, and then cultured in a UWA laboratory under stable seawater conditions. By analyzing differences in geochemistry and microbiome, we can gain unique insights into the calcification ability of reef-forming coral species. This understanding will contribute to a better grasp of the resilience of coral communities in the face of challenges like acidification and heat stress.</p> <p>The primary focus of this project lies in coral geochemistry, which will be closely linked with existing data on the coral microbiome collected during the culturing experiments.</p>

Project:	Tectonic assembly of northern Thailand
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Annette George, annette.george@uwa.edu.au, 6488 1923
Description:	<p>Thailand, like much of SE Asia, is an amalgam of a number of significant geological terranes that accreted to Indochina in the late Paleozoic–Mesozoic during the Indosinian Orogeny. There are opportunities for projects, within a larger project, focusing on specific elements of the tectonic history: e.g. characterisation of igneous suites (rocks and mineral grains) related to volcanism and potential back-arc basin development; detrital zircon geochronology and geochemistry to constrain sediment provenance and sediment dispersal during basin development. This region is well known for hosting a wide array of mineral deposits and major energy resources. These topics are also suitable for 36 pt Master of Science projects with suitable prior learning.</p>

Project:	Sedimentary basins as deep time archives and subsurface characterisation, WA Basins
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Annette George, annette.george@uwa.edu.au, 6488 1923
Description:	WA has a broad suite of sedimentary basins that record significant events through geological time. These projects may focus on reconstructing depositional and tectonic history of a specific basin or focus on specific stratigraphic intervals (e.g. for energy reservoirs, carbon sequestration, biotic crises/mass extinctions, mineral resources). Projects may include drillcore to petrographic-scale description and interpretation to establish depositional and relative sea-level history (using sequence stratigraphy and related datasets e.g. biostratigraphy and chemostratigraphy) and/or major controls on the distribution of porosity and permeability. Projects may include Hylogger® spectral analysis and portable XRF analysis of core to obtain geochemical data for characterising facies, chemostratigraphic correlation and establishing diagenetic history. Some projects could involve application of higher level microscopic techniques (scanning electron, cathode luminescence). Also suitable for 36 pt Master of Science projects.

Project:	Microbialites
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Annette George, annette.george@uwa.edu.au, 6488 1923
Description:	Microbialites are common carbonate rocks, recording the activity of microbial communities that may form mats, stromatolites and thrombolites. Through geological time, calcimicrobes have been important contributors to stromatolites and thrombolites and more broadly to reef development and other types of carbonate buildups. These projects focus on characterising microbialites and fascinating calcimicrobes in ancient terranes and paleo-environmental and paleoecological interpretation at different scales. Characterisation requires petrographic and micro-imaging and micro-analytical techniques, with varying macro-scale contexts depending on project. These topics are also very suitable for 36 pt Master of Science projects.

Project:	Deciphering key magmatic processes of plutonic host-rocks of the Pataz gold vein system in northern Peru
Majors or Masters:	Geology, Geochemistry, Mineral Geoscience, Ore Deposit Geology
Supervisor:	Daniel Wiemer (Research Fellow), daniel.wiemer@uwa.edu.au, and Steffen Hagemann, steffen.hagemann@uwa.edu.au
Description:	The Pataz gold vein system in northern Peru displays typical characteristics of a mesothermal orogenic gold deposit. However, the deposit is exclusively hosted within a Carboniferous granitoid complex, suggesting a possible

	<p>genetic link. Indeed, preliminary chemical data and petrographic observations indicate that gold-bearing fluids were directly derived from the plutonic-magmatic system.</p> <p>The aim of this project is: a) to establish a consistent petrochemical model for the evolution of the Pataz plutonic complex, and b) to test the role of magmatic processes in the formation of the gold vein deposit.</p> <p>On the background of available bulk-rock geochemical data and spatial information, this project employs a strategy that entails the chemical and petrographic investigation of magmatic and hydrothermal mineral phases and mineralogic assemblages to: i) detect key processes in the differentiation of plutonic host rocks, ii) provide insights to the magmatic-hydrothermal transition, and iii) constrain the depth (pressure) of critical magmatic processes, using appropriate geothermo-barometers.</p> <p>This project is expected to contribute to our general understanding of the genesis of orogenic gold deposits, worldwide.</p> <p>This study will mostly involve laboratory work (petrography, SEM, EMP).</p>
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Project:	Geochronological and geochemical characterization of fayalite-bearing aplitic dykes intruding the Brixen Granodiorite (South Tyrol, Italy).
Majors or Masters:	Geology, Geochemistry
Supervisor:	Giulia Consuma, giulia.consuma@uwa.edu.au, Marco Fiorentini, marco.fiorentini@uwa.edu.au
Description:	<p>The Brixen Granodiorite (South-Tyrol, Italy) is part of the Permian calc-alkaline plutonic association that intruded the Variscan Southalpine metamorphic basement. The pluton is affected by local hydrothermal metasomatic alteration, and it is occasionally cut by felsic and mafic dykes which have long been ascribed to a late phase of the Permian magmatism.</p> <p>A new study by Visonà et al. (2021) reports first-time evidence for a hidden intrusion during the main stage of the Alpine orogenic metasomatism that infiltrated the overlying Permian Brixen pluton, suggesting the hypothesis of a continuous mantle upwelling during the late Eocene–early Oligocene in the Southern Alps.</p> <p>To test this hypothesis further, the student will investigate in details fayalite-bearing aplitic dykes intruding the Brixen Granodiorite near the village of Franzensfeste/Fortezza (South-Tyrol, Italy), whose magmatic source and emplacement age have not been determined yet. The samples are already available for investigation and the student will implement basic petrography, geochronology and mineral chemistry, with a particular focus on accessory minerals. The project will advance our knowledge in the context of the post-orogenic magmatic evolution of the European Variscan belt.</p>

Project:	Cost and value analysis of data collection scenarios to reduce geological uncertainty
Majors including:	Hydrogeology, Geology, Physics, Engineering, Computer Science
Supervisor:	Guillaume Pirot, guillaume.pirot@uwa.edu.au
Description:	<p>The objective of this project is to assess the economic efficiency of different data acquisition strategies in a geological characterization context. Based on real cases reported by industry partners, an ensemble of synthetic scenarios will be tested. It will involve 3D geological modelling and integration of surface and borehole geological data observations as well as geophysical measurements.</p> <p>This project is supported by the MinEx CRC industry and public consortium (https://minexcrc.com.au/program-two-data-from-drilling/project-6-automated-3d-modelling/). The scope is compatible for continuation to Masters or PhD level. This project would be suitable for students with an interest in 3D geological modelling and statistics. Programming experience would be a benefit, but is not essential.</p>

Project:	Assessment of geological uncertainty
Majors including:	Hydrogeology, Geology, Physics, Engineering, Computer Science
Supervisor:	Guillaume Pirot, guillaume.pirot@uwa.edu.au , Jérémie Giraud
Description:	<p>To improve the sustainability of our management and use of subsurface resources (water, energy and minerals), decision makers rely on ensemble of predictions, derived from ensemble of subsurface models. To estimate prediction confidence, it is necessary to characterize properly the uncertainty and diversity of (hydro-) geological or geophysical models. Though several measures can be computed to characterize this geodiversity, the choice of the measures is often subjective. This project will review and benchmark the different indicators in order to formulate some recommendations with respect to the properties of interest. The techniques to be investigated will be defined with the student and can comprise data science concepts, image processing, graph theory, etc.</p> <p>This project is supported by the MinEx CRC industry and public consortium (https://minexcrc.com.au/program-two-data-from-drilling/project-6-automated-3d-modelling/). The scope is compatible for continuation to Masters or PhD level. This project would be suitable for students with an interest in 3D geological modelling and statistics. Programming experience would be a benefit, but is not essential.</p>

Project:	Geophysical and geological analysis of Monte Carlo-generated collections of structural models
Majors including:	Geophysics, Geology, Physics, Engineering, Computer Science
Supervisor:	Guillaume Pirot, guillaume.pirot@uwa.edu.au, Jeremie Giraud, and/or Mark Jessell
Description:	<p>The characterization of subsurface properties from geological and geophysical data is challenging because this kind of problem admits numerous possible solutions. To reduce the various risks faced in the exploration of natural resources and achieve successful exploration, it becomes critical to identify plausible candidate models.</p> <p>This project will focus on the analysis of a collection of nearly 10,000 structural geological models from two areas in Australia. These models were generated by Monte Carlo sampling of the geological measurements defining the structures observed in the area and all fit the geological measurements within prescribed uncertainty levels.</p> <p>The analysis will be carried out in a quantitative, systematic way from the geophysical and geological point of views. Avenues to be explored comprise geophysical evaluation of the models (gravity and magnetic field responses) together with geological uncertainty, topological variability, image analysis and data science techniques (when applicable).</p> <p>This project is supported by the MinEx CRC industry and public consortium project 6 (https://minexcrc.com.au/program-two-data-from-drilling/project-6-automated-3d-modelling/). This project is suitable for students with an interest in 3D modelling and statistics. The scope is compatible with a 36 pt Master of Science project.</p>

Project:	Topological uncertainty propagation –application to mine dewatering
Majors including:	Hydrogeology, Physics, Engineering, Computer Science
Supervisor:	Guillaume Pirot, guillaume.pirot@uwa.edu.au , Mark Jessell mark.jessell@uwa.edu.au
Description:	<p>The objective of this project is to assess the uncertainty of topological constraints (e.g. presence or absence of a fault) on mining activities such as dewatering. Based on real cases reported by industry partners, a large ensemble of numerical synthetic models will be tested. It will in particular involve designing and performing a sensitivity analysis of variables describing topological uncertainty as well as other model input variables (e.g. mesh resolution) on the drawdown of the hydraulic head.</p> <p>This project is supported by the MinEx CRC industry and public consortium (https://minexcrc.com.au/program-two-data-from-drilling/project-6-automated-3d-modelling/). The scope is compatible for continuation to a 36 pt Master of Science project. This project would be suitable for students with an interest in 3D geological modelling and statistics. Programming experience would be useful but is not essential.</p>

Project:	Understanding the drivers of coastal morphodynamics in Western Australia using novel remote sensing techniques
For majors including:	Marine Science, Marine Geoscience, Geoscience
Supervisors:	Jeff Hansen, jeff.hansen@uwa.edu.au, 6488 3724 and Ryan Lowe
Description:	<p>The coastline of Western Australia (WA) is complex due to its geomorphology (e.g. many coral and rocky reef) and is exposed to a unique range of wave and water level conditions. For example, the south of the state is exposed to large waves and small tides with the opposite occurring in the north of the state. This projects aims to develop a more detailed understanding of the coastal dynamics at a particular site or region of WA. Historical (1980s- to present) shorelines will be mapped using a combination of satellite imagery and aerial photography. The variability in the mapped shorelines over time will then be linked to records of waves and water levels to understand the primary drivers of coastal change. For example, during La Niña years, the Leeuwin Current is stronger than normal which causes sea levels to be elevated. Some existing research has suggested the elevated sea level associated with La Niña conditions results in additional beach erosion- but this link needs to be further explored at additional locations. A greater understanding of how the coastline responds to variations in sea level and waves will increase our ability to manage the coast and mitigate the effects of climate change.</p>

Project:	Measuring the variability of the southwestern Australian coastline from oblique aerial imagery
For majors including:	Marine Science, Marine Geoscience, Geoscience
Supervisors:	Jeff Hansen, jeff.hansen@uwa.edu.au, 6488 3724, Michael Cuttler
Description:	<p>The Western Australian coastline is well known to exhibit seasonal variability in morphology. For example, WA beaches are typically wider in summer and narrower in winter. Typical methods for surveying beach morphology require accessing the beach at multiple times throughout the year. However, WA is one of the most remote and rugged coastlines globally. Thus, there are vast stretches of coastline that have limited access which limit the applicability of typical survey methods. Recently, advancement in photogrammetry techniques have allowed aerial photography to be exploited for measuring coastal morphology with cm-scale accuracy. These advancements now provide an opportunity for measuring stretches of coastline previously unmeasurable with typical surveying techniques.</p> <p>UWA has partnered with the Peron-Naturaliste Partnership to capture oblique aerial imagery of the southwestern Australian coastline, from Rockingham to Cape Naturaliste. This project will employ photogrammetry techniques and 4 years of bi-annual oblique aerial photographs to measure coastal morphological change along 250 km of coastline. This large-scale analysis will identify erosion/accretion 'hot spots' and provide value insight into the interannual variability of this coastline.</p>

Project:	Quantifying coastal morphodynamics through community-sourced imagery
Majors including:	Marine Science, Marine Geoscience, Geoscience
Supervisor:	Jeff Hansen, jeff.hansen@uwa.edu.au, 6488 3724, Michael Cuttler
Description:	With the proliferation of smart phones and social media, capturing and sharing images of the coast has never been easier. A new coastal monitoring program, CoastSnap, has recently been created to analyse community-sourced imagery to provide quantitative data on coastal morphology. CoastSnap was recently established at nine sites along WA's south west (between Rockingham and Busselton, see facebook.com/coastsnapwa). This project will involve analysing the imagery from each of the new CoastSnap WA sites to examine a range of coastal dynamics questions (e.g. magnitude of shoreline change) and social science questions (e.g. who is taking photos, what social media platform is the photo from, etc.).

Project:	Wave runup and rock fisher safety along the Great Southern coastline
Majors including:	Marine Science, Marine Geoscience
Supervisor:	Jeff Hansen, jeff.hansen@uwa.edu.au, 6488 3724, Michael Cuttler
Description:	The Great Southern region of WA is renowned for its rugged coastline, with common tourist attractions included locations such as 'The Gap and Natural Bridge'. A popular activity amongst locals and visitors to the Great Southern is rock fishing. However, this activity puts fishers in direct contact with the large Southern Ocean swells that are prolific along this coastline. When these large waves break, they cause up-rushes of water (wave runup) that surge over the rock platforms where fishers are located. In the worst cases, anglers can be knocked over, pulled into the sea, and drown. Furthermore, the remoteness of the Great Southern means that most common fishing spots are unpatrolled by lifesavers. Thus, there is a need to better understand the physical processes that drive wave runup along this coastline. This project will use video imagery collected at Salmon Holes (near Albany, WA) to develop a quantitative understanding of wave runup at rocky coastlines that will contribute to the development of a warning system for assessing rock fishing risk.

Project:	Mechanisms for salinization of coastal lake: Lake Clifton WA
Majors or Masters:	Hydrogeology
Supervisor:	Jim McCallum, james.mcallum@uwa.edu.au Greg Skrzypek
Description:	Freshwater coastal wetlands are an important habitat. In groundwater fed lakes, changes to the water balance may impact on the salinity of lakes through the mechanism of sea water intrusion. Changes in the water balance may be attributable to changes in groundwater recharge due to climate change. This study will investigate the Hydrogeology of the groundwater system around Lake Clifton in Western Australia to understand the onset of salinization in a groundwater fed lake. This study will utilise water level data,

	isotopes and salinity profiles to understand the, mechanisms of salinization, and the underlying drivers of the change.
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Project	Structural and metallogenic controls on gold mineralisation: deposit-scale study and insights into the gold mineral system of the West African craton
Majors or Masters:	Geology of ore deposits (structural geology, ore deposit mineralogy, geochemistry)
Supervisor:	Julien Perret, julien.perret@uwa.edu.au , +61475698290 Nico Thébaud, nicolas.thebaud@uwa.edu.au , 6488 7139
Description:	<p>In the framework of the stage 4 of the West African eXploration Initiative program (WAXI, 2023-2026) several Au deposits especially hosted in the Archean and at the junction between Archean and Paleoproterozoic terranes of the West African craton are investigated to further the province-scale gold mineral system understanding. By early 2024, several gold projects will have been visited throughout the Paleoproterozoic and Archean-Paleoproterozoic transition parts of the West African Craton in Senegal (Mako), Ivory Coast (Séguéla, Odienné, ABC), Guinea (Tri-K) and Ghana (Iduapriem).</p> <p>Relying on existing field structural and paragenetic observations, the project aims at assessing structural and metallogenic control on mineralisation for one or several deposits. Lab work will focus on the deciphering of (i) the paragenetic evolution with respect to the microstructural expression of the deposit-scale deformation history, (ii) the <i>in situ</i> geochemical and isotopic signature of ore-related minerals and (iii) timing of deformation and mineralisation. Insights for the understanding of the West African craton gold mineral system will be discussed at the light of our current understanding and remaining gaps in knowledge after completion of WAXI stages 1, 2 and 3 (Thébaud et al., 2020, Masurel et al., 2021).</p>

Project:	Oxygen isotope make-up of the Archean mantle
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au , 6488 3465 and Laure Martin
Description:	<p>Komatiites are remarkable rocks. These crystallised products of the hottest lava flows ever erupted on the surface of the planet provide a snap shot of the Early Earth and a glimpse of the planet's origin. Most of the preserved komatiites are Archaean and Proterozoic in age, although a few rare but notable examples formed in the Phanerozoic, such as the ones outcropping on Gorgona Island off the coast of Columbia. Komatiites are thought to be associated with mantle plumes sourced from deep mantle reservoirs, possibly at the core-mantle boundary. Thus, these lavas provide invaluable insights into the composition of the deep mantle, the nature of core-mantle differentiation processes and the chemical, physical and thermal state of the Early Earth.</p> <p>The modern mantle has an inferred bulk oxygen isotope composition ($\delta^{18}\text{O}$) of about 5.5‰. Hadean and Archaean magmatic zircons derived from sources in the upper mantle have $\delta^{18}\text{O}$ compositions in a similar range, implying that the oxygen isotopic composition of the upper mantle has remained relatively</p>

	<p>constant, and comparable to the modern mantle throughout Earth's history. Conversely, the composition of the deep mantle - inferred from $\delta^{18}\text{O}$ measurements on olivine crystals from komatiites - appears to have changed through time. Whereas the source of the Gorgona lavas exhibits signatures between 4.4 and 5.5‰, recent works shows that the source of ca. 3.3 Ga komatiites from the Barberton greenstone belt of South Africa is significantly lighter, about 3 to 4‰.</p> <p>This discovery is puzzling because there was previously no indication that the Archaean mantle may have had a different oxygen make-up to its modern counterpart. This project, part of a larger ARC-funded project, aims to understand whether the light oxygen isotope signature recorded in the South African komatiites is an isolated phenomenon or whether any secular evolution in the oxygen isotope composition of Archaean and Proterozoic komatiites globally can be ascertained. To address this conundrum, the project involves petrographic, mineral-chemical and isotopic study of fresh olivine grains from a selected range of 2.7 Ga Australian komatiites and 1.9 Ga Russian ferropicrites.</p>
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Project:	Fluxing of mantle carbon as a physical agent for metallogenic fertilization of the crust (funded by Australian Research Council)
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465

Description:	<p>Sulfur is a fundamental element that links the evolution of the Earth's main four spheres. Although the cycling of this volatile element across the atmosphere, hydrosphere and biosphere is relatively well understood, the long-term evolution of the sulfur budget in the lithosphere and its flux across from the mantle into the crust remains enigmatic. This knowledge gap may be addressed through new insights into the transport mechanisms of sulfide in magmatic systems.</p> <p>Recent work has shown that carbonate may be ubiquitously associated with sulfides from some of these magmatic systems, especially the volatile-rich ones emplaced at the lowermost levels in the continental crust that display a genetic connection with the lithospheric mantle. The consistent occurrence of mantle-derived carbonate intimately associated with magmatic sulfide mineralisation in these settings attests to a critical role of carbon, as a volatile or fluid phase, in the physical and chemical flux of sulfur and metals across the lithosphere.</p> <p>This project will be undertaken within a larger project run by a multi-national team of researchers, and will focus on the role of carbonate in sulfide transport along magmatic conduits. The work will involve the integration of whole-rock geochemical measurements of selected samples with in-situ minero-chemical information from a range of silicate, carbonate, phosphate and sulfide mineral phases using the analytical infrastructure available at UWA including scanning electron microscope, laser ablation ICP-MS and the ion probe. Depending on logistics, work will be undertaken on already available material and/or there is a possibility to visit selected field areas for sampling. It is expected that the project will lay the foundations required to develop much needed new tools for the successful exploration of elusive Ni-Cu-Co-PGE systems.</p>
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Project:	Garnet chemistry to constrain ore processes and establish exploration methodologies for orthomagmatic systems in high temperature metamorphic settings (funded by Independence Group NL)
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465 and Laure Martin
Description:	<p>Given its resilience to both chemical and physical processes, garnet has been widely used in exploration targeting as an indicator mineral in diamond exploration, especially in the northern hemisphere. Its mineral-chemical record is known to reflect precious information on the P-T conditions that characterised its genesis in a range of magmatic and metamorphic conditions. Furthermore, garnet is commonly recovered in heavy mineral concentrates. However, it is still unknown whether garnet can provide useful information on the conditions that favoured nickel-sulfide ore genesis, or whether garnet survives the weathering and regolith environment in Australia. Hence, it is unknown whether garnet can be used as an indicator mineral in exploration targeting for orthomagmatic systems.</p> <p>It is argued that there is potential for garnet to retain information about the ore forming process that formed the Nova-Bollinger Ni-Cu-sulfide deposits, Western Australia. However, at this stage this is just a working hypothesis that needs to be tested as it is currently based only on a significant but rather</p>

	<p>restricted range of anomalous trace element data. The objectives of the Honours/Masters project are:</p> <p>1- Expand our database on garnet occurrences and compositions (chemical and isotopic) in the different lithologies, in both the Nova and Bollinger deposits as well as in the metasedimentary country rocks, mafic granulites and mafic/ultramafic intrusions that host disseminated magmatic sulfides up to 5km from known mineralisation.</p> <p>2- Document the garnet-forming reactions in the different lithologies composing the Nova-Bollinger deposits to understand the chronology of garnet crystallisation versus the formation of the Ni-Cu-sulfides.</p> <p>3- Unravel the metamorphic history associated with the Ni-Cu Nova-Bollinger deposits. This objective is key to refine the geological model of the Nova-Bollinger deposits for further exploration by providing quantitative P-T conditions for the deposit, depth of formation, geothermal gradient and presence or not of a metamorphic gradient.</p>
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Project:	An investigation of the Cogleia nickel-cobalt laterite and the potential for an ultramafic hosted sulfide precursor, Laverton, Western Australia (to be sponsored by Panther Metals Ltd)
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Kerim Sener (Panther Metals), and Nigel Brand (Portable Spectral Services)
Description:	<p>In the Laverton region of Western Australia, the Cogleia prospect comprises a JORC Exploration Target of 30Mt-50Mt of nickel-cobalt laterite mineralisation, grading at between 0.6-0.8% nickel and 400-600ppm cobalt over an interpreted strike of approximately 5.5km. The geology of the Cogleia area consists of a layered sequence of mafic and ultramafic rocks within a broadly NW-SE oriented segment of the Merolia greenstone belt. While much of the drilling was shallow, two deeper angled holes intersected sulfide mineralisation with anomalous Pt + Pd. One hole, drilled to 250m depth intersected 12 metres at 2.18% nickel, 181ppm copper, 27ppb Pt+Pd, 0.57% chrome, 604ppm cobalt, and 536ppm zinc from 80m. An opportunity to identify further nickel laterite and associated nickel-sulfide style of mineralisation is evident.</p> <p>Metals such as nickel and cobalt are key to the development of battery technology and more broadly they play a crucial role in our effort to decarbonise the future of humankind. This exciting project will provide the student with the opportunity to work on an active exploration program. The work will mainly involve mapping of the regolith profile and selected sampling of relevant material to be investigated by means of whole-rock geochemistry and in-situ mineral chemistry. Furthermore, through the involvement of Portable Spectral Services (www.portaspecs.com), it will be possible to create 2D geochemical maps of selected polished samples, investigating the nature of metal mobility and concentration across different parts of the regolith profile. The ultimate goal is to understand whether the current metal anomaly in the laterite is associated to a primary sulfide target in the underlying mafic and ultramafic lithologies.</p>

Project:	The prospectivity for nickel-cobalt mineralisation in the vicinity of the Red Flag Project, Laverton, Western Australia (to be sponsored by Panther Metals Ltd)
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, Kerim Sener (Panther Metals), and Nigel Brand (Portable Spectral Services)
Description:	<p>A nickel focused soil sampling programme showed a linear nickel-copper-magnesium anomaly, which follows a southeast trending zone between the outcropping Woodline Well nickel-sulfide mineralisation and the Salamis Prospect (Laverton, Western Australia). The geochemical anomaly follows the same orientation as the mineralisation at Woodline Well itself. Limited drilling was conducted at the Salamis Prospect, which is represented by an aeromagnetic anomaly within the Mt Margaret granite to the northwest of the South Windarra Nickel Mine. Whilst ultramafic rocks were intersected, assays reflected the komatiite geochemistry but with no sulfide enrichment. This is in contrast to the Woodline Well prospect 5km further to the northwest, which is highly mineralised.</p> <p>In the region, there is an opportunity to identify further nickel-sulfide mineralisation elsewhere across the Red Flag Project, which is located between the Woodline Well and Salamis prospects. In this project, the student will have an opportunity to carry out core logging and sampling. Selected material will be analysed for whole-rock geochemistry (both major and trace elements) and XRF Tornado mapping. Results will be compiled and interpreted in order to provide further insights into the prospectivity of the area and inform future exploration strategies.</p>

Project:	Characterisation of the Salinbas gold-silver deposit and related Ardala Cu-Au-Mo porphyry, Turkey (to be sponsored by Ariana Resources plc)
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Kerim Sener (Ariana Resources), and Nigel Brand (Portable Spectral Services)
Description:	<p>The >1Moz Salinbas Project Area (SPA) is located within the Pontide Metallogenic Province, 20km east of Artvin in northeastern Turkey. The SPA is characterised by a transition in mineralisation styles from porphyry to epithermal, including skarnoid replacement in the vicinity of the intrusions. The SPA comprises the Salinbas deposit, which contains 10Mt @ 2.03 g/t Au, 10.2 g/t Ag for a total of 0.65 Moz of gold, and the Ardala porphyry which contains 16Mt @ 0.6 g/t Au, 0.22% Cu and 0.014% Mo.</p> <p>The Salinbas deposit is represented by a 5-10m thick ENE-dipping mineralised body, largely emplaced along the unconformable contact between folded Late Cretaceous (c.100 Ma) Ziyarettepe Formation and Late Palaeocene (c.56 Ma) Kizilcik Formation. The Ziyarettepe Formation comprises massive fossiliferous limestones, whereas the overlying Kizilcik Formation consists of an intercalated sequence of conglomerates, limestones, siltstones and mudstones (including black shales). This style of mineralisation is interpreted to be a carbonate replacement-type and is sulfide-rich to gossanous in character, selectively occurring within an</p>

	<p>irregular polymictic horizon. A steeply plunging breccia-pipe style of mineralisation is developed beneath part of the Salinbas deposit, emanating from the Ardala porphyry.</p> <p>Contiguous with, but at a lower elevation to the east of Salinbas, lies the Ardala Cu-Au (Mo-Re) Porphyry Complex, which is characterised by a nested series of Eocene quartz-diorite stocks, which intrude the Upper Cretaceous to Paleocene volcano-sedimentary sequence. Exposed parts of the porphyry measure 600 x 700m, displaying a well-developed potassic alteration core (including phyllic overprint with overlying argillic alteration), with lateral extensions beneath cover. Precious and base- metal bearing skarns and related disseminated mineralization in the host-rocks are also evident, particularly at the northern margins of the porphyry.</p> <p>The proposed study aims at characterising the trace element signature of accessory phases (mainly zircon and apatite) from magmatic rocks associated with the Salinbas gold-silver deposit and related Ardala Cu-Au-Mo porphyry. Depending on travel restrictions in 2023, the project will involve mapping and sampling in Turkey or work on already available samples at UWA. The samples will be processed for whole-rock geochemistry. Polished thin sections containing the accessory phases of interest will be imaged and analysed by scanning electron microscope, as well as by electron microprobe and laser ablation analyses. The study is nested within a global project funded by the Australian Research Council, which aims to 1) empirically calibrate zircon composition as a guide to gold ore deposits, and 2) refine existing whole-rock geochemical discriminants of gold-fertile igneous suites to explore for ore deposits associated with a broader set of igneous systems.</p>
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Project:	Characterisation of the VMS systems comprising the Magellan Cu-Au Project, Cyprus (to be sponsored by Ariana Resources plc)
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Kerim Sener (Ariana Resources), and Nigel Brand (Portable Spectral Services)
Description:	<p>The Magellan Project comprises three sectors (Klirou, Kokkinoyia and New Sha), containing a total JORC Mineral Resource of 9.5Mt @ 0.65% Cu, with additional potential for gold, silver and zinc-rich zones (up to 0.6% Zn). The mineralisation is associated with Volcanogenic Massive Sulfide (VMS) deposition at or near the paleo-seafloor. The mineralisation contains localised lenses of massive metal sulfides (dominantly pyrite, chalcopyrite and sphalerite) which are surrounded by pervasive chloritic alteration and sulfide dissemination in the volcanic host rocks. The mineralisation is partly structurally controlled, associated with N-S trending horst- and graben-bounding normal faults. Mineralisation is stratigraphically located near, or at the contact between, two gently NNE-dipping (10-20°) pillow basalt sequences; the Upper Pillow Lavas (UPL) and Lower Pillow Lavas (LPL), of Upper Cretaceous age (90 Ma to 80 Ma) in the Troodos Ophiolite.</p> <p>Depending on travel restrictions in 2023, the project will involve mapping and sampling in Cyprus or work on already available samples at UWA. The samples will be processed for whole-rock geochemistry to characterise the signature of the magmatic rocks as well as of the various alteration</p>

	domains. Additional work on sulfides will include petrographic documentation, characterisation of their sulfur isotopic make up as well as measurement of their metal concentrations, with specific focus on platinum group elements. The study will also include XRF Tornado mapping, in order to unveil the cryptic relationship between alteration and metal mobility. Results and interpretations will be utilised to better understand the poorly known geological context of the region as well as to inform exploration activities in the area.
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Project:	The source of sulfur in the komatiite-hosted nickel-sulfide deposits of the Widgiemooltha Dome, Western Australia
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Laure Martin (CMCA), Zoran Seat (Mincor Resources), and Nigel Brand (Portable Spectral Services)
Description:	<p>Some of Earth's largest iron-nickel (Fe-Ni) sulfide ore deposits formed during the Archean and early Proterozoic. Establishing the origin of the metals and sulfur in these deposits is critical for understanding their genesis. Recent outcomes from selected multiple sulfur isotope work shows that the sulfur in Archean komatiite-hosted Fe-Ni sulfide deposits was previously processed through the atmosphere and then accumulated on the ocean floor. The mineralising model for these systems assumes that high-temperature, mantle-derived komatiite magmas were then able to incorporate the sulfur from proximal seafloor hydrothermal sulfide accumulations and sulfidic shales to form Neoproterozoic komatiite-hosted Fe-Ni sulfide deposits at a time when the ocean were sulfur-poor.</p> <p>This model was recently challenged by studies indicating that the source of sulfur for komatiite-hosted nickel-sulfide deposits may actually be more distal than originally thought, potentially 10-100s kilometres away from the site of mineralisation. If this was true, it would be a game changer for exploration as it would open up significant search space in greenstone belt localities that were historically thought to be devoid of any significant mineralisation. The proposed study aims at testing this hypothesis on selected mineralised samples from deposits in the Widgiemooltha Dome of Western Australia. In partnership with Mincor Resources, the study will involve core logging and sampling of mineralised material to be characterised petrographically, imaged by XRF Tornado mapping, and analysed by electron microprobe and ion probe to establish the multiple sulfur isotope signature of magmatic sulfides.</p>

Project:	Geochronological and geochemical constraints on the genesis of the Ni-REE mineralisation in the Stanmore Intrusion, Western Australia
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Alan Aitken, Laure Martin (CMCA) and Nigel Brand (Portable Spectral Services)
Description:	<p>The Stanmore intrusion was recently discovered by Junior Exploration company Victory Goldfields in the northwest Yilgarn Craton. Distinctive mineralogy (olivine-orthopyroxene-kaersutite-phlogopite-carbonate and Mn-rich ilmenite), together with reconnaissance assay data, indicates that the host intrusion is alkaline in character. The magmatic system contains rare earth bearing minerals xenotime, apatite and zircon, which are suitable for geochronological analyses, and displays anomalous concentrations of Ni, Co and REE, which are strategic metals in the transition to a low-carbon emission energy future.</p> <p>Lack of deformation textures indicates that the Stanmore intrusion may be significantly younger than the 2.7 Ga craton-wide magmatic event and could be associated with a major plume that was emplaced at ca. 2.0 Ga, coeval with the Bushveld in South Africa, which also generated the Mount Weld REE deposit. This hypothesis, which could have significant implications for the strategic metal endowment of the Yilgarn Craton, needs to be tested.</p> <p>In partnership with Victory Goldfields, the study will involve core logging and sampling of mineralised material to be characterised petrographically, imaged by XRF Tornado mapping, and analysed by electron microprobe and laser ablation ICP-MS to establish the crystallisation age of the Stanmore Intrusion.</p>

Project:	Topological uncertainty in 3D geology
Majors including:	Geology, Geoscience, Physics, Engineering, Computer Science
Supervisor:	Mark Jessell, mark.jessell@uwa.edu.au, 6488 5803
Description:	<p>The geometry of geological models has long been recognised to be an important constraint on the validity of forward process modelling and geophysical inversions, however in many instances the topology of the model is as important if not more so, especially in situations where the continuity of lithologies, or the connectivity of structures controls the outcome, such as in fluid flow or some types of electrical measurements. This project will examine methods to characterise the 3D topology of geological models as a pathway to classifying end-member models that can be used in geophysical inversion schemes.</p> <p>This project is supported by the WA government-funded WA_In3D project, and the scope is compatible for continuation to Masters or PhD level. Computer experience and some maths are required.</p>

Project	The chemical make-up of life over Earth history
Majors or Masters:	Geology, geochemistry, environmental and marine geoscience, mineral geoscience
Supervisor:	Matthew Dodd; matthew.dodd@uwa.edu.au
Description:	Life is only known to exist on Earth and has done so for at least 3.8 billion years. Over this time life has evolved from simple single cell organisms to the multitude of complex organisms alive today. During this process the evolution of life has been directed by changing environmental conditions. How environmental change has controlled the chemical make-up of life during its evolution remains an enigma. The project will involve the geochemical analysis of organic compounds in marine sediments through the Precambrian era in order to determine the chemical make-up of organisms through time. Sample analysis will involve the preparation of geological samples for analysis, the measurement of trace and major elements in organic compounds making use of spectrophotometry and mass spectrometry instruments. This project(s) is also suitable for 36 pt Master of Science projects. Please email for further information.

Project:	The depositional history of Middle Gidley Island sediment basin, Murujuga
Majors or Masters:	Geology, Geoscience, Marine Geoscience
Supervisor:	Mick O'Leary, mick.oleary@uwa.edu.au , Caroline Mather (School of Social Sciences), Matthias Leopold (School of Agriculture and Environment), Jo McDonald (School of Social Sciences)
Description:	<p>Murujuga, in NW Western Australia, comprises an archipelago of distinctive igneous terrain that is renowned for abundant and diverse Aboriginal rock art. This region has undergone extreme climatic and geographic change, notably since the Last Glacial Maximum (LGM; between 30-18 kya) where sea levels rose ~130 m and transformed Murujuga from an inland range to a coastal archipelago. This project aims to investigate the depositional history of 10 m thick sedimentary deposits on Middle Gidley Island, Murujuga, improve our understanding of environmental and climatic change over the period of deposition. As part of this project, the mineralogy, geochemistry and texture of the sediments will be analysed to reconstruct the depositional history. Core scanning techniques, such as hyperspectral scanning and scanning-XRF techniques may be employed to detail changes in the composition of sediments with depth, and therefore over time. Outcomes of this research will improve our knowledge of environmental and climatic change in NW WA and inform on how climatic shifts may have influenced human occupation and rock art production in this unique art province.</p> <p>This exciting multidisciplinary project will be supported by supervisors across the School of Earth Sciences, UWA School of Agriculture and Environment and School of Social Sciences, and is supported by ARC Linkage Projects "Dating Murujuga's Dreaming" based at the Centre for Rock Art Research and Management at UWA (School of Social Sciences). The research is undertaken in collaboration with Murujuga Aboriginal Corporation.</p>

Project:	Drivers of coastal erosion and accretion along the Coral Bay Coast
Majors or Masters:	Geology, Geoscience, Marine Geoscience
Supervisor:	Mick O'Leary, mick.oleary@uwa.edu.au
Description:	The Coral Bay Coast is home to some of Western Australia's most iconic beaches. They are typically comprised of carbonate sediments that were produced within the nearshore reef system and transported cross and/or along shore under the prevailing coastal hydrodynamic regime. However, there is increasing evidence to show that many of the beaches along the Coral Bay coast are currently experiencing a regime of net sediment loss and erosion. The aim of the project is to investigate the historical trends in shoreline position along the Coral Bay Coast using historical aerial photography, and using recently acquired bathymetric Lidar for the region develop a hydrodynamic model to map current movement and sediment transport and identify whether recent coastal infrastructure or increased coral cover along the Coral Bay coast have resulted in the impounding or trapping of sediment, limiting supply to the beach.

Project:	Legacy and preservation of tropical cyclone deposits along the Pilbara Coast
Majors or Masters:	Geology, Geoscience, Marine Geoscience
Supervisor:	Mick O'Leary, mick.oleary@uwa.edu.au
Description:	Climate models are yet to accurately predict how tropical cyclone intensity and frequency might change under future climate scenarios. An alternative approach is to reconstruct time series of cyclone activity/intensity from the geological record. However, the nature of cyclone generated storm deposits and their preservation potential has not been explored. The aim of this project is to investigate the sedimentary deposits of recent and historical cyclone events along the Pilbara coast and establish what kind of sedimentological deposit constitutes a cyclonic event and whether these types of deposits are able to be preserved within the coastal sedimentary environments.

Project:	Submerged paleocoastal environments on the NW Shelf
Majors or Masters:	Geology, Geoscience, Marine Geoscience
Supervisor:	Mick O'Leary, mick.oleary@uwa.edu.au
Description:	During the last glacial cycle (80,000 to 10,000 yrs BP) sea level was between 20 and 120 metres lower than present. This period of time captured major climatological events, as well the arrival of first Australians and extinction of Australia's mega fauna. In order to reconstruct how these coastal paleoenvironments may have supported human populations, and responded to changing regional climate this project will analyse a collection of sediment cores collected on the North West Shelf. The student will employ sedimentological and geochronological methods to reconstruct paleoenvironmental evolution of the NW Shelf during this late Pleistocene period.

Project	Various projects involving working with geophysical datasets
Majors or Masters:	Geology, Geoscience, Mineral Geoscience, Energy Geoscience
Supervisor:	Mike Dentith, michael.dentith@uwa.edu.au, 6488 2676
Description:	<p>Projects are available in diverse applications of geophysical data to solve geoscience problems, especially involving the integrated interpretation of geophysical, geological and petrophysical datasets. Broad subject areas include mineral exploration, petroleum exploration, environmental-engineering geophysics and earthquake studies.</p> <p>Projects involving more quantitative studies are also available for students with appropriate computing and numerical skills.</p> <p>In 2024 there are particular opportunities in magnetic-gravity-seismic studies of basin-hosted mineral systems, magnetic-gravity-EM responses from carbonatite-hosted REE deposits, ground penetrating radar based studies of young sedimentary environments, aeromagnetic studies of geological factors influencing the seismicity in the Yilgarn Craton, seismic studies of greenstone belts, magnetic-seismic studies of impact craters in sedimentary basins.</p> <p>It may be possible to arrange projects on other subjects as suggested by interested students.</p>

Project:	Evaluating heterogeneity in carbonate reservoirs and their controlling influences: seismic to pore-system studies
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Moyra Wilson, moyra.wilson@uwa.edu.au
Description:	<p>Carbonate systems host ~50% of the world's hydrocarbon reservoirs and form major subsurface aquifers, yet their poro-perm characteristics remain notoriously fickle and difficult to predict. Unlike siliciclastics, carbonate systems commonly show a greater range of pore types (e.g., intragranular, biomouldic), significant secondary porosity, bi- to tri-modal pore systems, as well as connected and unconnected pores. Better understanding of the heterogeneity in carbonate reservoirs is reliant on evaluating the considerable depositional and diagenetic variability in carbonate systems. A number of often industry-supported projects are available, including at Masters level. These projects will variably involve training in the study and integration of: core, outcrop, seismic, sequence stratigraphic, facies, microscopy, geochemical and petrophysical datasets. All results are anticipated to be highly publishable when executed to high standard.</p>

Project:	Coral Reefal Environmental change during periods of global climatic shifts
Majors or Masters:	Geology, Geoscience, Marine Geoscience
Supervisor:	Moyra Wilson, moyra.wilson@uwa.edu.au

Description:	Environmental change during global climatic shifts may be manifest in marine carbonate successions through changing: biota, mineralogy, facies, platform structure, early diagenesis and geochemistry. Projects are available to investigate controls on regional versus local change during times of major climatic shifts. These periods include the shift from greenhouse to icehouse conditions during the Cenozoic and the switches from glacial to interglacials that are particularly marked in the Plio-Pleistocene to Recent. These projects will variably involve training in the study and integration of: core, outcrop, seismic, sequence stratigraphic, facies, microscopy and geochemical datasets. All projects may be extendable to Masters level. Where executed to a high standard results are anticipated to be highly publishable.
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Project:	Reefal and carbonate edifices: integrated seismic and sample studies to evaluate environmental change and economic aspects
Majors or Masters:	Geology, Geoscience, Marine Geoscience
Supervisor:	Moyra Wilson, moyra.wilson@uwa.edu.au, Victorien Paumard victorien.paumard@uwa.edu.au
Description:	Reefal and carbonate systems are sensitive indicators of environmental change, building edifices or platforms that are some of the world's largest bioconstructions. In the subsurface the origins, evolution, controlling influences on, and economic potential of such edifices are best investigated through combined seismic, log and sample datasets. A range of studies on subsurface carbonate systems from Australasia will involve training in seismic analysis, facies approaches, petrology and where possible petrophysics to investigate the evolution of a range of carbonate systems and their controlling influences. All projects are suitable for Honours, and extendable to Masters level. Where executed to a high standard results are anticipated to be highly publishable.

Project:	Western Australia's coastal deposits as proxies for global climate change
Majors or Masters:	Geology, Geoscience, Marine Geoscience
Supervisor:	Moyra Wilson, moyra.wilson@uwa.edu.au
Description:	Marine and coastal deposits of SW Australia lie at the transition of warm to temperate waters, with the reefal and carbonate deposits acting as sensitive indicators of local to regional environmental and climatic change. A series of projects are available to investigate the impacts of oceanographic, climatic habitat, and eustatic sea level changes on the modern and Plio-Pleistocene coastal and marine deposits of SW Australia. These projects will variably involve training in the study and integration of: modern sediment studies, field outcrop, microscopy and geochemical datasets with fieldwork a possibility. This topic is also suitable for a 36 pt Master of Science project.

Project:	Microplastics and Muck in the Swan
Majors or Masters:	Geoscience, Geology, Environmental Geoscience
Supervisor:	Moyra Wilson, moyra.wilson@uwa.edu.au
Description:	<p>Plastics in our environment and food webs is of global concern with the Ocean Garbage Patches already ~10 times the size of the state of WA. By 2050 it is estimated there will be more plastic in the oceans than fish and 99% of seabirds will have ingested plastic. Much of this trash enters the oceans and food chains through our riverine and coastal environments. This Woodside funded RiverLab project will use <i>low-cost technical surveys to evaluate likely environmental and anthropogenic controlling influences on links between trash and microplastic distributions with Swan-Canning river-beach sediment characteristics. The hypothesis here is that if surges in meso- to macro-scale trash are linked to strong winter storms and proximity to local urban or commercial sources there should also be predictable variability in microplastic and sediment characteristics of the RiverPark beaches.</i></p> <p>RiverLab is a high profile component of the Oceanworks program at UWA which is supported by Woodside FutureLab. While undertaking their final year project, RiverLab students will have access to a cohort experience which includes training and industry networking opportunities. RiverLab students are well supported by a network of industry-focussed researchers from a wide range of backgrounds. RiverLab is a high profile component of the Oceanworks program at UWA which is supported by Woodside FutureLab. While undertaking their final year project, RiverLab students will have access to a cohort experience which includes training and industry networking opportunities. RiverLab students are well supported by a network of industry-focussed researchers from a wide range of backgrounds.</p> <p>No prior knowledge is necessary, though a keen environmental interest and ability to undertake regular field studies and learn new techniques and a desire to produce publishable quality work are highly advantageous.</p>

Project:	Coastal Particle Dynamics: the link between Coastal Setting, Erosion, Accumulation and Infrastructure
Majors or Masters:	Geoscience, Geology, Environmental Geoscience
Supervisor:	Moyra Wilson, moyra.wilson@uwa.edu.au
Description:	<p><i>What are the environmental controls on coastal erosion, accumulation and particle dynamics on carbonate islands at the limits of tropical coral reef development in WA's super stormy location? The setting and nature of beaches, intervening headlands and adjacent marine areas are critical influences on coastal erosion and accumulation thereby strongly impacting coastal and offshore infrastructure. The aim of this project is: through a detailed study of coastal sediment and microplastics, landscape, seascape characterisation linked to evidence of coastal evolution, oceanographic and weather records to better evaluate influences on particle dynamics and the nature of coastal erosion versus accumulations on carbonate islands, specifically Rottneest, Barrow Island or potentially Christmas Island.</i></p>

	<p><i>Additionally students will assess and potentially trial the efficacy of different infrastructure types in the varying coastal settings.</i></p> <p><i>This project has potential Riverlab support. RiverLab is a high profile component of the Woodside FutureLab at UWA. While undertaking their final year project, RiverLab students will have access to a co-hort experience which includes Science Communication Training, Industry networking opportunities, and interactions with researchers from a wide range of backgrounds. At the completion of the project, students will present a 3 minute thesis to members of the Woodside FutureLab team.</i></p> <p><i>A keen environmental and/or civil engineering interest and ability to undertake regular field studies and learn new techniques and a desire to produce publishable quality work are highly advantageous. Projects are suitable for Honours, and extendable to Masters level. Where executed to a high standard results are anticipated to be highly publishable.</i></p>
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Project:	Thresholds for coral reef survival
Majors or Masters:	Geoscience, Geology
Supervisor:	Moyra Wilson, moyra.wilson@uwa.edu.au , Jody Webster (University of Sydney)
Description:	<p>Carbonate systems build amongst the largest edifices on the planet, are able to keep-up with most tectonic or glacio-eustatic induced sea-level rises and consequently the foundering of many platforms is often enigmatic. The cause of demise of platforms and the deposition of potential overlying seal units are critical for understanding thresholds for carbonate platform survival as well as petroleum systems evaluations in better understanding relationships between reservoirs and caprocks.</p> <p>The paradox of foundering of carbonate platforms has been variously linked to 'drowning' via (1) fast glacio-eustatic sea-level rise, (2) tectonic induced sea-level rise (3) nutrient and/or clastic poisoning and (4) subaerial exposure, shut-down of the carbonate factory and a subsequent inability to 'catch-up' on subsequent reflooding. Despite better understanding of the foundering of carbonate platforms being critical for their survival, evaluations of the sedimentary, geochemical and petrophysical signatures of each of the potential causes for demise remain understudied. This study will evaluate the sedimentary, geochemical and diagenetic signatures across key outcrop analogue sections and subsurface reservoirs to understand the impacts of different causes of foundering on reservoir and caprock development. Dataset for study include carbonate reefal rocks from SE Asia, Australia and Hawaii.</p> <p>Projects are suitable for Honours, and extendable to Masters level. Where executed to a high standard results are anticipated to be highly publishable.</p>

Project:	Geological mapping of Venus
Majors or Masters:	Geology, Geoscience
Supervisor:	Myra Keep myra.keep@uwa.edu.au, 6488 7198
Description:	Our record of the early evolution of Earth is limited by erosion, burial, tectonic dismemberment and periods of impact cratering. The Venusian surface preserves a rare and pristine record of terrestrial planet evolution. We aim to map in detail parts of the Atalanta Planitia Quadrangle (V4) of the northern hemisphere. Our proposed area contains vast areas of Venusian “tesserae” that is thought to represent the oldest surviving Venusian landscapes, and which provides a rich and detailed history of the evolution of the Venusian planetary surface. This project will involve interpreting SAR data and using first-order geological relationships to understand the kinematic evolution of the ancient tessera terrains in this block. Students must have a good understanding of structural geology and tectonics to 3rd year level. The scope of the project is compatible with extension to Masters level.

Project:	Neotectonics and mass transport deposits in offshore petroleum basins of northern WA
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Myra Keep, myra.keep@uwa.edu.au, 6488 7198
Description:	The northwest of WA hosts Australia’s largest recorded earthquakes (ML 7.3, Meeberrie, 1941). Identification of modern surface offsets (fault scarps), both onshore and offshore, together with recently calculated earthquake focal mechanism data suggests that modern geomorphology may yield evidence as to recent earthquake activity throughout north-western WA, which may have triggered mass transport deposits. This project seeks to map modern mass transport deposits and fault reactivation in offshore areas in the Carnarvon Basin, using 3D seismic data, with a view to understanding the pre-reactivation geometries and timing, and relating them to the modern tectonic setting.

Project:	General projects in seismic structural interpretation
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Myra Keep, myra.keep@uwa.edu.au, 6488 7198
Description:	Projects are available in seismic structural interpretation across the North West Shelf, on a range of topics including: fault reactivation and inversion, neotectonics, igneous distributions, cross section restoration and potentially also in microstructure and geomechanics for qualified students. Please see Myra for details.

Project:	Identifying mass transport deposits in the Japan Trench – records of past mega-earthquakes
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Myra Keep, myra.keep@uwa.edu.au, 6488 7198
Description:	Trench-slope basins along the Japan Trench potentially record sedimentary evidence of historical mega-earthquakes. New sub-bottom profile and seismic data, along with a number of piston cores, allow us to interpret likely mass-transport deposits triggered by tsunamis generated from historical large magnitude earthquakes that are recorded in the trench-slope basins. This project is part of IODP project 386, investigating event stratigraphy and palaeo earthquakes in the Japan Trench.

Project:	Structural Geology and/or petrology projects, Albany-Fraser orogenic belt
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Myra Keep, myra.keep@uwa.edu.au, and/or Tony Kemp
Description:	At both Hopetoun or Bremer Bay there are several potential projects to resolve aspects of the structural geology and/or petrology. These projects are most suitable for the students who have completed the EART3343 field trip to the same area and are familiar with the geology.

Project	How hot is the Narryer Terrane? Constraining the crustal heat production of Australia's oldest rocks
Majors or Masters:	Earth Science, Geology, Geoscience, Geochemistry
Supervisor:	Naomi Tucker, naomi.tucker@uwa.edu.au, in collaboration with GSWA
Description:	<p>The Narryer Terrane is one of the oldest crustal terranes on Earth. It contains the oldest rocks in Australia, and the oldest terrestrial material on the Earth that has been dated by U-Pb isotopes. The Narryer Terrane also preserves one of the oldest remnants of granulite facies metamorphism in the world. Recent work focusing on metamorphism also suggests that these rocks formed under one of the hottest thermal regimes in the geological record (>150°C/kbar, ca. 2680-2660 Ma).</p> <p>But what exactly caused the crust to attain ultrahigh thermal gradient conditions? Recent metamorphic work in the Narryer Terrane suggests that elevated radiogenic heat production may have been a significant contributing factor. To date, however, no heat flow studies have investigated the Narryer Terrane.</p> <p>The aim of this project is to apply a non-destructive method to determine the concentrations of K, U and Th to a number of samples from the Narryer Terrane that have been collected by UWA and the Geological Survey of Western Australia (GSWA). These results will be combined with existing whole-rock geochemistry to build a dataset of geochemical concentrations that can be used to calculate bedrock heat production and ultimately a heat production/heat flow map. This information will help us to assess crustal</p>

	contributions to heat flow in the Narryer Terrane, and to evaluate the likely thermal drivers for Neoproterozoic ultrahigh thermal gradient metamorphism.
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Project:	Hot and cold - contrasting eclogites in the South New England Orogen
Majors or Masters:	Earth Science, Geology, Geoscience, Geochemistry
Supervisor:	Naomi Tucker, naomi.tucker@uwa.edu.au External co-supervisor: Martin Hand (University of Adelaide)
Description:	<p>'Cold' eclogites form under relatively low-temperature (mostly < 600°C), high-pressure and 'wet' (hydrous) environments and produce highly hydrous minerals such as lawsonite. Lawsonite is only stable at abnormally low geothermal gradients, less than $\sim 7 \text{ }^\circ\text{C km}^{-1}$. This means that lawsonite eclogites require cold subduction to mantle depths and rapid exhumation, which can be attained only by the subduction of old, cold, oceanic crust, or very old continental crust. In contrast, eclogites formed by continental subduction typically record 'hot' ($T > 650^\circ\text{C}$) and 'dry' ultrahigh-pressure metamorphic conditions. These rocks form via different processes in the subduction channel. One interpretation is that they become stuck to the base of the mantle wedge, beneath the overlying plate.</p> <p>The South New England Fold Belt (SNEB) contains both types of eclogite. Garnet-pyroxene-rutile eclogites are documented in Gleneden and Attunga and are thought to have formed at $\sim 800^\circ\text{C}$. In contrast, garnet-lawsonite-omphacite eclogites are documented at Pigna Barney, where they occur with blueschists. These 'cold' eclogites are thought to have formed at $\sim 450^\circ\text{C}$. Existing geochronology, mineral chemistry, thermobarometry and petrographic observations of the rocks at these localities indicate that they preserve evidence for multiple discrete high-pressure events in the Cambrian and Ordovician.</p> <p>The aim of this project is to:</p> <ol style="list-style-type: none"> (1) Provide robust P-T constraints on 'hot' eclogites at Gleneden and/or Attunga, to compare with existing P-T models for 'cold' eclogites at Pigna Barney; (2) Investigate whether the garnets preserve textural, chemical and/or isotopic evidence for polyphase metamorphism or "yo-yo" subduction, as is the case in other parts of the fold belt (e.g. Port Macquarie); (3) Integrate P-T-t results from this study with existing work on the SNEB to explore whether contrasting styles of eclogite metamorphism represent (a) discrete, (b) co-existing or (c) transitional subduction channel dynamics from oceanic "cold" subduction to continental "warm" subduction (or vice versa). <p>Some familiarity with metamorphic petrography is essential (i.e. EART3343).</p> <p>This project is supported by an Australian Research Council Discovery Project.</p>

Project:	Refining the record of deep subduction in Norway
Majors or Masters:	Earth Science, Geology, Geoscience, Geochemistry
Supervisor:	Naomi Tucker, naomi.tucker@uwa.edu.au External co-supervisor: Chris Clark (Curtin University)
Description:	<p>The Western Gneiss Complex in Norway is reported to contain coesite-bearing eclogites implying that the rocks have been subducted to depths >100km. However, recent studies of the host felsic gneisses suggest that the rocks do not record pressures of more than 12 kbar. These contradictory observations have significant implications for how we understand what goes on inside a subduction channel during continental subduction. There are three potential ideas to explore:</p> <ol style="list-style-type: none"> 1. Hypothesis 1 – felsic gneisses were subducted to and exhumed from UHP depths but converted back leaving a cryptic record of their high-pressure history 2. Hypothesis 2 – the felsic gneisses were never subducted but juxtaposed later during the exhumation of the eclogites 3. Hypothesis 3 – There are two types of felsic gneisses, those that were subducted and are associated with eclogitic gneisses and those that were never subducted and only record metamorphism at mid to lower crustal depths during the Caledonian (i.e. it's a bit of 1 and a bit of 2 but it's complicated) <p>To test these hypotheses requires a detailed understanding of the field relationships of the eclogites and felsic gneisses (structural geology), characterisation of the P-T conditions recorded by the gneisses, eclogites and other styles of boudins found within the gneisses (metamorphic petrology) and the chronology of deposition, burial and exhumation preserved within the rocks (geochronology).</p> <p>Some familiarity with metamorphic petrography is essential (i.e. EART3343).</p> <p>This project is supported by an Australian Research Council Discovery Project.</p>

Project:	A geological cold case: investigating blueschist conglomerates from a Cambrian-Ordovician subduction channel
Majors or Masters:	Earth Science, Geology, Geoscience, Geochemistry
Supervisor:	Naomi Tucker, naomi.tucker@uwa.edu.au External co-supervisor: Martin Hand (University of Adelaide)
Description:	<p>Unique exposures of high-pressure low-temperature metamorphic rocks are preserved at Port Macquarie in New South Wales. Here, a tectonic mélange hosts an assortment of different high-P blueschists and eclogites that record a complex evolution of Cambrian-Ordovician subduction along the eastern margin of Gondwana.</p> <p>Rare blocks of deformed, blueschist conglomerate occur within the mélange. Although they were metamorphosed to blueschist facies, these meta-conglomerates retain relic primary igneous textures, such as relic phenocrysts that are now replaced by coarse lawsonite and glaucophane.</p>

	<p>The rocks contain a variety of clasts, including chrome-spinels that are embedded in a fine-grained matrix of glaucophane, chlorite and titanite.</p> <p>These rocks are thought to represent detritus from the subduction channel, which accumulated in an accretionary wedge between the two converging tectonic plates. At some point after sedimentation, the conglomerates were subjected to blueschist facies metamorphism at depth, before being rapidly exhumed back to the surface.</p> <p>K-Ar age dating from blueschists in the <i>mélange</i>, and Sm-Nd ages from the meta-conglomerates, suggest that the rocks in the subduction channel were exhumed at ca. 490-470 Ma. However, recently obtained U-Pb ages from detrital zircon in the meta-conglomerates suggest that blueschist metamorphism instead occurred <i>after</i> ca. 340 Ma. These contradictory observations mean that the metamorphic evolution of the blueschist conglomerates in the subduction channel requires further investigation.</p> <p>This project will involve a combination of titanite U-Pb geochronology, Rb-Sr geochronology, major and trace element mineral chemistry, and P-T modelling.</p> <p>Some familiarity with metamorphic petrography is essential (i.e. EART3343).</p> <p>This project is supported by an Australian Research Council Discovery Project.</p>
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Project	Petrochronology in the Savannah Ni-Cu-Co Camp.
Majors or Masters:	Earth Science, Geology, Geochemistry
Supervisor:	Naomi Tucker (SES), Laure Martin (CMCA)
Description:	<p>The aim of this study is to better understand the processes leading to Ni-Cu-Co mineralisation in the Savannah deposit, located in the East Kimberley region of WA. The deposit consists of interlayered mafic-ultramafic sequences, from peridotite-norite-gabbro-norite to troctolite, that intruded the Tickalara Metamorphics during the Paleoproterozoic Halls Creek orogeny. Massive sulfides bearing rocks in the Savannah deposit are associated with abundant crystallization of garnet within the orebody (Le Vaillant et al. (2020). Garnets are also abundantly observed within the country rocks, mainly composed of metapelites metamorphosed in the granulite facies.</p> <p>The proposed methodology is twofold. (1) Identify the petrological relationships between the massive sulphides and their host granulite to understand their potential interactions and the implication for the formation of the mineralisation. (2) Characterise the timing of these interactions using Lu-Hf in garnet and U-Pb in zircon/monazite in-situ in rock sections, to integrate geochronology and microstructures.</p>
Project:	Characterisation of proximal to distal alteration footprint of gold deposits
Majors or Masters:	Structural geology, geochemistry, ore deposit mineralogy
Supervisor:	Nico Thébaud, nicolas.thebaud@uwa.edu.au , 6488 7139

Description:	A range of projects are available focusing on gold mineralisation. These projects either aim at characterizing the mineral paragenesis and structural contexts of Au mineralization within a deposit, or investigate the mineralogical and petrological characteristics associated with Au transport and deposition. These studies rely on multi-disciplinary approach that may combine field mapping, structural core logging, ore mineralogy, and/or lithogeochemistry.
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Project:	Yilgarn mapping projects in collaboration with the Geological Survey of Western Australia
Majors or Masters:	Geology, Petrology, Geochronology
Supervisor:	Nico Thébaud, nicolas.thebaud@uwa.edu.au, 6488 7139 Co-supervision with GSWA geologist (Dr R. Quentin de Gromard, Dr T. Ivanic)
Description:	<p>In collaboration with the Geological Survey of Western Australia (GSWA), multiple areas have been identified in the nearby Yilgarn Craton that require detailed geological investigation. A range of projects are available to conduct field-based study in collaboration between the School of Earth Sciences and GSWA mapping division. These mapping projects may cover topics including but not limited to:</p> <ul style="list-style-type: none"> • Defining stratigraphic assemblages and the correlation of stratigraphic packages across greenstone belts. • The petrology and geochemistry of volcanic rocks. • The petrology and geochemistry of granitic and gabbroic magmatic suites. • Structural observations and constraints on the deformation history in targeted areas. <p>Accordingly, research methodology will combine field-based geological mapping, petrological investigation and characterisation using optical and electronic microscopy, microprobe mineral analyses deployed on selected samples and geochronology (if required).</p>

Project:	Structural architecture of the Hamersley Iron Ore province and structural evaluation of structural controls of iron ore deposits
Majors or Masters:	Structural geology
Supervisor:	Nico Thébaud, nicolas.thebaud@uwa.edu.au , 6488 7139, with Clement Fay (Rio Tinto)
Description:	A range of projects in structural geology are available focusing on the structural architecture of the Hamersley Iron Ore province and aspects related to Iron ore extraction and exploration. These projects include: (1) evaluation of damage zone vs fault displacement in faulted terrains, (2) evaluation of the uncertainty in modeling folded structures from structural surveys, (3) evaluation of the active tectonic footprint in the Hamersley Ranges.

Project:	Stream-aquifer interaction – moving beyond the hillslope
Majors including:	Hydrogeology
Supervisor:	Sarah Bourke sarah.bourke@uwa.edu.au_ Department of Water and Environmental Regulation personnel
Description:	It is now widely acknowledged that best-practice water resource management requires a robust understanding of water fluxes between surface water and groundwater. Streamflow is often generated by groundwater outflowing to the surface, while water infiltration from streams forms an important source of aquifer recharge. The majority of studies examining streamflow generation processes have been conducted in the context of hill-slope hydrology, where topography plays is the dominant control on water movement. However, in highly weathered landscapes like WA, subsurface geology can be more important than topography in determining how much water ends in in streams and aquifers. Research project opportunities can include the analysis of existing data sets as well as field data collection to improve our understanding of geological controls on surface water – groundwater interaction and streamflow generation. Field sites may include Preston, Pemberton or sites in northern WA. Research projects will be aligned with current water resource management challenges and the outcomes will be used to inform robust water management decisions.

Project:	Hydrogeological controls on water quality in remote communities
For majors including:	Hydrogeology
Supervisors:	Sarah Bourke sarah.bourke@uwa.edu.au
Description:	Communities in rural and remote Australia commonly rely on groundwater for their potable water supply. The potential for adverse health impacts due to poor water quality in remote areas is a current focus of concern for some communities. However, to date there has not been a systematic assessment of water quality in remote communities. The student will collate and interpret existing data from remote communities across Western Australia. Where data gaps are identified additional data collection may be possible. Based on these data the relationships between any water quality issues and the hydrogeology of the source – aquifer(s) will be elucidated.

Project:	Geological structures as controls on groundwater flow in southwest WA
Majors or Masters:	Hydrogeology, Geoscience
Supervisor:	Sarah Bourke sarah.bourke@uwa.edu.au , Department of Water and Environmental Regulation (DWER) personnel
Description:	Geological structures are a key control on groundwater flow paths and residence times. Robust management of groundwater resources therefore

	<p>requires an understanding of the presence of faults and folds and their influence on groundwater flow.</p> <p>Research project opportunities are available to work on existing data sets held by DWER to refine our understanding of geological structures in south-west WA. Research will involve the re-interpretation of drill logs, water levels, environmental tracer data and geophysical data sets to refine our understanding of subsurface geological structures and their influence on groundwater flow. Project outcomes will be directly related to current groundwater management issues and will inform robust water resource management decisions.</p>
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Project:	Modern fluvial-deltaic reservoir analogues for subsurface Reservoir modelling
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Simon Lang, simon.lang@uwa.edu.au , Mick O'leary, mick.oleary@uwa.edu.au , Victorien Paumard, victorien.paumard@uwa.edu.au
Description:	<p>Subsurface reservoir facies modelling (for oil, gas, geo-sequestration, waste disposal and water resources) requires a range of uncertainty to be considered regarding the size, shape and 3D geometry of geobodies in the subsurface. Predicting likely spatial relationships of facies both in 2D and in the connected 3D space is critically important because it can impact the outcome of flow simulations it models (high-permeability networks, barriers and seals).</p> <p>This project focussed on coastal-deltaic geobodies and specifically on aspects of several modern Deltas on the WA coast from the Gascoyne region to the Pilbara. The project will be GIS based followed up by a field sortie to confirm facies predictions and to obtain vital statistics on texture and sedimentary structures. Sediment sampling, augering, drone mapping, coring, and a range of geophysical tools will be used to make facies maps that will be used to characterize the Deltas in the mode of the WAVE3 classification scheme and ultimately to guide reservoir modelling as training images. Field work will be conducted between May and August. The project will be supported by funds from the new Reservoir Analogues Consortium funded by industry.</p>

Project:	Quantitative Seismic stratigraphy
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Simon Lang simon.lang@uwa.edu.au , Victorien Paumard, victorien.paumard@uwa.edu.au

Description:	<p>With ~15% of siliciclastic hydrocarbon reservoirs located within deep-water basins, a key challenge for the industry is to predict when and where coarse-grained sediments are delivered from the edge of continental margins (i.e. shelf-edge) to the continental slope and basins, and how these sediments accumulate in deep water (i.e. type and architecture of deep-water systems).</p> <p>This project aims at applying the innovative approach of quantitative 3D seismic interpretation (QSS) to investigate the linkages (quantified relationships) between shelf margin architecture, hydrodynamic processes along deltaic shorelines and reservoir properties (type, volume, architecture) in deep water in a variety of basin settings. The project is underpinned by state-of-the-art, full volume, semi-automated 3D seismic interpretation methods that enable very high-resolution seismic stratigraphic analysis of large datasets in a short time frame. The project will involve detailed analysis of one or more subsurface case studies (margins in a variety of climatic and tectonic settings), including the use of appropriate analogues from literature and outcrops.</p> <p>This study will evaluate how quantitative measurement of shelf edge parameters on seismic data can be a useful exploration tool to predict shallow marine depositional style and deep-water play development.</p>
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Project:	Quaternary to Recent coastal processes and evolution from high resolution seafloor mapping of the Western Australian continental shelf
Majors or Masters:	Geology, Geoscience, Marine Geoscience
Supervisor:	Simon Lang, simon.lang@uwa.edu.au ; Mick O’leary, MickOleary@uwa.edu.au ; Victorien Paumard, Victorien.Paumard@uwa.edu.au
Description:	<p>Regional scale seafloor mapping of the West Australian continental shelf based on high resolution 3D seismic datasets and satellite imagery offers a valuable dataset for understanding larger scale coastal processes and shoreline evolution based on sedimentation patterns observed from bathymetric datasets. The project will help create improved datasets from various data sources and using GIS mapping (enhanced by sediment sampling, drone mapping and shallow borehole data), will focus on the evolution of selected clastic and/or carbonate geobodies and their spatial and temporal relationships.</p> <p>The results will be used to improve our understanding of the evolution of the continental shelf during significant changes in relative sea-level and variable climate history, with spin-off value for sedimentology of shallow marine and shoreline deposits, including geotechnical aspects and geo-archaeology. The opportunity to conduct field work may arise in conjunction with related projects by the School. The project will be supported by funds from industry and related research grants and related research grants focused on climate change and its impact on coastal evolution.</p>

Project:	Garnet and clinopyroxene chemistry of the O'Callaghans polymetallic W-Zn-Pb-Cu skarn, Paterson Orogen, Western Australia: Constraining the physico-chemical conditions of prograde skarn formation
Majors or Masters:	Geology, Geochemistry, Geoscience, Ore Deposit Geology
Supervisor:	Steffen Hagemann, steffen.hagemann@uwa.edu.au, 6488-1517, and Laure Martin
Description:	The O'Callaghans polymetallic skarn is located in the Paterson Province in Western Australia and is one of the world's largest W deposit in the world. Garnets and pyroxene are part of the prograde, high temperature hydrothermal silicate alteration which consists of garnet-clinopyroxene-quartz, minor sulphides and scheelite. This investigation will define the garnet and pyroxene species; define intra-garnet and pyroxene zonation and provide P-T estimates based on e.g., the garnet-pyroxene geothermometer. The petrographic and geochemical results of the garnet-pyroxene assemblage will be used to better characterize stage 1 prograde hydrothermal alteration and mineralization at the O'Callaghans skarn deposit and, thereby, further refine the classification of this skarn type. The project is also suitable for a 36 pt MSc thesis. Appropriate prior study and successful completion of the SEM course in early 2020 (as advertised by the CMCA at UWA).

Project:	Fluid evolution in the Karouni gold deposit, Guyana, South America
Majors or Masters:	Geology, Geochemistry, Geoscience, Ore Deposit Geology
Supervisor:	Steffen Hagemann, steffen.hagemann@uwa.edu.au, 6488-1517, and Mike Tedeschi
Description:	The Karouni orogenic gold deposit, located in the Guyana Shield in South America, is Troy Resources flagship gold deposit with production starting in 2015. The key objective of the project is the reconstruction of the paleohydrothermal evolution of this gold system via fluid inclusion and stable isotope investigations. The project involves detailed petrography of quartz veins and breccias, cathodoluminescence of quartz-carbonate crystals and identification of suitable fluid inclusion assemblages. The carefully constrained fluid inclusions will be analysed using the in house fully automated Linkham heating-freezing stage and laser-Raman spectroscopy. Oxygen and hydrogen isotopes will be measured on quartz and fluid inclusions, respectively. The results will be used to constrain the characteristics and evolution of the Karouni gold system and aid in the exploration for new, concealed ore bodies in the area. This project is part of the 'to be established' SAXI (South American Exploration Initiative) project, thus the proposed Honours/Masters project provides the candidate with the opportunity to collaborate with a team of national and international researchers. The project is also suitable for a 36 pt MSc thesis. Appropriate prior study and successful completion of the SEM course in early 2020 (as advertised by the CMCA at UWA).

Project:	Copper-gold mineralization at the Burns intrusive complex near Kambalda – hydrothermal or felsic magmatic? (sponsored by Lefroy Exploration Ltd)
Majors or Masters:	Geology, Geochemistry, Geoscience, Ore Deposit Geology
Supervisor:	Steffen Hagemann, steffen.hagemann@uwa.edu.au, 6488-1517 and Walter Witt (Postdoctoral fellow), wittww@iinet.net.au
Description:	<p>Orogenic gold systems in the Yilgarn craton of Western Australia and worldwide are gold-only deposit with low or absent base metals. The Burns intrusion complex near Kambalda is characterized by an unusual, high amount of copper mineralization besides gold. Presently, there is no model that explains the significant amount of copper in an orogenic gold system.</p> <p>The aim of this project is to address the relationship of gold-copper mineralisation to the spatially associated Burns intrusion complex. Specifically, is the copper (and gold?) mineralization related to felsic magmatic (porphyry or intrusion-related) or orogenic hydrothermal style mineralization? The strategy for addressing this question is to: i) determine the hydrothermal alteration mineralogy and mineral chemistry, ii) constraint the pressure and temperature of hydrothermal alteration via appropriate geothermobarometers, and iii) develop a hydrothermal alteration model for this most unusual copper-gold mineralization style.</p> <p>This study will involve a combination of field work (mapping and diamond core logging) and laboratory work (petrography, SEM, EMP).</p>

Project:	Terrific tourmaline: a tracer of critical mineral potential?
Majors or Masters:	Geology, Geochemistry, Geoscience, Mineral Geoscience
Supervisor:	Tony Kemp tony.kemp@uwa.edu.au, 6488 7846
Description:	<p>The 'Critical Minerals' underpin high technology applications on Earth and in space, and are essential for the transition to low carbon energy sources. Pegmatites are a major source of some of the most critical commodities, such as lithium, tantalum, beryllium and the rare earth elements. These generally small igneous bodies are, however, difficult to explore for, particularly under cover, and there is no robust model to explain why some pegmatites are enormously endowed in critical minerals, yet others are barren. There is therefore much interest in developing proxies based on the chemistry of certain resistate minerals (i.e., minerals that can survive in stream sediments and in weathering profiles) as to whether a particular area may be fertile for rare metal pegmatites or not. This project is to test this approach using the mineral tourmaline. This is a complex boro-silicate that is common in pegmatites, sometimes as gemstones, but how the chemistry of tourmaline varies within pegmatite bodies and relates to their critical minerals potential is unknown. The project will involve studying tourmaline crystals from a variety of pegmatites in Western Australia, including the green and pink varieties that are prized as gems. Analysis would involve conventional petrographic examination, as well as electron microscopy and laser ablation ICPMS techniques to explore whether tourmaline chemistry can be linked</p>

	to high grades of pegmatite-hosted critical metals like lithium, tantalum or the rare earth elements. A secondary aim is to use the microstructure and trace element chemistry of tourmaline to unravel the crystallisation history of pegmatites, and the degree to which they are fractionated.
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Project:	Critical minerals: lively lithium
Majors or Masters:	Geology, Geochemistry, Geoscience, Mineral Geoscience
Supervisor:	Tony Kemp tony.kemp@uwa.edu.au, 6488 7846
Description:	Soaring market demand for lithium, a major component of Li-ion batteries, has driven exploitation of rare metal pegmatites containing lithium-rich minerals. These minerals include the highly sought after spodumene (Li-pyroxene), the chief ore mineral in the world-class lithium-mineralised pegmatites of Western Australia (Greenbushes, Wodgina, Pilgangoora) and the bright purple Li-mica lepidolite. However, lithium also occurs in phosphates, such as amblygonite and lithiophilite (up to 10% Li ₂ O), as well in Be and Li bearing species, such as bityite (Li-Be mica) and (pink) tourmaline. The distribution and composition of these minerals in pegmatites, and pegmatite-associated alteration haloes, is of great interest from a metallurgical and recovery point of view. This study would target these lithium minerals in different pegmatites from Australia, the aim being to characterise their distribution, textural occurrence and microchemistry/microstructure.

Project:	Critical Minerals: The cryptic Critical Zone (Cr-PGE) in the Windimurra Layered Mafic Intrusion, WA
Majors or Masters:	Geology, Geochemistry, Geoscience, Mineral Geoscience
Supervisors:	Tony Kemp tony.kemp@uwa.edu.au, 6488 7846, Tim Ivanic, Geological Survey of Western Australia
Description:	Layered mafic intrusions (LMIs), such as the Bushveld Complex in South Africa, dominate the world's supply of chromium and the Platinum Group Elements (PGE), the latter essential as a catalyst in 'green' hydrogen-powered fuel cell electric vehicles. In Western Australia, the 2.8 Ga Windimurra Complex is an enormous LMI that has all the hallmarks of the Bushveld intrusion, except that the highly sought after Critical Zone (that hosts the PGE) has yet to be located. However, localised occurrences of Cr-PGE mineralisation are known, which may be signposts for larger resources that are yet to be discovered. This project is to undertake a detailed petrographic and mineral chemical study of a thin chromite seam that is associated with PGE-rich sulfides and draped over a megacrystic anorthosite layer in the lower part of the Windimurra LMI. The project would involve characterisation, micro-mapping, and analysis of the chromite and PGE sulfides using electron microscopy and X-ray fluorescence techniques, and placing this information in the broader context of the evolution of the Windimurra layered intrusion. If undertaken as a two-year project, the second year would involve in situ trace element geochemistry and Re-Os geochronology to reveal the

	age and nature of the mantle sources, and how this compares with LMIs in other Archean cratons.
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Project:	Planetary science: meteorite studies
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Tony Kemp tony.kemp@uwa.edu.au, 6488 7846
Description:	Meteorites are rare, incredibly valuable rock samples delivered to Earth from the cosmos, and provide unique information on the earliest evolution of the solar system and the formation of the terrestrial planets. Projects are available to study a range of different meteorite types recently recovered from expeditions to sub-Saharan Africa and from the salt lakes of outback Australia. These include the primitive 'chondritic' (stony-iron) meteorites, and brecciated stony meteorites that may have been ejected from the asteroid 4-Vesta. Studies would involve detailed petrography (optical and electron microscopy) and mineral chemistry to characterise and classify the meteorites, and establish whether these samples can be matched with known meteorite falls, or represent new discoveries to science. If the latter, the specimens will be registered in the Meteoritical Society database (https://www.lpi.usra.edu/meteor/).

Project:	Critical Minerals: Rare minerals and Rare Earths in pegmatites
Majors or Masters:	Geology, Geochemistry, Geoscience, Mineral Geoscience
Supervisor:	Tony Kemp, tony.kemp@uwa.edu.au, 6488 7846
Description:	Mineralised pegmatites fall into two families – lithium-cesium-tantalum (LCT) pegmatites, and the more alkaline niobium-yttrium-fluorite (NYF) pegmatites. Of these, the LCT pegmatites have received the most attention (because of Lively Lithium!), however interest is growing in the NYF variety as these contain minerals that may host large quantities of the highly sought after rare earth elements. For example, minerals such as euxenite-Y and fergusonite-Y that occur in NYF pegmatites are enriched in the valuable 'heavy rare earths' like dysprosium and terbium that are essential for 'hot' magnets in electric vehicles. This project is to examine NYF pegmatites from occurrences in Western Australia and the Northern Territory, with the aim to identify the rare earth bearing minerals in these rocks, and to understand how and where these minerals are concentrated in the pegmatite body. The project could entail fieldwork, and will involve optical petrography, electron microscopy, and laser ablation plasma-source mass spectrometry. There is also potential to assess the viability of these rare earth bearing minerals as geochronometers.

Project:	Numerical modelling of basins and synthetic gravity modelling
Majors or Masters:	Geoscience, Geology, Computer science
Supervisor:	Weronika Gorczyk, weronika.gorczyk@uwa.edu.au, 6488 1516
Description:	Numerical modelling of basin evolution is a great way to understand the processes of basin development. The models generate a full suite of physical properties of evolving crust (e.g. density), which then can be expressed through geophysical inversion tools that are applied to geophysical data sets obtained in the field. Projects are available to apply new technologies to numerical modelling and gravity inversion problems. Work will be completed making full use of Pawsey Centre supercomputer infrastructure and will involve testing new codes, assessing performance and helping to further develop the approach. Software is designed to be used by non-specialists, however, computing experience and reasonable maths ability are desirable.

Project:	Paleogeographic and tectonic framework and evolution of Central European Basin.
Majors or Masters:	Geoscience, Geology, Computer science
Supervisor:	Weronika Gorczyk, weronika.gorczyk@uwa.edu.au, 6488 1516
Description:	<p>The Central European Basin is a host to massive hydrocarbon and copper deposits, with large datasets available. The general tectonic history of this area is considered well known, but new observations are still to be made by holistic systems approach. This project integrates compilation and interpretation of datasets from whole basin or its parts to unlock remaining resources.</p> <p>This project would be suitable for students with an interest in GIS, geological modelling, and data manipulation.</p>