THE UNIVERSITY OF WESTERN AUSTRALIA

School of Earth Sciences

Potential research projects offered for Level 4 (Honours) and Level 5 (Masters) students commencing in 2020.

- Geology
- Geochemistry
- Geophysics
- Environmental and Marine Geoscience
- Hydrogeology
- Mineral Geoscience
- Petroleum 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 Masters degree. Some projects are also suitable for the larger thesis in the Master of Science by Thesis & Coursework degree.

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 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 industry and government agencies*. It is also a pathway to higher degrees by research (MSc, MPhil, PhD) and students often discover 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 2020*. Do not leave organising a project until the first teaching week of 2020 or late July! 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 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. 36pt projects). You are welcome to contact supervisors to discuss as required.

Project	**Gravity analysis of Kings Park hydrology**
Majors or Masters:	Geology, Geophysics, Hydrogeology
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 data collected over the last 4 years. This project suits those with an interest in environmental applications of geophysics. Some computing experience and reasonable maths ability are required.

Project:	**Methods of large-scale 3D joint gravity & magnetic inversion**
Majors or Masters:	Geoscience, 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. 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, computing experience and reasonable maths ability are required.

Project:	**How the West was one…the Rodona-Totten Shear Zone**
Majors or Masters:	Geology, Geophysics
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au; 6488 7147
Description:	The reconfiguration of Mesoproterozoic Australia occurred between ca. 1600 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:	**Mapping workflow for subglacial geology: A data analytics approach**
Majors or Masters:	Geology, Geophysics, Computer Science or related
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au, 6488 7147 and Eun-Jung Holden, eun-jung.holden@uwa.edu.au, 6488 5806
Description:	Knowledge of the geology beneath the Antarctic Ice Sheet is essential to understand ice-sheet bed conditions and to constrain its volume changes over time, responsible for sea level change. 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:	**Magnetic depth of cover in the Yilgarn Craton**
Majors or Masters:	Geology, Geophysics
Supervisor:	Alan Aitken, alan.aitken@uwa.edu.au, 6488 7147
Description:	This project will apply depth to magnetic basement techniques in the Yilgarn Craton, seeking an improved knowledge of the thickness of sediments and sedimentary rocks. Results will be generated through applying Euler deconvolution and SPI to magnetic data, and verified against drillcore information and other geophysical data.

Project:	**Hydrogeology of the Tamala Limestone – Bassendean Sand contact**
Majors or Masters:	Hydrogeology
Supervisor:	Jim McCallum (james.mcallum@uwa.edu.au) and Jon-Philippe Pigois (Department of Water and Environmental Regulation, DWER)
Description:	The superficial aquifer of the Perth Basin is an important resource for water supply. Effective management of groundwater requires the balancing of private, industrial and public water requirements, whilst maintaining water levels in environmentally important wetlands. The transition between the Tamala Limestone and Bassendean sand units of the superficial aquifer are characterised a high hydraulic gradient, suggesting a barrier to flow, despite both these units having a high hydraulic conductivity. This barrier is particularly significant in maintaining water levels in a chain of lakes. However, the mechanism that leads to this barrier behaviour is still poorly understood, and difficult to represent in hydrogeological models. This is particularly important as many of the trigger points for groundwater management are located in vicinity of wetlands located at this boundary, making it important to understand the hydrogeological characteristics of this boundary. This project will aim to characterise the hydraulic conductivity of the boundary between the two units through a detailed understanding of the hydrofacies of the Tamala unit.

Project:	**Recharge prediction in the Weeli Wolli Catchment, Pilbara region.**
Majors or Masters:	Hydrogeology
Supervisor:	Jim McCallum (james.mcallum@uwa.edu.au Greg Skrzypek Shawan Dogramaci (Rio Tinto)
Description:	Groundwater management depends strongly on quantifying the amount of water entering aquifers through the process of recharge. This process can be challenging in arid and semi-arid regions where potential evapotranspiration is much greater than rainfall, and recharge is focussed in alluvial sediments around ephemeral creeks. Understanding groundwater recharge requires an understanding of hydrogeology, soil and climate. This project will aim to quantify recharge process using detailed data from two focussed measurement points, and upscale these measurements to the larger Weeli Wolli catchment in the Pilbara region of Western Australia. The project will incorporate field data and modelling techniques to better understand recharge mechanisms in arid and semi-arid regions.

Project :	**Oxygen isotope make-up of the Archean mantle** (funded by Australian Research Council)
Majors or Masters:	Geology
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 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:	**A terrestrial hot spring setting for the origin of life? Darwin's Warm Little Pond revisited (funded by Australian Research Council)**
Majors or Masters:	Geology
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465
Description:	Understanding the origin of life is one of the grand challenges for modern science and gets to the very root of who we are, how we got here, and whether life may exist elsewhere in the solar system. The proposed Honours/Masters project provides the candidate the opportunity to collaborate with a team of researchers and address a focussed component of a larger study funded by the Australian Research Council to unveil the origins of life. More specifically, this study will test the proposal that a terrestrial hot spring field could have been the setting for the origin of life, in preference over the currently favoured site at deep sea vents. The natural laboratory to test this hypothesis is the 3.5 billion year old Dresser Formation in the Pilbara Craton of Western Australia. The Honours/Masters project will investigate the role of base and precious metals in the catalysis of early life mechanisms. More specifically, 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 and sulfide mineral phases. The candidate will have the opportunity to utilise the world-class analytical infrastructure available at the university of Western Australia, including scanning electron microscope, laser ablation ICP-MS and the ion probe. Depending on logistics, the candidate will either work on already available material and/or has the possibility to visit the remote field area where access to the Dresser Formation is possible.

Project:	**Fluxing of mantle carbon as a physical agent for metallogenic fertilization of the crust (funded by Australian Research Council)**
Majors or Masters:	Geology
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. The candidate of this Honours/Masters will have the chance to work with a multi-national team of researchers to 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. The candidate will have the opportunity to utilise the world-class analytical infrastructure available at the university of Western Australia, including scanning electron microscope, laser ablation ICP-MS and the ion probe. Depending on logistics, the candidate will either work on already available material and/or has the possibility to visit selected field areas for sampling purposes. 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:	**The mineral chemistry of detrital minerals as a pathfinder for magmatic mineral systems (funded by AngloAmerican, FQM and Boliden)**
Majors or Masters:	Geology
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465
Description:	**Objective** To develop reliable, widely applicable resistate mineral indicators for use in the exploration for magmatic mineral systems, based on data collected on selected geological sites selected by exploration companies of this UWA-CSIRO joint research program. A successful outcome to this project will provide results and interpretation of trace element geochemical data on detrital heavy mineral samples from drainage, till and drill hole sampling, and to detect suitable mineral-chemical signatures that are diagnostic of metal fertility, thus informing and improving regional ground selection and local target definition. **Opportunity** Unprecedented new analytical advances, particularly ultra-trace level laser ablation ICP-MS, permit the accurate and precise determination of trace element concentrations in mineral phases from resistate heavy mineral samples, and enable new techniques for pre-screening and reducing sample volumes. Previous CSIRO-UWA research has identified a number of potential indicators, including the use of PGE and Ni contents of spinel minerals. The time is ripe to develop a “G10 Garnet” equivalent tool for magmatic sulfide systems. **Project plan** The study will be carried out within the various inter-related research themes (bedrock sample indicators, till samples, stream sediment samples, blind

	tests), as outlined below. Samples will be collected by FQM + Boliden staff and supplied to UWA-CSIRO. In the context of the study, the objectives of the Honours/Masters project are to study drill core samples from the host rocks to the various study sites, to: (i) confirm the compositional controls and signatures that have been observed/described in previously published studies of chromite and magnetite chemistry (using EMPA and LA-ICP-MS analyses); (ii) evaluate the textural (and paragenetic) characteristics of chromite/magnetite in the studied samples (e.g., using automated SEM and/or other appropriate techniques); (iii) identify any textural and/or major/minor element characteristics that allow to effectively recognise and distinguish chromite/magnetite grains from mineralisation-related units/bodies; and identify and analyse any other potential indicator minerals (pyroxenes, apatite, zircon, Ti-oxides).

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
Supervisor:	Marco Fiorentini, marco.fiorentini@uwa.edu.au, 6488 3465 and 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:	**Interpreting Airborne Geophysical Data from Sedimentary Basins: Recognising Responses from Evaporites**
Majors or Masters:	Geology, Geophysics
Supervisor:	Mike Dentith Michael.dentith@uwa.edu.au 6488 2676 and Annette George
Description :	Structural traps associated with movement of evaporites are common in many petroleum provinces and so their recognition is important. Aeromagnetic and aerogravity 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 petrophysical property measurements. Seismic data are also available. The research project comprises an integrated interpretation of the available data leading to an understanding of how salt appears in aeromagnetic data and potentially a publication in a major journal.

Project	**Archean-Proterozoic metamorphism in Western Australia**
Majors or Masters:	Geology
Supervisor:	Naomi Tucker, naomi.tucker@uwa.edu.au
Description:	Projects are available in the field of metamorphic petrology. Some familiarity with metamorphic petrography is essential. Possible areas of study include, but are not necessarily limited to: **(1) High-temperature metamorphism in the Albany-Fraser Orogen** The Albany-Fraser Orogen preserves an intriguing record of thermally extreme metamorphism that occurred during Mesoproterozoic suturing of parts of Australia and East Antarctica. The orogen is also unique for its seemingly rapid exhumation rate, which is an unusual feature, compared with other Mesoproterozoic orogens. Despite these remarkable characteristics, the Albany-Fraser Orogen is understudied, with a lack of quantitative *P-T-t* constraints on the peak metamorphic conditions, 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. This project will investigate the P-T-t evolution of amphibolite-granulite facies rocks from spectacular coastal exposures near Albany. Work will

	involve petrography and a combination of P-T modelling, geochronology (zircon, monazite) and/or mineral chemistry. **(2) Yilgarn Craton greenstone belt** Metal-rich fluids may be produced by dehydration reactions during prograde metamorphism. Metamorphic rocks that host ore-deposits are therefore often implied to be the source of the metals, and are an important control on mineralisation. Many of Earth's richest gold deposits are found in the low-medium metamorphic grade Archean greenstone belts of the Yilgarn Craton. This study is a pilot project to investigate greenstone belts from the Yilgarn Craton to understand the nature and timing of metamorphism, and the relationship of metamorphism to orogenic gold mineralisation. The scope of work involved in this project is dependent on sample availability and quality, but may include: a field-work component, petrography, geochronology, P-T modelling, and/or whole-rock geochemistry. This project is part of the broader CET Yilgarn 2020 research program involving a range of researchers and mining and exploration companies.

Project:	**Characterisation of proximal to distal alteration footprint of gold deposits in the Yilgarn craton**
Majors or Masters:	Geology, Geochemistry, Ore Deposit Geology
Supervisor:	Nicolas Thébaud, nicolas.thebaud@uwa.edu.au , 6488 7139
Description:	A range of projects are available focusing on gold deposit of the Yilgarn Craton. These projects aim at characterizing the mineral paragenesis and structural contexts and place gold mineralisation within this context. These studies rely on a multi-disciplinary approach combining structural core logging, mineralogy and lithogeochemistry. Contact the Dr Thebaud for further details on these projects.

Project:	**Tellurium in the lithosphere**
Majors or Masters:	Geology, Geochemistry, Mineral Geoscience, Ore Deposit Geology
Supervisor:	Nico Thebaud, nicolas.thebaud@uwa.edu.au, 6488 7139, Marco Fiorentini and Laure Martin
Description:	Tellurium is an element weakly abundant in the crust (~0.001ppm in the crust) but commonly recognised in mineral systems including ortho-magmatic Ni-PGE deposits but also in orogenic gold deposit. The purpose of this project is to evaluate the nature and abundance of the Te-bearing mineral phases associated with a range of environments including ore deposits, sediments, volcanic complexes and intrusions. This in turn will provide an opportunity to discuss how tellurium may be used to track the metal source within mineralised systems. Accordingly, research methodology will combine petrological investigation and characterisation using optical and electronic microscopy and microprobe analyses deployed on selected samples.

Project:	**Early architecture controlling gold mineralization, Yilgarn Craton**
Majors or Masters:	Geology, Geochemistry, Mineral Geoscience, Ore Deposit Geology
Supervisor:	Nicolas Thébaud, nicolas.thebaud@uwa.edu.au, 6488 7139,
Description:	Early architecture and fundamental structures have been proposed to apply a first order control on gold mineralisation. Often cryptic, this early architecture, consists of unexposed structures often located along lithostratigraphic interfaces. These structures may have been subsequently reactivated in response to the regional stress field and/or by over-pressured fluids. A range of project are proposed in the Yilgarn Craton taking advantage of the strong synergies existing between the CET and the Geological Survey of Western Australia, to conduct lithostratigraphic analysis at the camp scale in the Eastern Goldfields. These field based mapping projects will aim at re-investigating both field districts using core logging and field mapping techniques to unravel the lithostratigraphic record and its spatial distribution. Such an approach has provided valuable insights into the evolution of magmatic systems, tectonic setting and associated hydrothermal circulation. Accordingly, research methodology will combine sedimentological and volcanological lithofacies analysis with lithogeochemistry and depending on time and resources geochronology including U-Pb SHRIMP, U-Pb LA-ICPMS and/or U-Pb TIMS analyses along selected traverses.

Project:	**Igneous Petrology of crustal rocks**
Majors or Masters:	Geology, Geochemistry, Geoscience, Mineral Geoscience
Supervisor:	Tony Kemp, tony.kemp@uwa.edu.au, 6488 7846
Description:	Projects are available in the general fields of igneous and metamorphic petrology. Topics include, but are not limited to - (1) petrology and geochemistry of Proterozoic dolerite dyke swarms, (2) determining granitic pluton emplacement depths using hornblende-plagioclase geobarometry, (3) formation of anorthosite complexes, (4) tin and rare metal mineralization in pegmatites, and (5) characterization of chondritic meteorites. All projects would involve petrography and mineral chemistry, with scope for whole rock geochemistry and, potentially, U-Pb isotope geochronology. Projects can be tailored to suit individual interests, and may be undertaken over one or two years.

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, Petroleum 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) 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 mass transport deposits 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.

Project :	**General projects in seismic structural interpretation**
Majors or Masters:	Geology, Geoscience, 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 potentially also in microstructure and geomechanics for qualified students. Please see Myra for details.

Project:	**Modern fluvial-deltaic reservoir analogues for subsurface Reservoir modelling**
Majors or Masters:	Geology, Geoscience, Petroleum Geoscience
Supervisor:	Simon Lang, simon.lang@uwa.edu.au
Description:	Subsurface reservoir facies modelling requires a range of uncertainty to considered regarding the size, shape and 3D geometry of geobodies. 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 will examine one of several modern Deltas on the WA coast from the Gascoyne to the de Grey rivers in 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. 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 :	**Hydrogeologic modelling in a changing climate, and an uncertain world**
Majors or Masters:	Hydrogeology
Supervisor :	Adam Siade (adam.siade@uwa.edu.au), Jon-Philippe Pigois (Department of Water and Environmental Regulation, DWER)
	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 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. Analyses may include data-worth, Null-Space monte Carlo, Ensemble Kalman Smoother, etc. Students should have some experience with linear algebra and statistics before starting this project.

Project:	**Electrokinetic In Situ Leaching: Towards a greener mining future**
Majors or Masters:	Hydrogeology, Geochemistry
Supervisor:	Henning Prommer (henning.prommer@csiro.au), James Jamieson (james.jamieson@research.uwa.edu.au) and Andy Fourie (Andy.Fourie@uwa.edu.au)
Description:	Electrokinetic In Situ Leaching (EK-ISL) is a novel mining technique that is currently developed. It expands the application of conventional in situ leaching (ISL) to ore deposits that would otherwise be unsuitable due to unfavourable ore characteristics such as low hydraulic permeability. EK-ISL relies on establishing electric fields across ore bodies. It uses those to induce the migration of specific chemical solutions (lixiviants) from a source towards a target reservoir. During its subsurface passage the lixiviant dissolves specific minerals and facilitates the transport of selected metals towards the target reservoir. The in-principle feasibility of this technology has been successfully proven for copper and gold through small-scale experiments. However, the mechanisms that control mineral efficiencies are still poorly understood as well as key parameters that determine the electromigration process. This project aims to better define the key processes and necessary geochemical conditions that allow to maximise mineral recovery rates. Several different thesis projects will be available. Multiple experimental studies will be conducted to explore (i) the application of EK-ISL to a wider range of metals (ii) to explore the application of alternative lixiviants and (iii) to identify the physical and chemical processes that control recovery rates.

Project:	**Groundwater quality dynamics near wastewater infiltration sites**
Majors or Masters:	Hydrogeology
Supervisor:	Henning Prommer (henning.prommer@csiro.au), Clive Hampton (Water Corporation)
Description:	Treated wastewater is increasingly recognised as a valuable resource to supplement existing water supplies. However, specifically in areas where there are important environmental receptors, it is important to understand the response in both groundwater dynamics and groundwater quality to the long-term infiltration of treated wastewater. In this project we will apply a portfolio of numerical modelling approaches, i.e., flow, solute transport and reactive transport modelling, to (i) accurately delineate the flow path of the infiltrated wastewater using a range of wastewater indicator substances (such as trace organics) and (ii) determine the fate of nutrients and other reactive species within the studied aquifer system. The modelling results will be used to determine the importance and critical factors controlling the physical and biogeochemical attenuation mechanisms in the aquifer systems

	targeted by wastewater infiltration. Numerical modelling will be undertaken in comparison with previously collected hydrochemical data. The project will assist with clarifying the suitability of each investigated wastewater indicator with respect to constraining the flow and solute transport behaviour at the selected study sites.

Project:	**Modelling the fate of PFAS at selected DoD sites**
Majors or Masters:	Hydrogeology
Supervisor:	Henning Prommer, henning.prommer@uwa.edu.au, Greg Davis (CSIRO)
Description:	Perfluoroalkyl substances (PFASs) contained within aqueous film forming foams (AFFF) have been historically used by the Australian Department of Defence (DoD) in firefighting training from 1970s until the mid-2000s. PFAS compounds in AFFF are emerging contaminants of increasing concern given they are highly persistent, bio-accumulative and potentially toxic to humans and the environment. Understanding the PFAS transport and attenuation behaviour within groundwater systems is an important prerequisite for determining the risks of human exposure and in selecting suitable remediation strategies at sites where an elevated risk is identified. In this project numerical groundwater flow and solute/reactive transport modelling will be used to interpret groundwater quality data from PFAS-affected aquifers with the aim of improving the conceptualisation of the contaminated sites and to quantify contaminant concentrations and mass fluxes. After completion of the model development and calibration stage predictive simulations might be performed to assess remediation time-scales for a range of plume management options.

Project:	**Depositional history and petroleum reservoir characterisation, North West Shelf and onshore basins**
Majors or Masters:	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 and onshore basins in WA. 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, both conventional and unconventional). Projects typically use 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® spectral 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 work focuses on integration of core work (sedimentology, facies analysis ± petrography ± biostratigraphy) with seismic

	and/or wire line log data in a sequence-stratigraphic framework to achieve the research objectives. These projects are also suitable for 36 pt Master of Science projects.

Project:	**Tectonic assembly of northern Thailand**
Majors or Masters:	Geology, Geoscience, Petroleum Geoscience
Supervisor:	Annette George, annette.george@uwa.edu.au, 6488 1923 and Luis Parra Avila
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 an honours or masters project within a larger industry sponsored project focusing on elements of the tectonic history, e.g. using detrital zircon geochronology and geochemistry to constrain sediment provenance and sediment dispersal during basin development, or in the characterisation of igneous suites related to volcanism and potential back-arc basin development. The research provides opportunity to combine petrographic and geochemical analytical techniques. This topic is also suitable for 36 pt Master of Science projects.

Project:	**Late Triassic landscape and vegetation evolution in Australia: Insight from the Ipswich Coal Measures, Ipswich Basin, southeastern Queensland**
Majors or Masters:	Geology, Geoscience, Petroleum Geoscience
Supervisor:	Daniel Peyrot, daniel.peyrot@uwa.edu.au, 6488 2672
Description:	The vegetation of Eastern Australia and other high-latitude locations underwent near complete turnovers during the transition between the Middle and Late Triassic and during the Triassic–Jurassic mass extinction. The flora of that interval can be distinguished from other coetanous Gondwanan plant communities by a series of compositional differences which have still not be clearly established. The project will focus on the spores/pollen assemblages of historical successions from the Ipswich Coal Measures and compare them with the palynofloral content extracted from various locations of Western Australia. The purpose of the project is to finely characterize the differences between both floras.

Project:	**Evolution of the vegetation of Western Australia during the Jurassic and Cretaceous**
Majors or Masters:	Geology, Geoscience, Petroleum Geoscience
Supervisor:	Daniel Peyrot, daniel.peyrot@uwa.edu.au, 6488 2672

Description:	The study will focus on twenty Late Jurassic-Late Cretaceous samples from the Canning, Carnarvon and Perth basins. The taxonomy of the material has already been characterized by Balme in a seminal study from 1957. The project will focus on the abundance and composition of the main biological groups in order to characterize the evolution of the vegetation and its transition from Mesophytic conifer-dominated flora to a vegetation with modern characteristics.

Project:	**Taxonomic description of *Leptodinium* FM *sensu* Backhouse and its biostratigraphic significance for the Lower Cretaceous dinoflagellate cyst succession of Western Australia**
Majors or Masters:	Geology, Geoscience, Petroleum Geoscience
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:	**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:	**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 contact: steffen.hagemann@uwa.edu.au; Tel., 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 pts MSc thesis or Honours thesis. Prerequisites are knowledge in geochemistry and successful completion of the SEM course early in 2020 (as advertised by CMCA).

Project:	**Understanding the controls on gold mineralization in the Gidgee gold deposits, Southern Cross Province, Western Australia**
Majors or Masters:	Geology, Geoscience, Mineral Geoscience, Ore Deposit Geology
Supervisor:	Steffen Hagemann: Contact: steffen.hagemann@uwa.edu.au; phone: 6488-1517, and Peter Langworthy (Gateway Mining)
Description:	The Gidgee gold project is located 800 km north-east of Perth, near the township of Sandstone in Western Australia. The deposits are located in the

	Gum Creek greenstone belt, which is part of the Southern Cross Province. Despite the significant historic gold production, (gold was first mined in 1905) there is only scant geological knowledge available about these deposits and their mineralization type and style. The objective of this project is to document the lithostratigraphy setting, structural control and gold mineralization of various open pits and selected diamond core. The results will be used to establish the first descriptive and genetic model for these exciting gold deposits. This model will then be used to propose new targets within the deposits and regional. The project is suitable for a 36 pts MSc thesis or Honours thesis. The candidate should enjoy field geology and basic laboratory investigations. This project is sponsored by Gateway Mining Ltd, thus the proposed Honours/Masters project provides the candidate with the opportunity to work and collaborate with a team of exploration geologists. The project is suitable for a 36 pts MSc thesis or Honours thesis. Prerequisites are knowledge in structural geology, mineralogy and successful completion of the SEM course early in 2020 (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 or Masters:	Geology, Geochemistry, Mineral 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 pts MSc thesis. Appropriate prior study and successful completion of the SEM course in early 2020 (as advertised by the Centre for Microscopy, Characterisation and Analysis 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 and Mike Tedeschi Contact Steffen: 6488-1517; steffen.hagemann@uwa.edu.au
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 pts MSc thesis. Appropriate prior study and successful completion of the SEM course in early 2020 (as advertised by the Centre for Microscopy, Characterisation and Analysis at UWA).

Project:	**Evaluating heterogeneity in carbonate reservoirs and their controlling influences: seismic to pore-system studies**
Majors or Masters:	Geology, Geoscience, Petroleum 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 poroperm characteristics remain notoriously fickle and difficult to predict. Unlike clastic reservoirs, carbonate 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:	**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:	**Geophysical and geological analysis of Monte Carlo-generated collections of structural models**
Majors or Masters:	Geophysics, Geology, Physics, Computer Science
Supervisor:	Jeremie Giraud (jeremie.giraud@uwa.edu.au) and Guillaume Pirot (guillaume.pirot@uwa.edu.au)
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 series of 10,000 structural geological models from two areas in Australia. These models where generated by Monte Carlo sampling and reproduce the geological measurements defining the structures observed in the area. 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) as well as topological variability. This project is supported by the MinEx CRC industry and public consortium project 6. Computer experience and some maths and physics are required.