THE UNIVERSITY OF WESTERN AUSTRALIA

School of Earth Sciences

Potential research projects offered for Level 4 (Honours) and Level 5 (Masters) students commencing in 2018.

- Geology
- Geochemistry
- Geophysics
- Mineral Geoscience
- Petroleum Geoscience
- Hydrogeology
- Coral Reefs and Coastal Systems

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 24 pt research project as part of an Honours or Masters degree.

Two key points to note:

We encourage you to consider what geoscience research problems interest you and to choose a project topic that will motivate you to do your best work throughout the year. The aim of the 24 pt project is to provide an opportunity to learn how research works and to begin developing your research skills. The 24-pt project is a pathway to higher degree by research (MSc, MPhil, PhD).

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. Do not leave organising a project until the first teaching week of 2018 ! Remember that many of the staff take leave through January.

Geoscience is a broad discipline that includes Geology, Geophysics, Geochemistry, Geobiology and Computation/Numerical Modelling. The breadth of research activity in the School of Earth Sciences[1] means that students have opportunities to undertake diverse research projects. Research may be focused on resolving questions related to fundamental Earth processes and knowledge or have various levels of application to specific resources including mineral deposits, petroleum and groundwater.

You are welcome to contact staff directly (contact details are provided in the booklet) to discuss projects where they are listed as the main contact. 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. 36 pt projects). You are welcome to contact supervisors to discuss as required.

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1. New school name from 2017 resulting from demerger of the School of Earth & Environment

Project:	**The sulfate capacity of silicate liquids**
Majors including:	Geology
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465, Malcolm Roberts, Jason Bennett, Hugh O'Neill
Description:	Sulfur plays an important role in the distribution and concentration of many metals with economic and strategic importance. An understanding of how sulfur controls various mineralised systems allows for better theoretical models that can predict and target future orebodies. Our current understanding of how sulfur behaves in magmatic systems is based on empirical analyses of natural samples, as well as thermodynamic variables measured in controlled experiments. One of these thermodynamic variables is the sulfate capacity ($C_{SO_4^{2-}}$), which allows for the calculation of sulfur solubility. The sulfate capacity can be thought of as the equilibrium constant between SO_2 gas and SO_4^{2-} anions dissolved in a silicate liquid. This is important in understanding how much sulfur is available for the transport and deposition of metals in oxidised magmatic environments, and their associated hydrothermal systems. The aim of this project is to accurately and precisely measure the sulfur content in a series of 43 one-atmosphere gas furnace experiments. Each experiment contains 3-7 synthetic silicate liquid compositions equilibrated at 1200-1500°C with variable oxygen and sulfur fugacities. Analysis of these experiments will be via EPMA, with possible scope for SIMS work on samples close to or below the detection limit for EPMA. The sulfur contents of each glass will then be used to calculate the 'sulfate capacity' for each experiment, which will in turn allow for a thermodynamic model of sulfate capacity for any silicate magma of a given composition.

Project:	**Petrology and geochemistry of majorite-bearing peridotite as a source of Barberton-type komatiite volcanism**
Majors including:	Geology
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465, Laure Martin
Description:	Komatiites are ultrabasic magmas that formed through high degrees of partial melting of the mantle and therefore provide the most reliable information on bulk mantle compositions. Komatiites have been subdivided into two main groups: Barberton-type komatiites are Al-depleted and have trace element patterns that are undepleted in the most incompatible elements, whereas Munro-type komatiites are Al-undepleted and show incompatible-element-depleted trace element patterns. It is also notable that Barberton-type komatiites are generally depleted in platinum-group element (PGE) contents in relation to Munro-type komatiites. The compositional differences between Barberton- and Munro-type komatiites reflect the conditions under which the melts separated from

	their plume sources. Barberton-type komatiites formed by 30% batch melting of a mantle source enriched or slightly depleted in Ca–Al at a depth exceeding 300km, and are depleted in Al owing to majorite garnet retention in the source, whereas Munro-type komatiites formed by 50% fractional melting of a Ca–Al-depleted mantle source at a shallower depth. However, the genesis of komatiite magmatism is still highly debated as very few reliable mantle sources have been identified. The aim of this study is to determine the petrological and geochemical features of a series of majorite-bearing peridotites from the Otroy Complex in western Norway. These peridotites are thought to represent the mantle restite of Archean Barberton-type komatiite volcanism. Hence, through this study it will be possible to investigate further the genesis of komatiite volcanism and address the question whether majorite garnet plays a role in PGE fractionation and concentration during magmatic processes. This research will build on existing material that was collected during previous studies combining: • Petrology using optic and electronic microscopic methods. • Microprobe analysis (depending on results) • Laser Ablation ICPMS (depending on results) • Ion probe (depending on results) This project does not include a fieldwork component and requires a student interested in doing detailed analytical work. A successful outcome has the potential to result in a publication.

Project :	**CAMPing in the Ivrea Zone, Italy**
Majors including :	Geology
Supervisor :	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465, Greg Dering, Steve Denyszyn
Description :	The Ivrea Zone is a section of the lower continental crust exposed in the Southern Alps that has long served as a natural laboratory to examine igneous and metamorphic processes in the deep crust. Remarkable preservation and exposure of deep crustal rocks that formed in the Mesozoic and Palaeozoic was achieved by exhumation along a major lithospheric suture between the European and Adria plates, demarcated by a long-lived and complex fault zone, referred to as the Insubric Line. During exhumation this intact crustal section was tilted ~90°, effectively providing a rare cross-sectional view of the lower continental crust. Mantle-derived mafic and ultramafic intrusions have been the focus of many Ivrea Zone studies, yielding insight into fundamental igneous processes, which are thought to occur in many other terranes. Protracted late Paleozoic magmatism modified and weakened the continental crust via the accumulation and emplacement of mantle-derived magma, a process referred to as magmatic underplating. The most voluminous pulse of magmatic underplating occurred at ca. 288 Ma, resulting in a mafic pluton (the Mafic Complex). This was followed by a series of alkaline pipes that cross-cut the upper magmatic stratigraphy of the Mafic Complex and

	were locally emplaced within the lower continental crust between 275-249 Ma. Much less understood is Mesozoic magmatism in the Ivrea Zone. Recent geochronological results from ultramafic intrusions have yielded Triassic-Jurassic ages. This surprising result opens up the exciting possibility to study a heretofore unrecognised magmatic event in the Ivrea Zone. One possibility is that these intrusions are related to a far-reaching large igneous province, the Central Atlantic Magmatic Province (CAMP). CAMP-related rocks are recognised to extend as far as Brazil, Ghana, New York state, and Spain. The possibility of CAMP-related intrusions emplaced at the base of the continental crust in the Ivrea Zone of NW Italy, would significantly extend farther to the east the presently known footprint of this large igneous province. The target of the proposed study is a series of attenuated mafic and ultramafic bodies that have historically been thought of as a product of the Paleozoic magmatic underplating event. The largest body among these is the La Balma-Monte Capio intrusion (LBMC), which is made up of a layered sequence of dunites, peridotites, pyroxenites and gabbros that contain significant Ni-Cu-PGE sulfide mineralisation. Previous workers suggested that the LBMC intrusion formed by in-situ differentiation of a high-magnesium magma emplaced coevally with the Mafic Complex at ca. 288 Ma. However, the new geochronology and mapping motivates a reappraisal of the LBMC intrusion and related mafic-ultramafic bodies. The proposed study aims to build on recent petrological, isotopic and structural work and investigate the petrographic, geochemical and mineralogical make up of a series of samples collected ultramafic bodies from the Ivrea Zone, with the purpose to elucidate their spatial and genetic relationship with the other known magmatic events in the area.

Project :	**Oxygen isotope make-up of the Archean mantle**
Majors including :	Geology
Supervisor :	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465, 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 aims to understand whether the light oxygen isotope signature recorded is 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	**Gravity monitoring of Kings Park hydrology**
Majors including:	Geology, Geophysics, Hydrogeology, Computer Science
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au, 6488 7147
Description:	Gravity data can be used to monitor subsurface storage of water, and can help to understand impacts on ecological change. This project seeks to better understand the hydrology of King's Park through gravity monitoring (including field data collection) and modelling. This project suits those with an interest in environmental applications of geophysics. Some computing experience and reasonable maths ability are required.

Project:	**A methodology of large-scale 3D joint gravity & magnetic inversion**
Majors including:	Any geoscience related degree, physics, computer science
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au, 6488 7147
Description:	Geophysical inversion is a modelling process that generates a spatial property model (e.g. density) directly from geophysical data. Several projects are available to apply new technologies to gravity and magnetic inversion problems. Work will be completed making full use of Pawsey Centre supercomputer infrastructure and will involve testing new codes against existing approaches, assessing performance and helping to further develop the approach. This project suits those with an interest in geophysics. Software is designed to be used by non-specialists, however, some computing experience and reasonable maths ability are required.

Project:	**Antarctic Geology and East Antarctic Ice Sheet vulnerability**
Majors including:	Geology, Geophysics or related
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au, 6488 7147
Description:	The vulnerability of the East Antarctic Ice Sheet (EAIS) is the biggest uncertainty in projections of future sea-level rise driven by climate change. Recent studies show that it may be much more vulnerable to change than is commonly supposed (see http://theconversation.com/antarctic-glaciers-unstable-past-reveals-danger-of-future-melting-59589; http://www.nature.com/news/antarctic-model-raises-prospect-of-unstoppable-ice-collapse-1.19638). Geophysical datasets from the US-UK-AUS ICECAP program have revealed for the first time the geology of Wilkes Land in East Antarctica. Several projects are available that will utilise these new data to reconstruct and understand subglacial geology, including mapping key controls on EAIS flow organisation and evolution. These projects are best suited towards students with an academic focus at MSc level as the results are highly publishable if well executed. Some familiarity with geophysical methods and a willingness to understand cross-disciplinary concepts are essential.

Project:	**How the West was One…The Rodona-Totten Shear Zone**
Majors including:	Geology, Geophysics or related
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au; 6488 7147
Description:	The reconfiguration of Mesoproterozoic Australia occurred between ca. 1400 Ma and ca. 1300 Ma, through a complex series of plate margin processes. The culmination of this was the collision of the South and West Australian continents. Past and recent studies indicate that this collision may have occurred along the Rodona Shear Zone, which lies offshore east of Israelite Bay in WA. This project involves the use of high-resolution aeromagnetic and gravity data from Australia and Antarctica to understand shear-zone structure and kinematics. This new map of the shear zone will be tied in with new geochronological and isotopic data emerging from beneath the Eucla Basin, from the Albany Fraser Orogen, and from Antarctica.

Project:	**Petrological investigation of recent meteorite finds**
Majors including:	Geology, Geochemistry
Supervisor:	Tony Kemp, tony.kemp@uwa.edu.au, 6488 7846 Ray Pickard, Bathurst Observatory Research Facility
Description:	Meteorites are extremely rare objects that are of immense scientific value for understanding the early history of the solar system and the development of the rocky planets. Each year a number of meteorites are 'discovered' by avid (typically eccentric!) collectors scouring the Earth's surface. It is critically important to establish whether these are fragments related to known meteorite falls, or are indeed new to terrestrial science. In the first instance, this is done by determining meteorite type (stony, stony-iron or iron) followed by documentation of microstructure, chemical composition, degree of thermal metamorphism (for stony meteorites), intensity of shock metamorphism and the degree of weathering. Projects are available to examine recent meteorite finds, for characterisation and classification. Techniques to be employed include optical microscopy, secondary and backscattered electron microscopy, and electron probe microanalysis. Should a new find be indicated, the meteorite would be formally named and categorised. The results would be submitted for publication in the Bulletin of the International Meteoritic Society which maintains a comprehensive database on all meteorites found on Earth (see http://meteoriticalsociety.org). The projects would provide an opportunity for students to contribute to our knowledge of meteorites and the parent bodies from where they were ejected.

Project:	**High-Precision Uranium-Lead Geochronology applied to Igneous Processes and Tectonics**
Majors including:	Geology, Geochemistry
Supervisor:	Steve Denyszyn, steven.denyszyn@uwa.edu.au, 6488 7329
Description:	The use of thermal-ionisation mass spectrometry to determine the isotopic composition of uranium and lead in minerals such as zircon and baddeleyite can provide the most accurate and precise ages available for igneous events. This enables the determination of the timing, rate, and correlation of all sorts of geological processes, such as magma chamber development, ore-forming events, tectonic activity from the local to continental scales, or global biotic events such as mass extinctions. A variety of projects are available that will use this methodology, which involves careful laboratory practice, in combination with petrography and geochemistry to answer important questions in these fields using rocks already collected. Most currently available projects involve the study of mafic intrusive rocks (dykes and sills, often from Large Igneous Provinces) and the timing of their emplacement, with implications for ore-deposit genesis, and the reconstruction of past climate and plate motion. Projects to study granites and their mode of emplacement, and metamorphic rocks to determine the timing of formation and metamorphism.

Project:	**Geological mapping of Venus**
Majors including:	Geology
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 including:	Geology, Petroleum Geoscience
Supervisor:	Myra Keep, myra.keep@uwa.edu.au, 6488 7198 Julien Bourget
Description:	The northwest of WA hosts Australia's largest recorded earthquakes (ML 7.3, Meeberrie, 1941). Identification of modern surface offsets (fault scarps) and drainage capture, together with recently acquired earthquake focal mechanism data for 28 recent events, 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 structural orientations and fault reactivation in offshore areas in the Carnarvon and Browse basins with a view to understanding the pre-reactivation geometries and timing, and relating them to the modern tectonic setting. Two projects are available, and the scope is compatible for continuation to Masters level.

Project :	**General projects in seismic structural interpretation**
Majors including :	Geology, Petroleum 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 others. Please see Myra for details.

Project:	**Tectono-stratigraphy of the Roebuck Basin from 3D seismic data analysis**
Majors including:	Geology, Petroleum Geoscience
Supervisor:	Julien Bourget, julien.bourget@uwa.edu.au, 6488 2679 Myra Keep, myra.keep@uw.edu.au
Description:	The main objectives of this research are to understand the tectonic evolution of the Roebuck Basin on the North West Shelf of Australia. This basin has gained an increasing attention during the last decade due to successful oil and gas discoveries. However it has been far less studies than the other basins of the North West Shelf, and its structural and sedimentological evolution remain poorly understood. Thanks to the newly available, extensive seismic datasets donated to UWA by the industry, a number of projects can be accommodated and co-supervised by Myra Keep and Julien Bourget. Focus will be on 3D Seismic interpretation with additional well biostratigraphy and wireline log data. Aims will be to map the main seismic sequences of the Mesozoic and Cenozoic intervals, along with the main faults and structures that formed during multiple phases of rifting and inversion. Students will aim at reconstructing the tectonic evolution of the basin and investigate the links between tectonics and sedimentation (e.g., deposition of possible source, reservoir and seal rocks in the basin).

Project:	**Depositional history and petroleum reservoir characterisation, North West Shelf basins**
Majors including:	Geology, Petroleum Geoscience
Supervisor:	Annette George, annette.george@uwa.edu.au, 6488 1923
Description:	A wide variety of petroleum reservoirs are encountered in the offshore basins of the North West Shelf of Australia. Petroleum-focused projects can be undertaken in shallow or deep marine depositional systems to reconstruct depositional and tectonic history of specific basins or through specific stratigraphic units (notably reservoirs). These projects typically involve integration of core work (sedimentology, facies analysis ± petrography ± biostratigraphy) with seismic and/or wire line log data in a sequence-stratigraphic framework. There are specific projects focusing on seismic sequence-stratigraphic interpretation of basin-margin history and characterisation of reservoir intervals. These projects are also suitable for 36-42 pt Masters projects.

Project:	**Characterisation of siliciclastic- or carbonate-dominated reservoirs associated with conventional and unconventional resources in onshore WA Basins (e.g. Canning Basin, Perth Basin)**
Majors including:	Geology, Petroleum Geoscience
Supervisor:	Annette George, annette.george@uwa.edu.au, 6488 1923
Description:	Understanding reservoir quality is a fundamental aspect of petroleum system analysis. The onshore basins of WA have been the sites of earliest petroleum exploration in WA, and despite the dominance of the NWS as the major petroleum producer, the onshore basins have had some exciting oil discoveries in the last few years (e.g. Cliff Head, Perth Basin, and Ungani in the Canning Basin). Projects will focus on conventional and unconventional reservoir development using core to petrographic-scale description and interpretation to establish depositional setting/environments and major controls on reservoir quality (i.e. principally distribution of porosity and permeability). Some of these projects include Hylogger® analysis and portable XRF analysis of core to obtain geochemical data for characterising facies and diagenetic effects. Some projects could involve application of higher level microscopic techniques (scanning electron, cathode luminescence).

Project:	**Characterization of fluvial, lacustrine and deltaic depositional settings of the Mungaroo Formation (Northern Carnarvon Basin, NW Australia) by palynofacies analysis**
Majors including:	Geology
Supervisor:	Daniel Peyrot, daniel.peyrot@uwa.edu.au, 6488 2672
Description:	The Upper Triassic Mungaroo Formation represents a mega-deltaic system in the offshore Northern Carnarvon Basin (NW Australia) and hosts hydrocarbon reservoirs in world-class LNG projects. A detailed understanding of the architecture and stratigraphic framework of the formation is required to establish the most efficient well-to-well reservoir correlations. The project will focus on using palynofacies analysis of selected intervals deposited under a wide array of settings will help to understand the main factors controlling the deposition of organic sedimentary particles. This project has important implications for biostratigraphic correlation because many of the key microfossil markers used for correlation are facies-controlled.

Project:	**Taxonomic description of *Leptodinium* FM *sensu* Backhouse and its biostratigraphic significance for the Lower Cretaceous dinoflagellate cyst succession of Western Australia**
Majors including:	Geology

Supervisor:	Daniel Peyrot, daniel.peyrot@uwa.edu.au, 6488 2672
Description:	Dinoflagellate cysts are important biostratigraphic markers to date and correlate Berriasian-Valanginian (Lower Cretaceous) hydrocarbon-bearing strata from the North-West Shelf of Australia. Among other numerous informal taxa defined by consultants, *Leptodinium* FM *sensu* Backhouse has been widely used to refine the regional stratigraphy but has never been formally described. The project will focus on the morphologic characterization and taxonomic formalization of this taxon and its significance to improve the biostratigraphic framework of Western Australia.

Project:	**Landscape evolution: impacts on coral reefs and seascapes**
Majors including:	Geology
Supervisor:	Moyra Wilson moyra.wilson@uwa.edu.au
Description:	Sediment-, nutrient- and freshwater-influx are widely considered deleterious to coral reefs and carbonate development. Yet in the global reefal biodiversity hotspot of Australasia such impacts are common on modern and Cenozoic reefs, but remain poorly understood. Two separate projects are available to evaluate impacts of terrestrial weathering and runoff, together with oceanographic processes on carbonate production and reefal development. Systems studied will be either a narrow fringing reef system, or reefs on a broader clastic-dominated shelf, both adjacent to weathering tropical landmass. An integrated approach will utilise sediment and facies analysis, environmental analysis, experimental weathering studies, with the potential to involve petrology, scanning electron microscopy and geochemistry. This highly publishable research has implications for better understanding the: thresholds for reefal development, future survival of reefs under increased anthropogenic-induced runoff, and dynamic interactions between clastic and carbonate systems. The scope of each project can be extended to Masters.

Project:	**Evaluating heterogeneity in carbonate reservoirs and their controlling influences**
Majors including:	Geology
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 poroperm characteristics remain notoriously fickle and difficult to predict. Unlike clastic reservoirs, carbonates ones 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:	**Environmental change during periods of global climatic shifts**
Majors including:	Geology
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:	**Response of Western Australia's coastline to non-tidal sea level variations**
For majors including:	Geophysics, Marine Science
Supervisors:	Jeff Hansen jeff.hansen@uwa.edu.au, 6488 3724, Ryan Lowe
Description:	The coastline of Western Australia (WA) is unique in that it features a poleward flowing warm water current, the Leeuwin Current (typically warm water currents occur on the eastern side of continents). The strength of the Leeuwin Current fluctuates seasonally and this fluctuation results in increases and decreases in the sea level along WA that can reach +/- 0.25 m and last for several weeks. These non-tidal sea level variations can be as large as the tide in many parts of Southwest WA. Analysis of seven years of shoreline positions collected at Garden Island, SW of Perth indicate that the shoreline responds more strongly to these non-tidal sea level variations than to seasonal variations in wave height (which typically drive seasonal shoreline changes). The aim of this project is to extend these results to a number of other beaches in WA and compare the shoreline response due to non-tidal sea level fluctuations between reef-fringed and sandy beaches. Shorelines will be extracted from high-resolution aerial photos taken approximately bi-monthly and available from 2009 onwards.

Project:	**Do "representative" coastal sites exists?**
For majors including:	Geophysics, Marine Science
Supervisors:	Jeff Hansen jeff.hansen@uwa.edu.au, 6488 3724, Ryan Lowe
Description:	In order to mitigate the coastal hazards associated with climate change, including rising sea levels and potentially increasing storm intensity, we first need to understand how the present day beach responds to storms and seasonal variations in wave energy. Typically, coastal response is measured using a variety of intensive field or remote sensing techniques. However, it is not feasible to measure large swaths of coast without considerable cost and effort, and it may indeed be unnecessary. The objective of this project is to investigate the idea of a "representative" coastal site. A number of researchers have suggested that in many locations beaches along stretches of coastline extending 10s of km or more respond in a similar manner to storms and seasonal variations in wave energy. Thus, detailed observation may only need to be collected at a single site, with these observations being representative of the coastal response some distance away. The project will test this hypothesis by quantifying beach changes from a number of storm events along the WA coastline at different locations using exiting high-resolution aerial photography.

Project:	**Decadal scale variability of Perth's beaches**
For majors including:	Geophysics, Marine Science
Supervisors:	Jeff Hansen jeff.hansen@uwa.edu.au, 6488 3724, Ryan Lowe
Description:	A 60-year record of shoreline position has been compiled for much of the Perth metropolitan coast and provides an opportunity to examine the inter-annual and decal variability of Perth's coastline. For example, recent research has shown that portions of Perth's coastline erode more during La Nina events, which occur every few years, as a result of higher water levels. The project will extend these results by examining the shoreline response at a number of coastal sites and correlate the response to a number of climate indices, some of which vary on the decadal timescale. As most climate events can be reasonably well forecasted (e.g. El Nino/La Nina conditions can usually be predicted months in advance) any links between shoreline position and various climate indices can be used to predict the likely state of the shoreline (i.e. more or less eroded than average), thus providing useful information for local coastal managers.

Project:	**Investigating coral sensitivity to climate change via geochemistry**
Majors including:	Geology, Geochemistry
Supervisor:	Aleksey Sadekov, aleksey.sadekov@uwa.edu.au, 6488 4384, Malcolm McCulloch; Thomas DeCarlo
Description:	Anthropogenic emissions of CO_2 pose severe threats to the oceans and their inhabitants. Future high concentrations of carbon dioxide in the atmosphere are projected to increase global temperatures up to 1-4°C by the end of this century and lead to acidification of shallow marine realms. Marine calcifiers, such as corals, are among the most sensitive marine organisms to these changes. This project will address the question how corals are affected by increased temperatures and acidification of seawater. The student will study geochemistry of coral skeletons collected in the field and cultured in the laboratory to understand their growth mechanisms. The student must have a strong background in geochemistry and will also benefit from some knowledge in marine geology or marine biology.

Project:	**Use of foraminifera geochemistry for monitoring anthropogenic pollution of seagrass meadows**
Majors including:	Geology, Geochemistry
Supervisor:	Aleksey Sadekov, aleksey.sadekov@uwa.edu.au, 6488 4384, Malcolm McCulloch
Description:	Seagrass meadows are one of the most productive ecosystems in the world and are present along coastlines of almost every continent. Urbanisation of marine coastlines over the last century poses significant challenges in sustaining these unique ecosystems. Reduction in water quality due to agricultural and urban runoff is one of the major factors contributing to seagrass decline around the world. The project is aimed at developing novel approaches in monitoring water quality around the meadows by studying the geochemistry of foraminifera, which are abundant in seagrass meadows. The student will collect and study foraminifera shells along Rockingham coast (one of the most polluted areas of WA coast) to understand how geochemical signatures of these shells correspond to human pollution by heavy and toxic metals. The student must have a strong background in geochemistry and will also benefit from some knowledge in marine geology or marine biology.

Project:	**Tracing variability of the Leeuwin Current through the last glacial to interglacial climate transition.**
Majors including:	Geology, Geochemistry
Supervisor:	Aleksey Sadekov, aleksey.sadekov@uwa.edu.au, 6488 4384, Julie Trotter
Description:	The Leeuwin Current flows along the WA coastline starting from tropical region in the north, extending south into the Great Australian Bight. Its variability is linked with major climate systems, such as ENSO and the Asian monsoon, and it plays a crucial role in climate and rainfall patterns around Australia. This variability, observed from instrumental data that covers only the last few decades, is poorly understood. This project is

	focused on reconstructing changes in the Leeuwin Current over the last 30 kyr using the geochemistry of planktonic foraminifera. The student will use deep-sea sediments from cores collected along the NW Australian margin to reconstruct changes in circulation during the last glacial to interglacial climate transition. The student must have a strong background in geochemistry and will also benefit from some knowledge in marine geology or paleoceanography.

Project:	**Tracing environmental change recorded by deepwater corals from the Red Sea.**
Majors including:	Geology, Geochemistry
Supervisor:	Aleksey Sadekov, aleksey.sadekov@uwa.edu.au, 6488 4384, Julie Trotter
Description:	Deepwater (azooxanthellate) corals inhabit a wide range of depths, from hundreds to thousands of metres, throughout the ocean basins. They are very slow growing and long-lived, and their skeletons can be excellent archives of ambient seawater conditions. A suite of live-caught and fossil deepwater corals collected from the Red Sea (~500 to ~1000m) will be the basis for the student project, with the aim to reconstruct environmental records from coral skeletons using geochemical proxies. The Red Sea is a region with some of the warmest, most saline, and oligotrophic conditions on the planet, characterised by high temperatures sustained year-round. The student must have a strong background in geochemistry and will also benefit from some knowledge in paleoceanography or marine biology.

Project:	**Linking biomineralisation of marine calcifiers with microscale geochemistry of their mineralised skeletons**
Majors including:	Geology, Geochemistry
Supervisor:	Aleksey Sadekov, aleksey.sadekov@uwa.edu.au, 6488 4384, Malcolm McCulloch, Matt Kilburn
Description:	Shell geochemistry of marine calcifiers (e.g. coral, mussels, foraminifera) are often used as proxy for reconstructing past environmental conditions or impact of human pollution. However, biomineralisation of these calcifiers is not well understood and therefore limits the applicability of these proxies. This project aims to link high-resolution microscopy with nano-scale geochemistry to understand how different biological processes affect the shell geochemistry of marine calcifiers. Student will study biomineralisation processes in foraminifera at the IORMC culturing facilities and use CMCA facilities to map distribution of different trace metals in the cultured shells. Student must have a strong background in geochemistry and will also benefit from some knowledge in marine biology.

Project:	**Recharge responses to a drying climate and land use change**
For majors including:	Hydrogeology
Supervisors:	Sarah Bourke (sarah.bourke@uwa.edu.au), Department of Water and Environmental Regulation
Description:	An understanding of groundwater recharge is critical for sustainable management of groundwater resources. Climate change and land use changes both have the potential to substantially alter groundwater recharge. This project will use existing data to evaluate rainfall recharge through the unsaturated zone on Gnangara Mound. An extensive data set exists from a research station established by CSIRO in 2011 through the federal research program Terrestrial Ecosystem Research Network (TERN). Measured data includes groundwater levels from nested piezometers, soil moisture and weather data and an OzFlux tower. Additional data collection during this project may be possible, and could include measurement of unsaturated zone hydrochemistry and plant water use.

Project :	**Hydrogeologic modelling in a changing climate, and an uncertain world**
Majors including :	Hydrogeology
Supervisor :	Adam Siade (adam.siade@uwa.edu.au), Jon-Philippe Pigois (Department of Water and Environmental Regulation, DWER)
	The primary 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. These factors are defined using expert knowledge, climate model results, etc., and can also be indirectly estimated using relatively sparse data observed in the field. However, potentially significant errors may persist, which often results in a significant degree of uncertainty associated with future predictions. 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 environmental will respond to future anthropogenic influences such as groundwater pumping. Furthermore, reducing this uncertainty can dramatically improve our ability to develop low-risk 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, which is the primary management tool for groundwater in the Gnangara area, and extends from Cervantes to south of Mandurah, WA. Students should have some experience with linear algebra and statistics before starting this project.

Project :	**Regional groundwater resource management and allocation planning**
Majors including :	Hydrogeology
Supervisor :	Adam Siade adam.siade@uwa.edu.au , Jon-Philippe Pigois (Department of Water and Environmental Regulation, DWER)
Description :	As climate changes, many populated regions of the world, including Perth, will experience decreases in rainfall, which is essential for recharging groundwater systems. This reduction in available groundwater resources results in a need for more precise, quantitative methods for managing groundwater, especially when population and industry are expected to increase. Groundwater managers and decision-makers must make important decisions in order to create the best balance between (i) providing secure sources of fresh water to all of our taps, and (ii) maintaining the health of groundwater-dependent ecosystems. This study focuses on the methods, and groundwater modeling techniques, used to develop practical management solutions that achieve both of these goals. Topics may include managed aquifer recharge, allocation planning, multi-objective management solutions, and the improved development of important performance criteria including, seawater intrusion controls, water quality evolution, water distribution networks, land-use adaptation, etc. With the appropriate controls, and the aid of sophisticated solution procedures, we can improve the security of Perth's water resources for generations to come. Students will gain experience working with the Perth Regional Aquifer Management (PRAMS) modeling framework, which is the primary management tool for groundwater in the Gnangara area, and extends from Cervantes to south of Mandurah, WA. Students should have some experience with linear algebra before starting this project.

Project :	**Hyporheic and parafluvial exchange in ephemeral streams**
Majors including :	Hydrogeology
Supervisor :	Sarah Bourke sarah.bourke@uwa.edu.au , Rio Tinto Iron Ore
	Hyporheic and parafluvial flow paths (water flow in the subsurface, beneath and adjacent to streams) are important determinants of nutrient distributions in streams. As yet there are very few studies quantifying these processes in ephemeral streams. This project will involve data collection in the Pilbara, WA to assess the spatial scale and magnitude of these fluxes, with particular focus on how they change during and after flow events in ephemeral streams. Data collection will include environmental tracers (222Rn), nutrient conceitrations and water levels within the stream and alluvial aquifer. The interpretation of these data may be done in a numerical modelling framework. This project is part of a borader ARC Linkage project on the ecohydrology of ephemeral streams. The outcomes of this project will help improve our understanding of water fluxes nutrient cycling in semi-arid environments and ephemeral streams.

Project :	**Hydrogeochemistry of the Fortescue Marsh**
Majors including :	Hydrogeology, Geoscience
Supervisor :	Sarah Bourke (sarah.bourke@uwa.edu.au), Greg Skrzypek (UWA), Shawan Dogramaci (Rio Tinto)
Description :	The Fortescue Marsh is an ephemeral wetland system in the Pilbara (NW Australia) that can cover an area of 1000 km^2 when inundated. As part of a collaborative research project between UWA and Rio Tinto Iron Ore, hundreds of metres of continuous core were collected along two transects across the Fortescue Marsh The project will focus on measuring hydrogeochemical profiles within a sub-set of these cores that have been sealed in liners and stored in a cool room. The student will log the core and conduct laboratory analysis of multiple parameters, including, but not limited to, moisture content, stable isotopic composition of water and major ion composition. These data will be interpreted to delineate hydrogeochemical processes operating within the Fortescue Basin.

Project :	**Arsenic mobilisation during reductive dissolution of Fe-oxides**
Majors including :	Hydrogeology
Supervisor :	Henning Prommer (CSIRO/UWA, henning.prommer@csiro.au)
	Currently, more than 100 million people in S/SE Asia are exposed to arsenic contaminated groundwater above the WHO drinking water limit of 10 µg L^{-1}. Arsenic occurs naturally in sediments, particularly in low-lying flood plain type environments with most of the noteworthy occurrences in parts of Argentina, Bangladesh, Chile, China, Hungary, India, Mexico, Romania, Taiwan, and Vietnam. Understanding the coupled geochemical and hydrological processes that control arsenic mobility is vital for minimizing health impacts through the development of suitable mitigation strategies. Many of the major field studies that were performed over the last decade suggest that the reductive dissolution of Fe-oxy(hydr)oxides by labile organic carbon sources is the primary process to cause arsenic mobilisation. To test this hypothesis a small number of dedicated field experiments have investigated the geochemical response to the dedicated injection of degradable organic substrates such as lactate or sucrose. This project will review and compare previous experiments and select one of the data sets to guide the development of a numerical model of the flow, solute and geochemical processes.

Project :	**Heat transport during aquifer storage and recovery**
Majors including :	Hydrogeology
Supervisor :	Henning Prommer CSIRO/UWA, henning.prommer@csiro.au
Description :	Aquifer storage and recovery (ASR) is an important and increasingly used option for water management in water-scarce regions, during which surplus water is injected into a target aquifer for storage and later recovery. In this project numerical modelling of solutes and heat transport will be performed to analyse the data from a three-year long ASR experiment in the Leederville aquifer. The project will specifically explore how temperature data obtained through time-lapse temperature logging can be used to better define aquifer heterogeneity and how using temperature data will improve the robustness of a high-resolution model of the ASR experiment.

Project :	**Modelling impacts of wastewater infiltration**
Majors including :	Hydrogeology
Supervisor :	Henning Prommer CSIRO/UWA, henning.prommer@csiro.au
Description :	Infiltration of (treated) wastewater is a common practise at many places in Western Australia and elsewhere. Due to changes in the wastewater treatment process and other factors the composition of the infiltrated water has distinct characteristics for specific periods. This project aims at (i) analysing and identifying historic wastewater characteristics and (ii) a model-based investigation if these characteristics can be used as event markers to define residence times and travel distances within wastewater plumes.

Project :	**Model-based analysis of an uranium in situ leach field experiment**
Majors including :	Hydrogeology
Supervisor :	Henning Prommer CSIRO/UWA, henning.prommer@csiro.au
Description :	In situ leaching is an important technique to recover minerals from ore body. It relies on a detailed understanding of the complex transport and reaction mechanisms that influence its efficiency. A comprehensive uranium in situ leach experiment was conducted in 1985 near Manyingee/WA. A 5-spot test well configuration was set up and a leach solution containing NaOCl, CO2 and O2 was injected through the central well to leach uranium from the ore body and to recover it through the 4 extraction wells surrounding the central well. The objective of this thesis project is to integrate and analyse the data set collected during this experiment and use reactive transport modelling to identify the hydrogeological and mineralogical controls on uranium transport and on overall recovery.

Project :	**Modelling the fate of 14C to improve conceptualisation and parameterisation of groundwater flow in the Cowaramup groundwater subarea**
Majors including :	Hydrogeology
Supervisor :	Henning Prommer CSIRO/UWA, henning.prommer@csiro.au and David Schafer (Department of Water and Environmental Regulation, DWER)
Description :	Previous groundwater investigations in the Cowaramup groundwater subarea involved the installation of groundwater monitoring bores to develop an understanding of the hydrogeology and groundwater resources of the area. A number of complementary studies on groundwater age dating and hydrochemistry were also undertaken and a

	numerical groundwater model was constructed and calibrated. This student project aims to incorporate the transport of 14C and CFCs into the model simulations and compare the results with measured environmental tracer concentrations in order to evaluate the current conceptual hydrogeological model, including recharge rates and groundwater residence times.

Project:	**New approaches to 3D geological modelling- Case study of the Ashburton Basin, Western Australia**
Majors including:	Geology Geophysics, Physics, Engineering, Computer Science
Supervisor:	Mark Jessell, mark.jessell@uwa.edu.au, 6488 5803, Mark Lindsay
Description:	This project will compare two approaches to building 3D geological models of deformed terrains. The aim of the project is to characterise the outcomes of traditional 3D modelling approaches with a new system that extracts the necessary input data directly from digital maps and databases. The test area will be the Ashburton Basin, an arcuate belt of Paleoproterozoic sedimentary and volcanic rocks which forms the northern margin of the Capricorn Orogen, a major orogenic zone between the Pilbara and Yilgarn Cratons. This project would be suitable for students with an interest in 3D geological modelling and GIS. Programming experience would be a benefit, but is not essential.

Project:	**Topological uncertainty in 3D geology**
Majors including:	Geology Geophysics, Physics, Engineering, Computer Science
Supervisor:	Mark Jessell, mark.jessell@uwa.edu.au, 6488 5803, Mark Lindsay
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:	**Web mapping solutions for pre-competitive geoscientific data distribution**
Majors including:	Computer Science, Environmental Science/GIS
Supervisor:	David Glance, Mark Jessell , mark.jessell@uwa.edu.au , 6488 5803,
Description:	Web mapping applications are now a standard tool for delivering, sharing, analysing, or distributing spatial data worldwide. During the WAXI (West African Exploration Initiative) project a web-mapping tool called "waxiexplorer" was developed. This tool was also used for an open-access system called the IM4DC Open Data accessible at http://opendata.im4dc.org. Both of these web applications enable users to visualize and download any spatially enabled data that were gathered through the life of the particular project. These applications build on open-source web mapping solutions such as Geoserver and PostgreSQL with the PostGIS extension as well a number of JavaScript libraries like ExtJS, OpenLayers, GeoExt, and GXP. The proposed project will aim to upgrade the current platform with new functionalities and improving the platform efficiency and architecture mainly using newly developed tools available in the open source community. The potential students will gain knowledge of open source web mapping solutions and their application to the distribution of geoscientific data. This project would be suitable for students with an interest in web mapping, database applications and open-source software. Programming experience in JavaScript, HTML, is required (experience with Python would be a benefit).

Project:	**Gyrocopter based imaging of the regolith**
Majors including:	Geology, Geophysics, Physics, Engineering, Computer Science
Supervisor:	Mark Jessell, mark.jessell@uwa.edu.au , 6488 5803, Laurent Ameglio (GyroLAG Pty Ltd)
Description:	Gyrocopter platforms provide an opportunity to bridge the spatial divide between traditional airborne geophysical surveys and ground based systems. SWIR, LIDAR, Radiometric sensors attached to gyrocopters allow low elevation (10m) flying over large distances (a range of 400 km between refuelling). In collaboration with GyroLAG Pty Ltd, this project will acquire high resolution geophysical data as inputs to semi-automated analysis of regolith for a test region in Western Australia. This project will suit a student who is keen to be involved in both the acquisition and the data analysis phases of the project, with the aim of testing this new technology and its application to regolith characterisation.

Project:	**Geophysical Expression of REE-Bearing Carbonatites and Peralkaline Igneous Complexes**
For majors including:	Suitable for Hons (4th year) or M.Sc (5th year) research project. Geoscience degree including EART3353 Geological Mapping and GEOS4411 Mineralising Systems (UWA graduates)
Supervisor:	Mike Dentith, michael.dentith@uwa.edu.au, Tony Kemp
Description:	Peralkaline igneous rocks and carbonatites are important sources of REE. The geophysical expression of the igneous complexes where these rocks mostly occur are very easy to recognise, especially in potential field and radiometric datasets. The 'intra-complex' controls on geophysical complexes are much less well understood. The first phase of this project is a literature review to compile density and magnetism and K-Th-U content data for these unusual rock types. This will form the basis for analysing the geophysical responses of various igneous complexes from Africa, Greenland, Canada and, Brazil. Significant questions to be considered include: (i) which alkaline rock types have distinctive geophysical expressions, (ii) can the diverse magnetic responses be grouped and better understood geologically, (iii) is it possible to map fenitisation and other kinds of alteration using geophysical datasets.

Project:	**Interpreting Magnetic Data from Sedimentary Basins: Recognising Responses from Evaporites**
For majors including:	Suitable for Hons (4th year) or M.Sc (5th year) research project. Geoscience degree including EART3353 Geological Mapping, EART 3344 Basin Analysis and GEOS4412 Petroleum Systems (UWA graduates)
Supervisor:	Mike Dentith, michael.dentith@uwa.edu.au ; 6488 2676, Annette George
Description :	Recently compiled aeromagnetic data from the Canning Basin show responses which, based on their geometry, are possibly related to salt diapirs. Although rarely reported, the 'textbook' magnetic response of salt is a negative anomaly, however these responses are mostly positive anomalies. Core from two drillholes from the study area is available on which to make magnetic property measurements. Seismic data is also available. The research project comprises an integrated interpretation of the available data, including qualitative and quantitative interpretation of the magnetic data leading to an understanding of how salt appears in aeromagnetic data.

Project:	**Radiometric Responses of Mineral Deposits: Are Alteration-Zone Responses Actually Due to Changes in Geochemistry?**
For majors including:	Suitable for Hons (4th year) or M.Sc (5th year) research project. Geoscience degree including EART3353 Geological Mapping and GEOS4411 Mineralising Systems (UWA graduates)
Supervisor:	Mike Dentith, michael.dentith@uwa.edu.au ; 6488 2676
Description:	Several common types of mineral deposits are associated with alteration haloes where the concentration of the three radioelements (K, U, Th) is known to vary. Examples include VMS, epithermal precious metal and porphyry-style deposits. Some important kinds of host rocks for diamonds and REE are also anomalous with respect to radioelement content, notably carbonatites and kimberlites. An initial assessment of the extensive database of geochemical data suggests that measured changes in radioelement concentrations are often too small to be detected by radiometric surveys. Further data needs to be compiled and modelling of radiometric responses undertaken to investigate whether, for example, responses are being significantly affected by supergene enrichment, density variations or topography. There is no significant database of the radiometric responses from alteration haloes or mineralisation. A literature search is needed to address this problem, with the dimensions of these anomalies compared with common survey configurations, allowing for the effects of 'system footprints', to determine the probability of detection of these responses during reconnaissance exploration. This project is laboratory based and involves data compilation and geophysical data interpetation in a geological context.

Project:	**Geophysical Mapping of Mineral System Components of Carbonate Hosted Sedimentary Basin Mineral Systems**
For majors including:	Suitable for Hons (4th year) or M.Sc (5th year) research project. Geoscience degree including EART3353 Geological Mapping and GEOS4411 Mineralising Systems, EART 3344 Basin Analysis and GEOS4412 Petroleum Systems (UWA graduates)
Supervisor:	Mike Dentith, michael.dentith@uwa.edu.au; 6488 2676
Description:	The carbonate-hosted base metals is a subset of the sedimentary basin-hosted mineral system and includes the Mississippi Valley type (MVT) and Irish-style deposits. Key components of this system include 'basement highs' (where the basin is locally thinner and metal-bearing fluids are directed towards the surface), evaporite deposits (the ?source of the sulphur for the base metal minerals) and possibly also dolomitisation fronts (a spatial association with deposits of disputed genetic significance). The proposed project will use newly released gravity and magnetic data from one or more of the Canning Basin (Western Australia), the Irish Midlands Basin (Eire) and the mid-continental basin (USA) to study the

	geophysical response of various carbonate-hosted mineral system components at a basin-scale. Also, at the area scale, dolomitisation fronts are, in principle, detectable/mappable with geophysical methods. The petrophysical consequences of dolomitisation have been intensely studied by the petroleum industry and the opportunity exists to transfer these results/ideas to a mineral system context and potential develop entirely new area-scale exploration criteria for carbonate-hosted mineral systems. The proposed project will use entirely public domain datasets but collaboration with interested exploration companies and geological surveys is very likely.

Project:	**Hydrothermal alteration mineralogy and zonation in shallow surface Zn-Pb-Ag-V mineralization at the Wolf prospect, Pilbara**
Majors including:	Geology, Mineralogy, Geochemistry
Supervisor:	Steffen Hagemann and Leigh Bettenay contact via phone: 6488-1517 or email: steffen.hagemann@uwa.edu.au
Description:	This project will constraint the mineralogy and zonation in the highly unusual Zn-Pb-Ag-V style mineralization at the Prairie and Wolf prospects. Field work will include the careful documentation of mineralization and alteration in diamond core and mapping of the lithostratigraphy and structures across some selected traverses through the mineralized areas. Laboratory work will emphasise petrography, mineral chemistry (via SEM and EMP), and fluid inclusion as well as *in situ* laser ICP-MS on selected sulphides and silicates including the unusual Zn-chlorite baileychlore. Whole rock major oxide elements, trace elements and REE analyses will be conducted on selected hydrothermally altered samples. The outcomes of this project will be a descriptive hydrothermal alteration model with constraints on the P and T of the mineralising system as well as a set of pathfinder minerals and elements. The project is suitable for a 36 pts MSc thesis and Honours thesis. Prerequisites are good mineralogy and geochemistry background and successful completion of the SEM course early in 2018 (as advertised by CMCA).

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 including:	Geology
Supervisor:	Steffen Hagemann: contact via phone: 6488-1517 or email: steffen.hagemann@uwa.edu.au
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 suitable for a 36 pts MSc thesis and Honours thesis. Prerequisites are good mineralogy and geochemistry background and successful completion of the SEM course early in 2018 (as advertised by CMCA).

Project:	**Fluid chemistry of the Karouni gold deposit, Guyana, South America**
Majors including:	Geology, Geochemistry
Supervisor:	Steffen Hageman only via email: steffen.hagemann@uwa.edu.au
Description:	The Karouni orogenic gold deposit is Troy Resources new flagship gold deposit with production starting in 2015. 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. The results will be used to constrain the physico-chemical parameters (P-T-X) of the paleohydrothermal system that is responsible for the gold mineralization. A P-T-t curve will also be constructed that will illustrate the evolution of the hydrothermal fluids within the evolution of the structural-metamorphic-magmatic and hydrothermal alteration and mineralization system. The project is suitable for a 36 pts MSc thesis and Honours thesis. Prerequisites are good mineralogy and geochemistry background and successful completion of the SEM course early in 2018 (as advertised by CMCA).

Project:	**Fluid chemistry of the Sertão and Cascavel orogenic gold deposits, Goiás, Brazil**
Majors including:	Geology, Geochemistry
Supervisor:	Steffen Hageman only via email: steffen.hagemann@uwa.edu.au
Description:	The Sertão and Cascavel orogenic gold deposits are located in an Archean/Paleoproterozoic greenstone belt in Goiás, Brazil. The Cascavel deposit will start production end of 2016 and it will be the only gold mine starting production in Brazil in the past three years. The project involves detailed petrography of gold-quartz-carbonate veins, cathodoluminescence of quartz crystals and identification of suitable fluid inclusion assemblages in

	both deposits. The fluid inclusions will be analysed using the fully automated Linkham heating-freezing stage at CET. The results will be used to constrain the physico-chemical parameters (P-T-X) of the paleohydrothermal system at Sertão and Cascavel. The outcome of this project will be the characterisation of ore fluids in both deposits and interpretation of fluid inclusion assemblages with respect to fluid boiling, mixing and/or cooling as a gold precipitation mechanism. Isochores will be calculated and P-T conditions of gold mineralization estimated in order to construct a P-T-t evolution of these paleohydrothermal systems. This project will be part of a larger investigation on gold and base metal mineralization in the Goiás greenstone belt. The project is suitable for a 36 pts MSc thesis and Honours thesis. Prerequisites are good mineralogy and geochemistry background and successful completion of the SEM course early in 2018 (as advertised by CMCA).

Project:	**Characterisation of proximal to distal alteration footprint of the world-class Callie gold deposit**
Majors including:	Geology, Ore Deposit Geology, Petrography, Geochemistry
Supervisor:	Nicolas Thébaud, nicolas.thebaud@uwa.edu.au , 6488 7139, Laura Petrella
Description:	The Callie gold mine is located 650 km NW of Alice Springs within the Granites-Tanami Orogen in Northern Territory, Australia. Despite being a world-class deposit, the alteration footprint of the Callie deposit is not well defined due to the lack of specific study dedicated to the subject. Therefore the aim of this project will be to study the proximal to distal alterations associated with high-grade mineralisation emplacement. The host rocks to the high grade Au mineralisation at Callie are finely laminated siltstones. The composition of sediments generally varies within the same unit therefore it is challenging to quantify the geochemical changes resulting from hydrothermal alteration. To overcome this difficulty we propose to conduct an alteration footprint study on dolerite sills present throughout the stratigraphic sequence at Callie. The dolerite sills were emplaced parallel to the bedding and are affected by the same deformation events than the sediments including the hydrothermal events responsible for the formation of the high grade Au ore shoots. The geochemical composition of the dolerite sills (before alteration) is assumed to remain constant throughout the length of the sill and consequently would provide a reliable reference material to assess geochemical changes induced by hydrothermal alteration. This project aims at defining gold mineralisation controls to further support the exploration strategy in the region. The study relies on a multi-disciplinary approach combining structural core logging, mineralogy and lithogeochemistry.

Project:	**Gold mineralisation in the Nuuk province, West Greenland**
Majors including:	Geology, Ore Deposit Geology, Petrography, Geochemistry
Supervisor:	Nicolas Thébaud, nicolas.thebaud@uwa.edu.au, 6488 7139, Marco Fiorentini
Description:	The purpose of this project is to characterize the mineralogy and geochemical alteration associated with auriferous quartz veins from the Archaean high metamorphic Nuuk area, southern West Greenland. Sulfur isotope data for hydrothermal minerals will shed light on the possible fluid source, the nature of the pathway and precipitation mechanism. A better understanding will enhance our comprehension of large-scale fluid migration and mass transfer in high metamorphic terranes and, by that, the deeper crust of the Earth. The project will be based primarily on samples collected in the field in August 2016.

Project:	**U-Pb age distribution of Detrital Zircon populations across the Birimian Terrane / Man Shield boundary, West Africa**
Majors including:	Geology, Geochronology
Supervisor:	Nicolas Thébaud, nicolas.thebaud@uwa.edu.au, 6488 7139, Luis Parra Avilla and Elena Belousova
Description:	The West African Craton consists of an Archean core, the so-called Man Shield, and a Paleoproterozoic Birimian Terrane that is essentially composed of volcanic belts and intervening sedimentary basins. The overall relation and the boundary between the Man Shield and the Birimian Terrane further to the North remains poorly constrained. In order to understand the regional tectonostratigraphic evolution and associated mineralisation of the Birimian Terrane in Western Africa, it is important to develop a good understanding of the timing of emplacement of the various litho-stratigraphic pakages and intrustions forming the Craton. At present, very little is known about the stratigraphic variation within the Birimian Sedimentary Basins, which forms a large portion of the Birimian Sequence and even less is known about the relation of this basin with the underlying Archean Man Shield. In 2012 a field campaign was conducted in Guinea across the boundary between the Proterozoic and Archean Terranes. During this field campaign, sediments from streams and rivers were collected with the purpose of conducting a TerraneChron® reconnaissance study over the area. TerranChron® is a unique methodology integrating in situ analysis of zircons for U-Pb age, Hf-isotope composition and trace-element composition using LAM-ICPMS, LAM-Multi-Collector (MC) ICPMS and electron microprobe (EMP) providing a powerful tool for the study of crustal evolution and evaluation of the metallogenic potential of terranes. The methodology will be applied to detrital zircons recovered from drainage samples. The use of drainage samples has many advantages: nature has separated and concentrated a statistically more meaningful sample than is achievable by conventional single rock sampling and methods, and this can provide a more comprehensive coverage of rock types particularly in the areas where the rock outcrops are scarce.

Project:	**Finite strain analysis of a regional scale gold controlling structure in the goldfields of Western Australia: the Boulder Lefroy Shear Zone**
Majors including:	Structural geology
Supervisor:	Nicolas Thebaud, Nicolas.thebaud@uwa.edu.au , Jordan McDivitt
Description:	The Boulder Lefroy Shear Zone in the Eastern Goldfields (Western Australia) is commonly proposed to represent a large-scale plumbing system responsible for the mineralisation of the well-endowed Kalgoorlie area. The detail kinematic and strain recorded in the fault remains however poorly constrained. Using field mapping and finite strain analysis of the Boulder Lefroy field locality near Kambalda combined with geophysical data interpretation, this project aims at characterising further this major structural pathway in-order to better understand its role during the deformation leading to the mineralisation in the region.

Project:	**Lufilian fold belt modelling**
Majors including:	Geology, 3D modelling
Supervisor:	Nicolas Thebaud Nicolas.thebaud@uwa.edu.au , Weronika Gorczyk, Aurelien Eglinger
Description:	In the earth sciences, pressure is often assumed to be a well-defined variable dependent on depth and density. Local pressure gradients and magnitudes can however change without any associated change in depth. Detail metamorphic petrology studies of the whiteschist unit of the Lufilian fold belt of Zambia (Africa), have shown that the unit was metamorphosed at a temperature comprised between 600 and 700 °C and pressures below 1.1-1.2 GPa. The amount of structural thickening derived from stratigraphic compilations conducted in the area seems however insufficient to generate metamorphic conditions suitable for formation of the high-pressure whiteschist metamorphic assemblages. Using existing pressure and temperature estimates and petrographic analyses conducted on the whiteschist unit together with the aid of numerical simulations, the aims of this project is to evaluate the role of tectonic overpressure in the formation of whiteschist unit existing in the Lufilian fold belt.