THE UNIVERSITY OF WESTERN AUSTRALIA

School of Earth Sciences

Potential research projects offered for Level 4 (Honours) and Level 5 (Masters) students commencing in 2023

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

The projects outlined in this booklet are not necessarily all of those available. Please feel free to talk to staff members 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 begin developing 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 the resources industries and government agencies*. It is also a pathway to higher degrees by research (MSc, MPhil, PhD) with students often discovering a passion for research during their Honours or Masters research!

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 2023*. Do not leave organising a project until the first teaching week of 2023 or late July! Remember that many of the staff take leave through January.

Geoscience is a broad discipline that includes Geology, Geophysics, Geochemistry, Geobiology, Environmental Geoscience, Marine Geoscience and Computation/Numerical Modelling and Data 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 thus advancing important knowledge or have various levels of application to specific resources including mineral deposits, energy and groundwater, and management of important regions such as coastal zones, 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:	**Hydrogeologic modelling in a changing climate, and an uncertain world**
Majors or Masters:	Hydrogeology
Supervisor:	Adam Siade, adam.siade@uwa.edu.au
Description:	An important objective of hydrogeological modelling is to make predictions about how aquifer systems respond to anthropogenic influences. Such predictions are predicated on knowledge of aquifer properties, model construction, and future climate evolution, which are often unknown or highly uncertain. For example, the ability for a particular groundwater model to predict the drawdown in a sensitive wetland could be highly uncertain for a number of reasons. Therefore, quantifying this "predictive uncertainty" is paramount for understanding how the natural environment will respond to future anthropogenic influences such as groundwater pumping. Furthermore, reducing this uncertainty can dramatically improve our ability to develop low-risk (risk-adverse) groundwater management solutions. This project will focus on advanced methods of numerical groundwater modelling, along with the quantification of uncertainty associated with model predictions throughout the Perth region and beyond. Students will gain experience working with the Perth Regional Aquifer Management (PRAMS) modeling framework using the PEST and PEST++ software suites within high-performance computing facilities.

Project:	**Quantifying recharge rates using groundwater modelling**
Majors including:	Hydrogeology
Supervisor:	Adam Siade, adam.siade@uwa.edu.au
Description:	Groundwater models play an important role in water resource management. For example, managers often rely on groundwater model predictions to support/inform important management decisions. Therefore, accurate simulation of key processes, e.g., recharge mechanisms, is critical in order to make reliable predictions. It is also important to consider the spatial and temporal scale of the predictions, as certain processes may or may not be important at different scales. This project will focus on the conceptualization of the processes affecting net recharge rates, and their implementation within a regional-scale groundwater model of the Perth region. Topics could include how the water table elevation affects actual evapotranspiration (AET) rates, estimating AET rates with remote sensing data, addressing flow through the unsaturated zone, how land-use affects net recharge, etc. Students will gain experience working with the Perth Regional Aquifer Management (PRAMS) modeling framework, the primary management tool for groundwater in the Gnangara area. Students will also work alongside the CSIRO scientists tasked with developing new software for simulating net recharge in PRAMS.

Project:	**The Role of Geologic Structure on Lake Resilience – A Modelling Study**
Majors or Masters:	Hydrogeology
Supervisor:	Adam Siade, adam.siade@uwa.edu.au
Description:	The impacts of geologic structures are often overlooked when assessing the hydrology of lakes and their resilience. However, geology can play a critical role in driving the stage, and hence size, of a lake and whether or not a lake would even persist in the first place. This is due to the impact that geologic structures like heterogeneity, faults, aquitards, etc., may have on the nature of the water table. An example of this is a series of lakes along the coastline of the Perth metropolitan region within the Gnangara groundwater management area, e.g., Lake Joondalup. Preliminary studies indicate that these lakes are greatly impacted by the presence of a number of geologic units that have very different permeabilities, combined with the potential impacts of faulting and aquitards. In this project, the student will expand on these previous studies and construct a 3D model for the region in an effort to better characterise the observed lake dynamics. Students will work with modelling lake water balance (and stage), the contact between high- and low-permeability units, the impacts of aquitards, etc., to assess the hydrogeologic conditions in which the current lakes will exist with an appropriate stage and appropriate hydrologic fluxes. This work will then provide important insights for the larger Perth Regional Aquifer Management (PRAMS) modeling framework, a tool that is used to support management decisions such as groundwater allocation planning.

Project:	**Into the twilight zone of the North Australian Craton**
Majors or Masters:	Geology, Geoscience or related
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au
Description:	The concept of the North Australian Craton is central to models of Australia's formation. However its true nature and the details of its formation remain cryptic due to extensive cover of sedimentary basins. This project will seek to map the cratonic architecture, in particular using new geophysical models to map the poorly known zone from 20 – 80 km depth. Revealing the key features of this little known zone will allow a more comprehensive appreciation of cratonic development with impacts for the development of Australia and the Nuna supercontinent.

Project:	**Mapping workflows for subglacial geology: A data analytics approach**
Majors or Masters:	Geology, Geoscience, Computer Science or related
Supervisor:	Alan Aitken, alan.aitken@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:	**4D mapping of the thermal evolution of Aus-Ant-India triple junction**
Majors or Masters:	Geology, Geoscience, Computer Science or related
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au
Description:	Low temperature thermochronology data constrain the evolution of orogens and rifts, however the patterns of thermal evolution in these settings is complex. This project will use new data from Antarctica and from submarine plateaux alongside published data to review the thermal evolution of the Australia-Antarctica-India triple Junction region since the Cambrian. Using tectonic reconstructions, the project will place the thermal data in the 4D framework of Pangea and Gondwana, and will generate spatial representations of temperature, associated with uplift, burial, magmatism and glacial events.

Project:	**Teeth geochemistry as a tracer of environmental pollution in the Perth metropolitan area and the Kimberley rural communities**
Majors or Masters:	Geology, Environmental Geoscience, Geochemistry
Supervisor:	Aleksey Sadekov, Aleksey.Sadekov@uwa.edu.au, 64884384 Jilen Patel (UWA, Dental School)
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 Kimberley region. 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:	Aleksey Sadekov, Aleksey.Sadekov@uwa.edu.au, 64884384 April Abbott (Coastal Carolina University)
Supervisor:	Geology, Geochemistry, Marine Geoscience
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:	**3D morphology of desert varnish and its importance on the preservation of Aboriginal People rock arts in the Pilbara Region.**
Majors or Masters:	Aleksey Sadekov, Aleksey.Sadekov@uwa.edu.au, 64884384 Jo McDonald (UWA, Archaeology)
Supervisor:	Geology, Environmental Geoscience
Description:	Origin and formation of rock varnish in arid and semi-arid environments have been studied for nearly half a century with the primary aim of quantifying the age of human occupation and rock arts in different regions of the world. The most accepted hypothesis for varnish formation is attributed to the interplay between organic (through microbial activity) and inorganic processes on rock surfaces. In this project, 3D micro-morphology of rock varnish surfaces will be investigated in the effort to classify general forms and types of varnish in Murujuga's Rock Art area. This project will use micro x-ray tomography and general optical microscopy to characterise samples collected in 2021-2022 with further possibilities to collect additional materials in the Pilbara region. The aim of this project is to link microscale varnish morphologies with rate of varnish formation and abrasion in harsh arid environments and therefore provide general estimate on importance of varnish morphology on rock art conservation in Pilbara region.

Project:	**Tectonic assembly of northern Thailand**
Majors or Masters:	Geology, Geoscience
Supervisor:	Annette George, annette.george@uwa.edu.au, 6488 1923
Description:	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 industry-sponsored 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. These topics are also suitable for 36 pt Master of Science projects with suitable prior learning.

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 important 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 or biotic crises/mass extinctions). Projects may include core to petrographic-scale description and interpretation to establish depositional and relative sea-level history (using sequence stratigraphy and related techniques) 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, chemostratigraphy 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:	**The role of calcimicrobes in reef complex construction**
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 Paleozoic terranes and paleo-environmental and paleoecological interpretation. Characterisation is mainly undertaken via 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:	**From catastrophic to beneficial – how an extra-terrestrial bolide impact created an oasis in Western Australia.**
Majors or Masters:	Energy Geoscience
Supervisor:	Daniel Peyrot, Daniel.peyrot@uwa.edu.au
Description:	The Meyer crater is a 800m-wide impact structure, located 5km East of Coolgardie in Western Australia. The crater results from the impact of an extra-terrestrial bolide likely to have crashed between the Miocene (23Ma) and the Pleistocene (11.7ka). The impact produced a depression of a few hundreds of metres of depth, which becomes the location of a lake allowing the development of a wetland. The associated vegetation was strikingly different from its surrounding semi-arid heathlands and eucalypt-dominated

	woodlands and produced a conspicuous biomass (leaves, fruits, wood fragments…) which accumulated as peat. The crater acted as shelter and isolated the vegetation from the harsher conditions characterizing the region and created an oasis-like habitat which lasted hundreds or thousands of years and resulted in the accumulation of c. 200m-thick peat. This micro-environment eventually vanished, and the deposits were covered by a layer of clays acting as protective seal. This project will analyse the palynological and paleobotanical content of the post-impact sedimentary succession in order to establish the age of the impact, and reconstruct the wetland vegetation having colonized the sheltered, small-scale, habitat.

Project:	**Consequences of the Pliocene?–Pleistocene Coolgardie asteroid impact on the vegetation of Western Australia**
Majors or Masters:	Geology, Geoscience, Energy Geoscience, Botany
Supervisor:	Daniel Peyrot, daniel.peyrot@uwa.edu.au, 6488 2672
Description:	The crater of Calgoordie (NW Kalgoorlie), resulted from the impact of a <200m-wide asteroid likely to have crashed between c. 5 Ma and 800ka on the gold-bearing, Archean, Yilgarn Craton. The impact produced a 600m-wide and <150m-deep conical structure, where peat including plant fragments accumulated. The project will analyse the palynological content of the post-impact sedimentary succession in order to i) confirm the age of the impact, and ii) reconstruct the evolution of the wetland vegetation having colonized the sheltered, small-scale, habitat.

Project:	**Characterization of the Middle Triassic vegetation of Western Australia from palynological analysis of the Onslow-1 well**
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Daniel Peyrot, daniel.peyrot@uwa.edu.au, 6488 2672
Description:	The Triassic Period is the time of maximum diversification of gymnosperms. While most of the information on the vegetation of Western Australia focuses on lowland and water-logged environments dominated by seed ferns and spore-producers, little is known about plant formations involving early conifers and colonising hinterland areas. The project will study the pollen produced by these plants and recovered from the well Onslow-1 (Northern Carnarvon Basin) in order to infer the composition, structure and temporal dynamic of the vegetation integrating them.

Project:	**The Late Triassic Ipswich flora from the Clarence-Moreton Basin (Queensland) and its relationship with the high-latitude vegetation from Antarctica and South Africa**
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Daniel Peyrot, daniel.peyrot@uwa.edu.au, 6488 2672

Description:	The Late Triassic vegetation from Gondwana has been delimited into two realms: the low- to mid-latitude flora of Onslow including conifers and other floral elements adapted to warm conditions and the high-latitude flora of Ipswich, which typifies a more mesic vegetation mainly distributed in Antarctica and South Africa. The project will focus on a palynofloral succession associated with coal-bearing strata and aims to better characterize the peat-forming plant communities of the region and their relationship with the changing climatic conditions of the interval.

Project:	**Early Cretaceous planktonic communities from marine shallow water environments of the Carnarvon Basin, Western Australia**
Majors or Masters:	Geology, Geoscience, Energy Geoscience
Supervisor:	Daniel Peyrot, daniel.peyrot@uwa.edu.au, 6488 2672
Description:	The Lower Cretaceous strata of the Northern Carnarvon Basin host several gas fields with a high economic importance. The stratigraphic distribution of most of the source rocks and reservoirs of the basin is mainly based on species of planktonic unicellular organisms called dinocysts. The project aims to describe new species of dinocysts with the aim to better constrain the spatial and temporal distributions of key intervals.

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 genetic link. Indeed, preliminary chemical data and petrographic observations indicate that gold-bearing fluids were directly derived from the plutonic-magmatic system. 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. 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. This project is expected to contribute to our general understanding of the genesis of orogenic gold deposits, worldwide. This study will mostly involve laboratory work (petrography, SEM, EMP).

Project:	**Geochronological and geochemical characterization of fayalite-bearing aplitic dykes intruding the Brixen Granodiorite (South Tyrol, Italy).**
Majors or Masters:	Honours
Supervisor:	Giulia Consuma, giulia.consuma@uwa.edu.au, Marco Fiorentini, marco.fiorentini@uwa.edu.au
Description:	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. 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. 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.

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:	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. 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.

Project:	**Assessment of geological uncertainty**
Majors including:	Hydrogeology, Geology, Physics, Engineering, Computer Science
Supervisor:	Guillaume Pirot, guillaume.pirot@uwa.edu.au , Jérémie Giraud
Description:	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. 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.

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:	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. This project will focus on the analysis of a collection of nearly 10,000 structural geological models from two areas in Australia. These models where 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. 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). 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 be suitable for students with an interest in 3D modelling and statistics. The scope is compatible with a 36 pt Master of Science project.

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:	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. 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.

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:	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.

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:	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. 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.

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, Geology
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.

Project:	**Oxygen isotope make-up of the Archean mantle**
Majors or Masters:	Geology, Geochemistry
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465 and Laure Martin
Description:	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. The modern mantle has an inferred bulk oxygen isotope composition ($\delta^{18}O$) of about 5.5‰. Hadean and Archaean magmatic zircons derived from sources in the upper mantle have $\delta^{18}O$ compositions in a similar range, implying that the oxygen isotopic composition of the upper mantle has remained relatively constant, and comparable to the modern mantle throughout Earth's history. Conversely, the composition of the deep mantle - inferred from $\delta^{18}O$ 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‰. 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, minero-chemical and isotopic study of fresh olivine grains from a selected range of 2.7 Ga Australian komatiites and 1.9 Ga Russian ferropicrites.

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
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465
Description:	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. 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. 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.

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
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465; Laure Martin
Description:	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. 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 restricted range of anomalous trace element data. The objectives of the Honours/Masters project are: 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. 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. 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.

Project:	**An investigation of the Coglia 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
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Kerim Sener (Panther Metals), and Nigel Brand (Portable Spectral Services)

Description:	In the Laverton region of Western Australia, the Coglia 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 Coglia 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. 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 de-carbonise 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.

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
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, Kerim Sener (Panther Metals), and Nigel Brand (Portable Spectral Services)
Description:	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. 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.

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
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Kerim Sener (Ariana Resources), and Nigel Brand (Portable Spectral Services)
Description:	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. 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 irregular polymictic horizon. A steeply plunging breccia-pipe style of mineralisation is developed beneath part of the Salinbas deposit, emanating from the Ardala porphyry. 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. 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.

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
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Kerim Sener (Ariana Resources), and Nigel Brand (Portable Spectral Services)
Description:	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. 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 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.

Project:	**The source of sulfur in the komatiite-hosted nickel-sulfide deposits of the Widgiemooltha Dome, Western Australia**
Majors or Masters:	Geology, Geochemistry
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Laure Martin (CMCA), Zoran Seat (Mincor Resources), and Nigel Brand (Portable Spectral Services)
Description:	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 Neoarchean komatiite-hosted Fe-Ni sulfide deposits at a time when the ocean were sulfur-poor. 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.

Project:	**Geochronological and geochemical constraints on the genesis of the Ni-REE mineralisation in the Stanmore Intrusion, Western Australia**
Majors or Masters:	Geology, Geochemistry
Supervisor:	Marco Fiorentini marco.fiorentini@uwa.edu.au, Alan Aitken, Laure Martin (CMCA) and Nigel Brand (Portable Spectral Services)
Description:	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. 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. 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.

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:	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. 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.

Project:	**Drivers of the Great Oxygenation Event**
Majors or Masters:	Geology, geochemistry, environmental and marine geoscience, mineral geoscience
Supervisor:	Matthew Dodd, matthew.dodd@uwa.edu.au
Description:	Atmospheric oxygen sustains all animal life on Earth in the form of O_2 and O_3 (ozone), yet for half of planet Earth's existence atmospheric oxygen was virtually absent. Oxygen only became a major atmospheric gas during a colossal release of O_2 some 2 billion years ago during the Great Oxygenation Event. What drove this rapid accumulation of atmospheric oxygen is hotly debated. Popular models invoke a huge spike in oceanic phosphate (a critical nutrient) levels which drove enhanced oxygenic photosynthesis. This project(s) would test this model using the concentration of phosphate in carbonate minerals as a proxy for ancient oceanic phosphate levels. The project will involve the geochemical and petrological analysis of carbonate rocks collected across the globe from Brazil, USA, Finland, Gabon, South Africa and WA, all of which span the Great Oxygenation Event. Sample analysis will involve the measurement of trace and major elements in carbonate rocks making use of spectrophotometry, and state-of-the-art Laser ablation and Inductively Coupled Plasma 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:	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. 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.

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 the 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 sediment logical deposit constitutes a cyclonic event and whether these types of deposits are able to preserved within in 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 sediment cores collected on the North West Shelf. The student will employ sedimentological and geochronologial methods to reconstruct paleoevironmental evolution of the NW Shelf during this late Pleistocene period.

Project:	**Interpreting Geophysical Datasets**
Majors or Masters:	Geology, Geoscience, Environmental Geoscience, Mineral Geoscience, Energy Geoscience
Supervisor:	Mike Dentith, Michael.dentith@uwa.edu.au, 6488 2676
Description:	Projects are available in numerous applications of geophysical data interpretation, especially involving the integration of geophysical, geochemical and petrophysical datasets. Subject areas include mineral exploration, petroleum exploration, agricultural geophysics and earthquake studies. Projects involving more quantitative studies are also available for students with appropriate computing and numerical skills. In 2023 there are particular opportunities in geophysical studies of basin-hosted mineral systems, detection of pegmatites using radiometric methods, radar based studies of recent sediments, aeromagnetic studies of the SW Yilgarn Craton.

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:	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.

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 glacials 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.

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:	**Evaluating heterogeneity in carbonate reservoirs and their controlling influences: seismic to pore-system studies**
Majors or Masters:	Geology, Geoscience, Energy Geoscience
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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
Supervisor:	Moyra Wilson, moyra.wilson@uwa.edu.au
Description:	Use low-cost technical surveys to evaluate likely environmental and anthropogenic controlling influences on links between trash and microplastic distributions with river-beach sediment characteristics. Initial systematic baseline studies of trash on Swan-Canning River beaches by the DBCA (Novak, in press) has shown potential links between trash types (urban versus commercial waste), river-beach settings (location and facing directions) and seasonal weather patterns. 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. This study will use replicate, seasonal field and lab studies with students designing low-cost microplastic and sediment collection and characterisation workflows. Survey methods of anthropogenic muck will follow CSIRO trash monitoring and AusMap – Australian Microplastic study methods. Characterisation of sediment will be via textural, chemical and microscope studies New technical results will be compared with trash collection patterns over the time period of implementation of the single use plastics ban as well as beach settings and weather patterns to better evaluate likely influencing factors. The outcomes of this study will be a better understanding of factors influencing spatial and temporal variability of trash, microplastic and

	sediment characteristics. The impacts of legislation around single use plastic bans will be monitored. The findings will be of importance for local councils and communities in developing mitigation strategies for cutting trash and plastic waste at source as well as for clean-up efforts ultimately leading to a cleaner and healthier RiverPark environment. This study would suit engineering, environmental, marine studies or earth science students who are aiming to enhance their understanding of global environmental issues, environmental change, anthropogenic influences and scientific study design and methodology. Up to three students can be accommodated in this project with the potential for individual students to focus on their main interests or strength areas. Full training can be given in techniques that may be new to project students. Experience and/or willingness to undertake fieldwork, labwork (particle size analysis, microscopy), project design and investigation with scientific rigour would all be advantageous.

Project:	**Coastal Particle Dynamics: the link between COASTAL Setting, Erosion, Accumulation and Infrastructure**
Majors or Masters:	Geoscience
Supervisor:	Moyra Wilson, moyra.wilson@uwa.edu.au
Description:	What are the environmental controls on coastal erosion, accumulation and particle dynamics on carbonate islands at the limits of tropical coral reef development? Can we better understand how coastal erosion and accumulation around Rottnest is linked to coastal setting, deposit characteristics, seascapes, oceanography, and coastal environments at the southernmost boundary of the tropical reefal realm. 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, 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 Rottnest. Additionally students will assess and potentially trial the efficacy of different infrastructure types in the varying coastal settings Rottnest's >70 bays and beaches show huge variability in size, shape, facing direction, beach slope angles, compositional and grain size variability. The surrounding rocky cliffs of Pleistocene deposits have variability in minerals composition and grain textures, whereas seascapes have distinctive abundancies of grain types linked to proximity to coral reefs, seagrass beds versus rocky wave cut platforms. Photographs (of landscapes and coastal infrastructure) and satellite images over annual to decadal timescales, also show significant local differences in: erosion of cliff and headland areas, sediment removal from beaches and dune blow-out development, versus

	sites of accumulation of beach sediment, accumulation of wrack (seagrass accumulations on beaches), as well as potential variability in trash and flotsam concentrations. This study will use replicate, seasonal field and lab studies with students designing low-cost sediment, rock and flotsam collection workflows around the coastal environments of Rottnest. Characterisation of sediment, rock and flotsam will be via textural, chemical and microscope studies. Landscape and seascape evolution will be from photographic, satellite and archival records, with a linked element of understanding coastal setting from field and imaging records. Particular attention will be given to the history of effectiveness of coastal and shallow marine infrastructure around Rottnest. All results will be compared with oceanographic and weather records to evaluate overall coastal landscape evolution and grain dynamics to better understand coastal environmental change and variability and impacts on infrastructure. The outcomes of this study will have importance in understanding influences on coastal sediment dynamics, landscape evolution, coastal erosion and infrastructure preservation or covering around coastal islands. Tourism and the associated infrastructures (paths, steps, accommodation, jetties) linked to the unique coastal environments and pristine beaches and seascapes of WA's coast has monetary values in the billions of dollars and is one of the key income streams for the state. Additionally this study allows insight into coastal deposits and dynamics at the transition from tropical to temperate marine environments associated with the world's most southerly coral reefs off Rottnest.

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:	**Refining the Mesoproterozoic Australian-Antarctic connection with new P-T-t constraints**
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Naomi Tucker naomi.tucker@uwa.edu.au
Description:	This project will investigate the *P-T-t* evolution of amphibolite-granulite facies rocks from spectacular WA coastal exposures near Bremer Bay and Hopetoun. Potentially multiple projects are available. The Albany-Fraser Orogen (AFO) crops out along the southern coast of WA. These coastal exposures preserve an intriguing record of very long-lived and thermally extreme metamorphism during the Mesoproterozoic. Metamorphism was occurring as the southern and western cratonic elements of Australo-Antarctica came together, as part of supercontinent Rodinia. The AFO is also unique for its seemingly rapid exhumation rate, which is an unusual feature, compared with other Mesoproterozoic orogens. Despite these remarkable characteristics, south-western parts of the AFO are understudied. Specifically, there is a lack of quantitative *P-T-t* constraints on peak metamorphism in this part of the AFO, prior to exhumation. These new data are needed to: (1) Provide robust *P-T-t* constraints across the full extent of the orogen; (2) Make inferences about the likely thermal drivers of metamorphism, and; (3) To contextualise exhumation and better understand how fast the orogen was cooling. Work will involve petrography and a combination of *P-T* modelling, geochronology (zircon, monazite) and/or mineral chemistry. Some familiarity with metamorphic petrography is essential. This project also has broader implications for our understanding of the subglacial geology of Antarctica. Metamorphic rocks from the AFO correlate with outcrops in Wilkes Land, East Antarctica. But much of East Antarctica is covered by ice and snow, so our understanding of what lies below is very limited. Using the coastal exposures from southwest WA as a proxy, this project will provide further insights into the hidden geology of Antarctica.

Project:	**Taking the temperature of a garnet-cordierite granulite from the Narryer Terrane**
Majors or Masters:	Geology, Geoscience, Geochemistry
Supervisor:	Naomi Tucker, naomi.tucker@uwa.edu.au, in collaboration with GSWA
Description:	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. That's a lot of firsts for the Narryer Terrane! As demonstrated by the Narryer Terrane, Archean cratons are integral to our understanding of the geological processes that occurred on early Earth; however, globally, the evolution of Archean cratons is actually quite poorly understood. This is because Archean rocks are often poorly preserved on Earth today, and that they are nearly always modified or overprinted by younger geological events. While some outcrops in the Narryer Terrane have been intensely studied (e.g. Jack Hills), we know comparatively little about most of the terrane. In particular, there is a lack of information about the lithological characteristics, spatial extent and P-T-t regime of rocks that formed during ultrahigh thermal gradient metamorphism (>150°C/kbar, ca. 2680-2660 Ma). This project aims to address this shortfall by investigating the *P-T-t* evolution of a newly sampled garnet-cordierite granulite from the central Narryer Terrane. The results from this project will add another crucial piece to the P-T-t dataset for this geologically significant region. Investigating the P-T-t evolution of a metamorphic rock is a powerful means to fingerprint different tectonic settings and thermal drivers of metamorphism. This project will involve petrography and a combination of P-T modelling, geochronology (zircon, monazite) and/or mineral chemistry. Some familiarity with metamorphic petrography is essential.

Project:	**How hot is the Narryer Terrane? Constraining the crustal heat production of Australia's oldest rocks**
Majors or Masters:	Geology, Geoscience, Geochemistry
Supervisor:	Naomi Tucker, naomi.tucker@uwa.edu.au, in collaboration with GSWA
Description:	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).

	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. 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 contributions to heat flow in the Narryer Terrane, and to evaluate the likely thermal drivers for Neoarchean ultrahigh thermal gradient metamorphism.

Project:	**Characterisation of proximal to distal alteration footprint of gold deposits**
Majors or Masters:	Geology, Geochemistry, Geoscience, Ore Deposit Geology
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.

Project:	**Yilgarn mapping projects in collaboration with the Geological Survey of Western Australia**
Majors or Masters:	Geology, Geoscience
Supervisor:	Nico Thébaud, nicolas.thebaud@uwa.edu.au, 6488 7139 Co-supervision with GSWA geologist (Dr R. Quentin de Gromard, Dr T. Ivanic)
Description:	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: • 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.

	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).

Project:	**Structural architecture of the Hamersley Iron Ore province and structural evaluation of structural controls of iron ore deposits**
Majors or Masters:	Geology, Geoscience
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 requires an understanding of the presence of faults and folds and their influence on groundwater flow. 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.

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:	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).

	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.

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

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, Mick Oleary@uwa.edu.au; Victorien Paumard, Victorien.Paumard@uwa.edu.au
Description:	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. 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.

Project	**The origin of the Paroo Station lead carbonate mine: hypogene/ supergene or supergene-only genesis?**
Majors or Masters:	Geology, Geochemistry, Mineral Geoscience, Ore Deposit Geology
Supervisor:	Steffen Hagemann, steffen.hagemann@uwa.edu.au, 6488 1517, and Carl Brauhart (CSA Global)
Description:	The unique Paroo Station lead carbonate mine near Wiluna (Western Australia) was discovered in 1991 by Renison Goldfields Corporation. From 2004 to 2015 this mine produced approximately 300,000 tonnes of lead metal in concentrate form (rosslynhillmining.com.au). Cerussite is the main Pb-carbonate ore mineral. It is hosted in 35 metre thick quartz-clay carbonate (including cerrusite), mineralised zones within siltstone. The 'accepted' stratabound, sulphide free supergene ore deposit model has been questioned by various researchers. Fluid inclusions are observed in cerrussite and this projects main objective is to investigate the physico-chemical parameters $P_{ressure}$-$T_{emperature}$-$X_{Composition}$ (P-T-X) of the hydrothermal fluids that were trapped during mineralization and reconstruct the paleohydrothermal system that caused Pb transport and precipitation. Ultimately, the fluid inclusion data will be used to evaluate whether there is a hypogene mineralization event. The carefully petrographically constrained fluid inclusions will be analysed using the in house fully automated Linkham heating-freezing stage and laser-Raman spectroscopy. The project is suitable for a 36 pt MSc thesis. Requires knowledge in geochemistry and successful completion of the SEM course early in 2020 (as advertised by the CMCA at UWA).

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, Mineral 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:	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. 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 geothermo-barometers, and iii) develop a hydrothermal alteration model for this most unusual copper-gold mineralization style. This study will involve a combination of field work (mapping and diamond core logging) and laboratory work (petrography, SEM, EMP).

Project:	**Critical minerals: tantalising tantalum**
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Tony Kemp tony.kemp@uwa.edu.au, 6488 7846
Description:	Most of the world's tantalum, a valuable metal that is essential for sophisticated micro-electronic circuitry, is extracted from rare metal pegmatites. Within pegmatites, tantalum mainly exists as the oxide mineral tantalite [$(Fe,Mn)Ta_2O_6$], however it can also occur as the more complex mineral microlite [$(Na,Ca)_2Ta_2O_6(O,OH,F)$] or as a constituent of the tin ore minerals cassiterite or wodginite. The controls on the spatial distribution of these Ta-bearing minerals in pegmatite ore-bodies are unknown, but have large implications for optimal mining and mineral processing strategies. For example, microlite is generally finer grained and more difficult to recover from the ore than tantalite, commonly being bound up with species such as micas, and showing reaction relationships with tantalite. This project is to identify and examine the distribution of tantalum-bearing species in the lithium-rich pegmatites of the Pilgangoora district in the Pilbara Craton. Study materials would include both conventional petrographic type samples from the pegmatites, as well as SEM related techniques applied to spatially constrained heavy mineral concentrates. A secondary aim is to use the microstructure and trace element chemistry of tantalite to unravel the crystallisation history of the pegmatites, and to explore whether tantalite

	chemistry can be linked to Ta-Li grade and/or the composition of co-existing Li-minerals.

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 lithiophillite (up to 10% Li_2O), 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.

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:	**Petrology and geochemistry of Proterozoic mafic granulites**
Majors or Masters:	Geology, Geochemistry, Geoscience
Supervisor:	Tony Kemp, tony.kemp@uwa.edu.au, 6488 7846
Description:	The south coast of Western Australia provides spectacular cliff exposures of a variety of high-grade, coarsely-crystalline metamorphic rocks formed in the deep crust. These comprise part of the Mesoproterozoic Albany-Fraser Orogen, which developed along the ancient continental margin of the Archean Yilgarn Craton. Conspicuous amongst these metamorphic exposures are mafic rocks, which in the field are highly variable in terms of texture, mineralogy and structural setting. The mineral assemblages, mineral chemistry and geochemistry of these rocks, and their relevance for understanding the tectonic setting and evolution of the Albany-Fraser Orogen, are poorly known. This project would involve field examination of outcrops, detailed petrography (optical microscope and electron microscopy), mineral chemistry by electron microprobe and laser ablation ICPMS, and whole rock major and trace element geochemistry of a range of mafic granulite samples. The aim would be to try to determine the conditions of metamorphism, and reconstruct the nature of the original protolith to these rocks (i.e., were they intrusive bodies, magmatic cumulates, fragments of upper mantle, etc.) to determine what these rocks tell us about the magmatic and geodynamic evolution of the Albany-Fraser Orogen.

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:	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. This project would be suitable for students with an interest in GIS, geological modelling, and data manipulation.