GEOLOGY

- **Meteorite records of the formation of our Solar System and the planets — cosmochemistry and cosmochronology Advisor(s): Joel Baker, Mike Rowe**

Meteorites that arrive on Earth from small asteroids located in the Asteroid Belt between Mars and Jupiter are our only direct record of the formation of our Solar System and the processes of solid formation, planetary accretion and differentiation that took place in the first 50 million years of the Solar System's 4.5672 billion year history. The record of these processes can be elucidated from petrographic, chemical and isotopic study of meteorites.

Two projects are available to study meteorites and the oldest igneous rocks in our Solar System (note: both projects may involve a period of research at the *Centre for Star and Planetary Formation* [STARPLAN] in Denmark):

a. Ureilites are ultramafic igneous meteorites that form the second largest group of meteorites that originated from asteroids (also called planetesimals) that for some reason become hot enough to melt in the first few million years of the infant Solar System. They are the only group of meteorites that appear to represent the equivalent of "mantle" rocks and their age and formation processes are not well understood. Ureilites appear to have "lost" both a silicate melt component (to an igneous planetary crust) and a metal component (to a iron–nickel planetary core). This project will involve a detailed petrographic, mineral chemistry and isotopic study of a suite of ureilite meteorites obtained from NASA that have been found in Antarctica, in order to constrain their age and formation.

b. Cumulate eucrites are gabbroic igneous meteorites that form part of the largest group of meteorites that originated from asteroids (also called planetesimals) that for some reason become hot enough to melt in the first few million years of the infant Solar System. These meteorites are thought to originate from the asteroid 4 Vesta, which was recently visited by the Dawn Spacecraft Mission. This project will involve a detailed petrographic, mineral chemistry and isotopic study of a suite of cumulate eucrite meteorites obtained from NASA that have been found in Antarctica, in order to constrain their age and formation.

- **Crystal-specific insights into the processes and timescales of assembly and eruption of intermediate magmas in subduction zones Advisor(s): Joel Baker, Michael Rowe, Ian Smith**

There is mounting evidence that intermediate magmas (i.e., andesites and dacites) erupted at subduction zones represent mixtures of mafic and silicic magmas, and that their eruption may be ultimately facilitated by this mixing. For example, our recent work on Tauhara Volcano near Taupo has shown that the dacites were erupted there after mixing between crystal-rich rhyolitic magmas and either crystal-poor basaltic or andesitic magmas at crustal depths of 8–13 km. After several months of mixing, which reduced the viscosity and density of the silicic and mafic end-members, the "eruptable" dacite rapidly ascended to the surface on timescales of 2–3 weeks. The key to understanding how such intermediate magmas are assembled, and then erupted, lies in using in situ, crystal-specific, analytical techniques to forensically fingerprint the origins of the magma's crystal cargo and its melt inclusions. Three projects are available using such in situ analytical techniques (electron probe microanalysis and laser ablation inductively coupled plasma mass spectrometry) to study Edgecumbe Volcano (onshore Taupo Volcanic Zone), Whale Island Volcano (offshore Taupo Volcanic Zone) and Raoul (northern Kermadec Arc).

- **Changing basalt eruption styles in the Auckland volcanic field investigated through X-ray diffraction (BSc or MSc) Advisor: Michael Rowe**

Explosive basaltic eruptions within the AVF are a combination of both phreatomagmatic and "magmatic" styles. This study will use XRD analysis to look at changes in eruption style and groundmass crystallinity to help elucidate eruptive processes and the transition from phreatomagmatic to magmatic eruption style observed in many of the AVF eruptive centers.

- **Origins of Rangitoto Volcano revealed by silicate melt inclusions: (BSc or MSc) Advisor: Michael Rowe**

The presence of both alkaline and subalkaline magmatism on Rangitoto presents an opportunity to investigate the sources of these distinct basaltic compositions and investigate potential changes in mantle sources for magmatism. This study will focus on melt inclusion geochemistry and petrology, including the analysis of major, trace, and volatile elements in glasses and minerals.

- **Trace, and Ore metal analysis in silicate minerals and glasses: (BSc or MSc- multiple students needed for different aspects) Advisor(s): Michael Rowe, Joel Baker**

Ore metals often partition into either vapour or fluid phases during degassing of shallow magmas. Ore deposits associated with magmas are often found related to subduction zones. This is a multifaceted study to look at different aspects of the cycling of these elements. One aspect of this study aims to utilize variations in mineral and glass chemistry to investigate the conditions (Pressure, temperature, composition) under which these metals leave the magma, with potential links to understanding how porphyry style ore deposits can form and how magmas degas shallowly prior to eruption. This aspect will focus on Taranaki and White Island initially and then expand to other TVZ volcanoes. Another aspect of this project will focus on examining these same elements in basaltic magmas from along the TVZ to try to understand the cycling of these elements related to subduction zone processes and comparing this to MORB or OIB concentrations in more of a global context.

- **Distribution of metals associated with geothermal systems (BSc or MSc) Advisor: Michael Rowe, Joel Baker**

Volcanic degassing can result in accumulations of metals which in high concentrations can be potentially hazardous (for example Hg and As). This study will focus on the distribution of these elements as well as other trace metals related to the active geothermal system at Rotorua. This is a new project with a lot of potential directions including gas sampling, soil sampling, and analysis of tree samples/vegetation (dendrogeochemistry).

- **Petrology and volcanology of dacites in the Okataina region Advisor(s): Phil Shane/Jan Lindsay**

Small volume dacite eruptions are spatially associated with the predominantly rhyolitic Okataina volcano. However, little is known about their origin and genetic connection to Okataina. The project could involve aspects of physical volcanology and petrology (mineralogy, chemistry), depending on student interests.

- **Petrology and volcanology of Pukeonaki scoria cone, Mangatepopo Valley Advisor(s): Phil Shane/Jan Lindsay/Mike Rowe**

This scoria cone provides an opportunity to examine in detail the eruption style, chronology and magma composition of a complete volcanic construction. The work is aimed at providing an analog (in a subduction setting) for small-scale volcanoes of the Auckland region. The project could involve aspects of physical volcanology and petrology (mineralogy, chemistry), depending on student interest.

- **Miocene volcanology and petrology of Auckland's West Coast Advisor(s): Phil Shane/Lorna Strachan**

The West Coast region comprise eroded remains of Miocene stratovolcanoes, including lava domes, intrusions and volcaniclastic facies. There is an opportunity to revisit this region with new concepts of physical volcanology, sedimentology and petrology, to determine its tectonic and depositional setting. The topic would depend on the interests of the student.

- **Miocene volcaniclastic sedimentology of Auckland's West Coast Advisor(s): Phil Shane/Lorna Strachan**

The West Coast region comprise eroded remains of Miocene stratovolcanoes. There is an opportunity to revisit this region with new concepts of physical volcanology and sedimentology, to develop depositional models of volcaniclastic sediments in marine settings.

- **Volcaniclastic turbidite sequence, Mahia Peninsula Advisor(s): Phil Shane/Lorna Strachan**

Coastal outcrops at Mahia exposure an excellent sediment gravity flow sequence deposited in a fore-arc basin during the Miocene. The aim is the develop depositional models for the sediments that were derived from the Coromandel volcanic region, and help reconstruct the tectonic setting during the Miocene. The work would involve sedimentology, stratigraphy, mapping and volcanic geology.

- **Estuarine/coastal dynamics and history, Auckland region and Northland. Advisor(s): Kathy Campbell, Paul Augustinus, Lorna Strachan, Melissa Bowen, AUT ecologists**

Relevant to local regional councils and communities, where mangroves are advancing, and little is known of the sediment accumulation history of estuaries. Several projects available. Coastal dunes (plant-insect interactions, insect traces, sedimentology, paleoenvironmental reconstruction) or mapping/coring estuarine sediments (ichnology, (paleo)ecology, sedimentology, hydrodynamics palynology, and/or reconstructing basin fill history). Holocene, Pleistocene.

- **Using the trace element geochemistry of foraminifera to reconstruct past ocean temperatures, ocean circulation, and seasonality Advisor(s): Joel Baker, Kathy Campbell, Bruce Hayward**

Foraminfera are phylum or class of amoeboid protists that live in the ocean at depths from the near surface (planktic foraminifera) through to the seafloor (benthic foraminifera). Most foraminifera form shells of calcium carbonate that are preserved after their death as microfossils in marine sediments. It has been known for almost a century that the incorporation of magnesium into calcite is thermodynamically controlled and, in the case of foraminifera, related to the temperature of the ocean water in which the organism was living. Laser ablation inductively coupled plasma mass spectrometry can be used to measure the magnesium and other trace element contents of fossil foraminifera, which in turn can be used to reconstruct an ocean temperature and chemistry record through geological time. A number of projects are available to study foraminifera and their geochemistry, including:

a. Reconstructing the past temperature of the near-surface ocean during super-warm interglacials (Marine Isotope Stages [MIS] 11 and 31) during the Quaternary as an analogue for potential future global warming and also to constrain the threshold or tipping point that might lead to collapse of one or both of the Antarctic ice sheets, and subsequent significant changes in sea level. Our recent work at Ocean Drilling Program Site 1123 offshore of New Zealand has shown that near-surface ocean temperatures were 2˚C and 4˚C warmer during MIS11 and MIS31 than in our current interglacial. However, this site is located at the interface between warm Subtropical and cold Subantarctic waters and this “temperature” record might simply reflect dynamic changes in mixing between these water masses. This study will examine sediment cores clearly located within Subtropical and cold sub-Antarctic waters to constrain the ocean temperature changes of these two water masses during MIS11 and MIS31.

b. High-resolution trace element analysis of large benthic foraminifera in order to see if it is possible to extract ocean temperatures at seasonal resolution. If this is possible, then it will be possible to assess whether past changes in ocean (and global) temperatures are driven by even year-round changes in climatic temperatures versus more marked changes to a particular season. If such records can be obtained, then they will be critical in developing a clearer understanding of the potential impact of future climate change to New Zealand and our primary industries.

A number of other projects utilizing the geochemistry of foraminifera to examine a range of environmental processes are also available on discussion with the above staff.

- **Hot Spring (Sinter) Research Advisor(s): Kathy Campbell, Julie Rowland, Mike Rowe, Joel Baker**

Through student and staff research, the Geofluids Research Group has been building a better understanding of the textures, mineralogy, paleoecology and geologic context of New Zealand's active and extinct hot springs. Such studies help delineate the rich geologic history of terrestrial surface manifestations of geothermal activity, aid in geothermal prospecting, provide clues to the preservation and evolution of life in extreme environments, and also elucidate the pathways of and controls on hydrothermal migration through the crust. Several projects are available.

Recent studies have involved field mapping of sinter deposits (Taupo Volcanic Zone, Northland, Coromandel) and their facies, core studies, accretion/growth of hot spring deposits, mineralogic/chemical analyses, and textural studies (SEM, paleoecologic assessment). Holocene, Pleistocene, Mio-Pliocene.

- **Late Quaternary glacial history and paleoenvironments, north Canterbury, NZ, and Mt Aspiring National Park. Advisor: Paul Augustinus**

Mapping of glacial sequences and their dating using the cosmogenic nuclide 10Be. In addition, the north Canterbury work will have all field and analytical costs covered as a collaboration with NIWA (MSc)

- **Tracing the glacial history of Antarctica using authigenic marine sediments as a geochemical tape recorder *Advisor(*s): Joel Baker, Mike Rowe, Kathy Campbell**

The trace element and isotopic compositions of the ocean change through geological time in response to changes in sources and sinks of elements into the ocean. Element sources include contrasting hydrothermal, mantle-like, inputs from mid-ocean ridges versus continental material derived by weathering and then delivered to the ocean by glacial, fluvial and aeolian processes. Temporal changes in ocean chemistry, if these can be reconstructed, can thus constrain the timing and nature of large-scale environmental changes on Earth. Moreover, ocean chemistry has been proposed to control atmospheric carbon dioxide through the biogeochemical cycles of silicon and iron, which are ultimately derived by erosion of the continents (e.g., through mountain building) and delivery of this material to the ocean.

Authigenic sediments crystallize from seawater and progressively capture the chemical and isotopic composition of seawater through time. Such sediments are present as iron–manganese nodules and as coatings on pelagic sediments on the deep seafloor (4 km) east of New Zealand. These sediments are bathed in the Deep Western Boundary Current (DWBC) that is an offshoot of the deep Antarctic Circumpolar Current, and represent "tape recorders" of ocean chemistry controlled by changes in the glacial and erosional state of Antarctica.

Two projects are available to study the chemistry and isotope systematics of these sediments at very different scales:

a. In situ trace element analysis of a well-dated iron–manganese nodule from the DWBC. This nodule provides a 14-million-year-long record of Southern Ocean chemistry. Using our new laser ablation inductively coupled plasma mass spectrometry laboratory, the chemistry of this nodule can be extracted with a spatial resolution of 25 microns, which equates to a temporal resolution that is less than 10,000 years. This record will be able to detect and reveal changes in ocean chemistry linked to Antarctica at various scales from the major build-up of the Antarctic ice sheets in the mid-Miocene, through to glacial-interglacial changes during the Quaternary.

b. Trace element and hafnium-neodymium isotopic analysis of iron–manganese oxyhydroxide coatings leached and fossil fish teeth taken from Ocean Drilling Program sediment cores east of New Zealand. These sediment cores extend in age from the Quaternary through to the early Cenozoic. Given that a glaciated Antarctic results in a distinctive trace element and isotopic signature of the Antarctic Circumpolar Current, this projects aims to resolve the extent to which ephemeral ice sheets were present (or not!) in the early Cenozoic greenhouse world when the Earth is conventionally assumed to have been ice-free.

- **Ground penetrating radar and land sediment records as paleoseismic analysis tools in the vicinity of the Hope Fault (and projects focussing on other appropriate sites in NZ). (MSc) Advisor: Paul Augustinus**

- **Late Quaternary paleoenvironmental reconstruction from lake sediment records, north Canterbury. (MSc) Advisor: Paul Augustinus**

Use of multi-proxy approach including core sedimentology, geochemistry and pollen analysis. This is a collaboration with NIWA that will cover all field and analytical costs.

- **Identification and drivers of late Quaternary climates and environments from Auckland-Northland lake sediment records (BSc hons/MSc) Advisor: Paul Augustinus**

there are >50 suitable lakes to choose from and the tools required to undertake this work are available at UoA - including GPR/seismic profiling, sediment coring, sedimentology, geochemistry, paleoecology. MSc. the above can also be reduced in scope as BSc hons projects that involve working on a single lake and reducing the field and analytical components to fit the scope of a BSc hons. Dissertation.

- **Dendrochemistry as a tool to reconstruct past geological and environmental change Advisor(s): Joel Baker, Gretel Boswijk, Anthony Fowler, Jan Lindsay, Mike Rowe**

Studying tree rings has provided unique insights into past climatic conditions on Earth over the past few thousand years at extraordinary age resolution. The Dendrochronology Laboratory is a world-leader in this type of research and, using living and fossil kauri trees, has reconstructed a tree ring record for New Zealand that extends back almost 2,500 years. Our new laser ablation inductively coupled plasma mass spectrometry laboratory now provides an opportunity to undertake detailed chemical analysis of these tree ring records, which can potentially reveal completely new insights into the reconstruction of past geological and environmental events and conditions. This reflects the fact that the chemistry of the tree rings changes in response to changes in the availability of material for a tree to uptake elements from (e.g., volcanic ash, pollution particulates) and biological effects that influence the elemental uptake of trees during times of environmental stress.

Three research projects are potentially available in this new field of dendrochemical research:

a. Reconstructing the history of volcanic eruptions through study of living trees sampled on active or dormant volcanoes, which has the potential to reveal volcanic eruptions and activity not preserved in the geological record, but that are important for understanding volcanic risk.

b. Reconstructing past climate conditions in the past 2,500 years through analysis of the Dendrochronology Laboratory's kauri master chronology, with particular focus on understanding how tree ring chemistry responds to climate and the major climatic events and cycles that may have influenced New Zealand (e.g., Little Ice Age and Medieval Warm Period).

c. Building a record of anthropogenic pollution in New Zealand in response to the settlement and activities of Maori and European people.

GEOPHYSICS

- **Scanning the inside of a volcanic rock: Quantifying 3D pore geometry and mineralogy in basalts from Computerized Tomography-scan data (scans available) (BSc hons) Advisor: Ludmila Adam**

Description: 3D Computerized Tomography (CT) scans for three basalt samples have been acquired. CTscans are a measurement/representation of density contrasts. In this project the student will estimate the rock microstructure and mineralogy of young volcanic (basalt) samples from the Snake River Plain - Idaho (US). 3D CT-scans have been acquired on these samples. The student will quantify the shape of the pores and their independent contribution to the total rock porosity. Mineral

crystal size and distribution will also be assessed and compared to thin sections (also available). The study will be performed with the freely available ImageJ software and with other available programs. This rock microstructure data will be compared to porosity and permeability measurements in these samples.

- **Rocks and lasers: measuring the rock wave velocity under pressure using lasers (BSc hons) Advisor: Ludmila Adam**

Description: Knowledge of the seismic wave velocities in rocks is important for the analysis of seismic data in seismology or applied geophysics. This is because the physical properties of rocks (e.g. minerals, porosity) and the fluid within the rocks control these speeds. We can measure the velocity of the propagating waves in the laboratory for a range of rock samples, and under varying pressure and fluid conditions. This project will build on a newly developed non-contacting laser-based method to estimate the velocity of waves in rocks. The acquisition system consists of a high-energy pulsed laser that excites ultrasonic waves via thermoelastic expansion. The resulting waves that propagate and reflect in the rock sample are measured with a laser ultrasonic receiver (similar to a laser pointer!). This system is robust and has been used to measure the propagation of waves for a variety of rocks and materials (including ice, wood, and skin phantoms). The proposed project brings the system a step closer to measuring the wave velocity in a rock at pressure conditions as those deep inside the Earth (up to a depth of 2 Km). The student will setup the laser-ultrasonic system to be able to perform the measurements on rocks under pressure and correlating the wave velocity data to the rock's physical properties.

- **CO_2-rock alteration in young basalts (Auckland Volcanic Field): Can we remotely sense changes in these volcanic rocks with elastic (seismic) waves? How is rock permeability affected? (MSc) Advisor: Ludmila Adam**

Description: Basalts have been proposed as possible reservoirs for sequestration (injection) of anthropogenic CO2. These types of rocks are appealing because over time, the liquid-CO2 injected will be permanently trapped in solid form due to fluid-rock interactions. We need geophysical (seismic) tools to monitor these changes in the subsurface and monitor the progress of the CO2 plume and reactions. Laboratory experiments on CO2-water-basalt reactions will be performed. The study will include a detailed petrology analysis (thin sections, XRD, XRF and CT-scans), porosity/permeability and velocity measurements. Reactions and wave velocity will be measured at subsurface conditions in the lab.

- **How does mineralogy and organic content in shales affect its strength? Elastic waves, facies and petrological analysis can tell us! (MSc) Advisor: Ludmila Adam**

Shale formations represent 80% of the sedimentary sections in many parts of the world and act as reservoirs or cap/source rocks. Although they are less extensive in New Zealand, they are important cap rocks and potential oil and gas unconventional reservoirs. Although shales are an important part of the hydrocarbon reservoir system, there has been much less research performed on these rock types than for sandstones or carbonates. To date, there is sparse published data on the role the rock physical properties (minerals, alignment, TOC) have on the elastic response of shales. These need to be accounted for to correct geophysical seismic images for reservoir depth and thickness, as well as to understand some of the effects of a hydrofracturing program.

- **Sequestration of carbon dioxide in the subsurface: modeling wave velocity changes over time as basalt-CO2 reactions develop (MSc). Advisor: Ludmila Adam**

Description: Basalts have been proposed as possible reservoirs for sequestration (injection) of anthropogenic CO2. These types of rocks are appealing because over time, the liquid-CO2 injected will be permanently trapped in solid form due to fluid-rock interactions. We need geophysical (seismic) tools to monitor these changes in the subsurface and monitor the progress of the CO2 plume and reactions. Laboratory experiments on CO2-water-basalt reactions have already been performed with successful results. Carbonates have precipitated in the pore space, increasing seismic velocity. The student will model with simple theories the effect newly formed minerals and their distribution have on

the seismic wave speed as these precipitations progress. The modeling can be performed for rock samples or for a synthetic field experiment (student to choose).

- **Formation and evolution of seafloor pockmarks on the Chatham Rise (MSc only). Adviser: Ingo Pecher**

Description: A vast area of the Chatham Rise east of the South Island is covered by pockmarks, ~100-200 m wide seafloor depressions. These pockmarks are thought to be caused by sudden release of gas in response to glacial cycles. We have acquired a reflection seismic, echosounder, and multibeam data together with sediment cores across a transect on the western edge of the rise during a voyage by the R/V Sonne in early 2013. The seismic images show buried pockmarks that appear to be tied to specific seismic horizons as well as to fluid-migration paths from the deeper sub-surface. The student will evaluate these data and, together with collaborators at NIWA, tie seismic horizons to sediment cores from seafloor outcrops to investigate pockmark formation and evolution through glacial cycles.

- **Analysis of reflection seismic data from deep-water Taranaki Basin for shallow gas pockets (BSc hons or MSc). Adviser: Ingo Pecher**

Description: Shallow gas and gas hydrates beneath the seafloor constitute a major geohazard for oil and gas production Gas pockets often appear as high-amplitude reflections in seismic data. Indications for gas pockets have been observed recently in seismic data from the deepwater Northland Basin and parts of the northern Taranaki Basin. The proposed study aims at identifying for high-amplitude reflections in already processed seismic data from the deepwater Taranaki Basin that could be caused by shallow gas. The occurrence of potential gas pockets will be linked to sub-surface structure and possible fluid conduits, in particular faults. The focus of a BSc (hons) project will be on identifying and mapping high-amplitude reflections in already processed seismic data. For an MSc project, linkages to geology and quantitative analyses of selected seismic data will deepen the scientific scope of the project.

- **Dewatering in the proto-thrust zone of the southern Hikurangi Margin sediments based on seismic velocities from ocean bottom seismometer data (Collaboration with GNS Science; BSc hons; could be extended to MSc). Adviser: Ingo Pecher**

Description: Dewatering of sediments caused by tectonic compaction is a key factor for the structural evolution of accretionary prisms in subduction zones. Compaction of sediments manifests itself by an increase of seismic velocities. We have acquired ocean-bottom seismometer (OBS) data to study the earliest stage of tectonic compaction of sediments on the Hikurangi Margin in the proto-thrust region just landward of the Hikurangi Trench. The proposed project will focus on seismic velocity analysis of the OBS data in an attempt to quantify the degree of compaction across the proto-thrust zone. This project could also become a viable MSc project by extending the study area landwards to more broadly study compaction of the Hikurangi margin by linking OBS velocities to velocities from seismic reflection data further landward.

- **Seismic refraction study of the seafloor at cold-seep sites on the Hikurangi Margin (MSc only). Adviser: Ingo Pecher**

Description: Seep sites at the seafloor are prime locations for transfer of carbon, in particular methane, from sediments into the ocean and have been studied extensively in the past two decades by geologists, geochemists, and geophysicists. However, one of the main limitations for studying seep sites is our limited knowledge on their distribution – most seep sites have been discovered by coincidence. Many deep-water seep sites are characterized by carbonate build-ups close to the seafloor, which typically exhibit high seismic velocities. This study aims at applying newly developed techniques to identify near-seafloor regions of high seismic velocities utilizing refracted waves in commonly observed in seismic reflection data from the Hikurangi Margin east of New Zealand.

- **Analysis of multicomponent ocean-bottom seismic data from seep sites on the Hikurangi Margin (In collaboration with GNS Science). Adviser: Ingo Pecher**

Description: Densely spaced multicomponent ocean-bottom seismometer (OBS) data were collected in 2011 around two seep sites on the Hikurangi Margin in conjunction with 2-D and 3-D seismic reflection data. While most of the reflection data have already been analyzed, they did not allow velocity analysis. The OBS data will now allow P- and S-wave velocity analysis with the objectives to map gas, gas hydrates, and carbonates. Results will allow a better understanding of the evolution of seafloor seeps, including their gas hydrate systems. A comprehensive analysis of these data is planned to be the core of a future PhD project. An MSc or Hons. student will work on a subset of these data addressing a scientific question and using techniques that can be tailored towards the student's strengths and interests.

- **Analysis of 3D seismic data from submarine landslides in the Tuaheni Basin, Hikurangi Margin (Part of collaboration between Geomar, Germany, NIWA, GNS Science, and Auckland). Adviser: Ingo Pecher**

Description: Submarine slides in the Tuaheni Basin on the Hikurangi Margin east of Gisborne appear to be "creeping", which is unusual in the marine environment. We have hypothesized, gas hydrates may cause this slow sliding mechanism. To test our hypothesis, we plan to collect 3D high-resolution seismic data over these slides on the R/V Tangaroa in June 2014. 3D images of the slides should allow us to better reconstruct the temporal evolution of these slides. Furthermore, the seismic data will guide seafloor drilling in 2015-16 for geotechnical studies of these slides. The student will work on a subset of the collected data focusing on specific topics such as seafloor morphology or reflectivity with specific questions being defined after data collection; accordingly, the project is open to a broad set of interests from interpretation to quantitative seismic processing. The student will ideally participate in the 2-3 week-long acquisition survey.

- **DFDP-1: Tying Seismic Data to geophysical well logs through the Alpine Fault Zone. Comparing seismic data with that expected from the geophysical well-logs collected (data already collected). Adviser: Jennifer Eccles**

Description: Synthetic seismograms can be constructed from the 1D high resolution velocity logs measured in the DFDP-1 boreholes which can be compared to CDP gathers observed at the well locations from hammer and explosive seismic experiments. This allows us to draw conclusions about how representative of the 3D sub-surface structure the 1D well logs are and how the fine structure of the fault gouge etc are resolved at seismic wavelengths.

- **DFDP-1: Compatibility of in-situ vs sample measurements of physical rock properties. Comparing in-situ geophysical well log data with GEOTEK core scanner data (data already collected). Adviser: Jennifer Eccles**

Description: A GEOTEK core scanner was used to measure P-wave velocity and density for the DFDP-1 core through the Alpine Fault. This dataset will be compared to the geophysical well logs collected 'in situ' from the boreholes to assess the usefulness of core measurements and examine the factors that lead to variations in the two results.

- **2D resistivity imaging of the Alpine Fault at Gaunt Creek (fieldwork required). Adviser: Jennifer Eccles**

Description: 1D Geophysical well logs from the DFDP-1 boreholes through the Alpine Fault at Gaunt Creek showed the resistivity anomaly associated with the fault gouge and cataclastite was the most dramatic geophysical anomaly associated with the fault. 2D DC resistivity imaging of the Alpine Fault Zone at Gaunt Creek will be carried out to explore the resistivity structure laterally and with depth

- **Submarine volcanism in the Kermadec Arc/Back-arc (with NIWA). Joint interpretation of seismic reflection and multi-beam data over and around selected seamounts (data already collected). Adviser: Jennifer Eccles**

Description: Multi-beam data collected on submarine volcanoes allows a geomorphic interpretation of tectonic, volcanic, sedimentological and mass flow processes. Seismic reflection data collected over

these edifices allows the interpretation to be continued into the shallow sub-seafloor with the seismic signature of such features to be established.

- **The marine seismic reflection method in steep bathymetry: Pseudo-3D imaging of the Brothers Seamount (with NIWA, data already collected, MSc only). Adviser: Jennifer Eccles**

Description: The steep 3D bathymetry of a seamount leads to many out of plane reflections that limit our ability to interpret the internal structure of such edifices with marine 2D seismic reflection data. 3D processing algorithms have the potential to reduce these and pseudo-3D coverage of the Brothers seamount was recently completed. This project will involve processing of this dataset in conjunction with synthetic modelling to determine the seismic expression of know hydrothermally active areas.

- **Refining the Monte Carlo approach for travel time inversion – the role of parameterisation on uncertainty. Adviser: Jennifer Eccles**

Description: To explore solution space from travel-time inversions we have typically explored the effects of randomisation of the starting models and addition of noise to the travel-time picks. The choice of inversion parameterisation is however critical to the results achieved and the effect of including 'reasonable' variation in these will be explored.

- **Basement structure of Northland from aeromagnetic data. Adviser: Jennifer Eccles**

Description: The structure of the Northland basement will be considered continuing the work of Eccles et. al. (2005) examining the structure of the Auckland basement using aeromagnetic lineaments. High quality aeromagnetic data has been recently collected over the Northland Peninsula and the data made publically available by New Zealand Petroleum and Minerals.

- **Resonant ultrasound spectroscopy to estimate the elastic properties of shales (setup and codes are ready). Adviser: Kasper van Wijk (Physics)**

Description: The elastic properties of rocks are crucial when imaging the earth with seismic waves from earthquakes or man-made sources. In the laboratory, we can calibrate these properties with time-of-flight ultrasonic measurements, but also by resonating rock samples. In the latter case, it is the resonances that are uniquely defined by the elastic properties.

- **Discrimination of clouds of microseismic events with seismic coda waves (we have the data). Adviser: Kasper van Wijk (Physics)**

Description: Microseismicity – or small earthquakes – can be recorded in production areas (reservoirs) for geothermal applications, oil and gas production, or CO2 sequestration. The source locations (i.e. Epicenters) tell us about the fracture patterns in these reservoirs. Because fractures can be the conduits of fluid flow, there is a keen interest to get the best possible epicenter estimates. In this project, we focus on scattered seismic wave (the coda) to distinguish sets of microseismic events.

- **Building an open-source laboratory ultrasonics system in Python: kicking the LabView addiction. Adviser: Kasper van Wijk (Physics)**

Description: In our lab we study wave propagation, but hardware is often slave to Labview, matlab, Windows and other proprietary restrictions. Our aim in this project is to build a data acquisition system based on a free operating system (linux) and software (python).

- **Estimating landslide volumes from near-field seismic signals (data collected). Adviser: Kasper van Wijk (Physics)**

Description: landslides can be devastating events. It is hard to monitor for landslides, but the seismic waves excited by landslides may offer clues to the origin of the slide, its volume, and path. We

recorded some seismic data in Colorado, USA, in the vicinity of landslides caused by geothermally weakened granite.

- **Imaging the crust under a geothermal field in Idaho with seismic data and receiver functions (data collected). Adviser: Kasper van Wijk (Physics)**

Description: Often, the source for geothermal reservoirs is poorly understood. Earthquakes from around the world can be used to determine an image under geothermal sites. We recorded seismic data from Idaho, USA, where we'll use so-called receiver functions to image the (upper) crust, in search of the origins of the geothermal activity.

ENGINEERING GEOLOGY

- **A revised weathering classification of the Waitemata Group (Hons or MSc) Advisor: Simon Nelis/Nick Richards**

This project is focused on the development of a field classification scheme applicable to the weathering grades of the Waitemata Group sediments found in the Auckland region. The rationale for the study is centered on the establishment of a suitable weathering classification that is applicable to the sedimentary rocks encountered in engineering excavations in the greater Auckland region. The development of the classification system will be submitted to the New Zealand Geotechnical Society for inclusion in their Soil and Rock Description guidelines. This work will use 3D terrestrial digital photogrammetry to create digital outcrop models of the main rock mass types.

- **Weathering classification of the Waitemata group using studies of existing borehole material (Hons or MSc) Advisor: Simon Nelis/Nick Richards**

This project is focused on the development of a weathering classification of the Waitemata Group based on the study of borehole materials sourced from site investigations in the Auckland region. A suite of index tests (particle size, Atterberg limits) can be used in conjunction with clay mineral identification and fabric studies, to investigate the weathering profile. The rationale for the study is centered on the establishment of a suitable weathering classification that is applicable to the sedimentary rocks encountered in engineering excavations/borehole investigations in the greater Auckland region. The development of the classification system will be submitted to the New Zealand Geotechnical Society for inclusion in their Soil and Rock Description guidelines.

- **Towards a revised rock mass classification scheme on the East Coast Bays Formation (ECBF) (Hons or MSc) Advisor: Simon Nelis/Nick Richards**

Current rock mass classification schemes (GSI) have limited suitability when applied to the rock types found in the ECBF. A revised classification scheme using blockiness and defect structure that accounts for the lithological variability and deformation characteristics in the ECBF is the focus for this project.

- **The relationship between the fabric/texture, index properties and mechanical properties of the Waitemata Group (Hons or MSc) Advisor: Simon Nelis/Nick Richards**

An assessment of the lithological properties (texture, fabric, cement, and mineralogy) to the strength and durability of selected Waitemata Group rocks in the Auckland region. The geotechnical (mechanical) properties of sedimentary rocks is strongly influenced by lithology, and an understanding of these influences is critical to understanding the behavior of the Waitemata Group rocks in an engineering context.

- **The engineering geological classification of ignimbrites (Hons or MSc) Advisor: Simon Nelis/Nick Richards**

Ignimbrites (and their soil derivatives) exhibit a number of unusual and considerably variable physical properties, including low densities, high porosities, high friction angles, low compressive strengths. This project is designed around the classification of the rock/soil materials in terms of lithology and strength. An understanding of the relationship between geology and mechanical properties is important for geotechnical engineering design.

- **The engineering geology of sheared rocks in the Northland Allochthon (Hons or MSc) Advisor: Simon Nelis/Nick Richards**

This study investigates the geological parameters and geotechnical properties of sheared rocks found in the Northland allochthon. This study would involve both field based studies and the collection of undisturbed samples for shear box strength testing in the lab, as well as undertaking basic index testing and clay mineralogy of the sheared materials. The project aims to establish peak and residual shear strength parameters for the soils, which are very prone to the development of landslides.

- **The engineering geological properties of highly weathered and residual soils of the Waitemata Group (Hons or MSc) Advisor: Simon Nelis/Nick Richards**

This project involves the collection, collation and interpretation of existing geotechnical laboratory test data gathered during civil engineering projects in the Auckland region. The purpose of the project is to define the natural variability of engineering geological properties of the rocks and Quaternary deposits in the Auckland region. The data will use information submitted to Auckland Council as part of the consents processes and is freely available by request. The project will represent a very high quality data set which will be published in NZ Geomechanics News for use by Consultant Engineering Geologist and Geotechnical Engineers. This project will give students a firm grounding in the interpretation of laboratory test data and the derivation of geotechnical design parameters. It will also off the opportunity to become very familiar with the stratigraphy usually encountered in the Auckland region.

- **Landslide Hazard and Susceptibility Mapping of South Auckland and the Southern Landslide Zone, Auckland (MSc Only)**

Landslides are a major hazard in certain areas of Auckland. One of the high hazard areas is called the Southern Landslide Zone, located between Flat Bush and Whitford. This region has been identified as an area of active future development in the recent Auckland District Plan. In order to produce a landslide hazard map, we need to know where landslides have occurred in the past, when they occurred, how big they are and what sort of landslide they are. The mapping will be undertaken in GIS using multi-temporal aerial photographs and will be combined with a knowledge of the geology, topography and terrain classification. The overall aim is to produce a landslide susceptibility map for this part of Auckland which can be used by Auckland Council for landuse planning and reducing the effect of landslide hazards.

- **Landslide Hazard and Susceptibility Mapping of North Auckland Region, including Northland Allochthon zones (MSc Only). Advisor: Simon Nelis/Nick Richards**

To the north of Auckland, landslides represent a major hazard to infrastructure and building. Under the recently released unitary plan, this area, which covers the North Shore to Warkwarth, is identified as a zone of intensive development, largely on Greenfield sites. This project aims to produce a series of landslide hazard and susceptibility maps for this area of Auckland. You establish a landslide inventory using multi-temporal aerial photographs and use this to build a susceptibility map, combining geological, topographic and terrain information. The overall aim is to produce a landslide susceptibility map for this part of Auckland which can be used by Auckland Council for landuse planning and reducing the effect of landslide hazards.

- **Investigating the structural geological controls and age of Deep-Seated Gravitational Deformations in the Makarora Region, Otago (MSc Only). Advisor: Simon Nelis/Nick Richards**

Deep-Seated Gravitational Slope Deformations (DSGD) are slow creep movements which cause the deformation of mountain slopes. They are often found in areas which have been recently glaciated and in strongly anisotropic rocks, such as Schist. In the Makarora Valley, there are numerous DSGD features indicating large scale instability of the slopes. Geomorphic features of movement include uphill facing scarps, hummocky terrain and large ridge-top grabens. Virtually nothing is known about the structural geological controls on these slope failures, or how old they are. In terms of hazard management there is a major research question of how far these creep deformations represent pre-cursory movement to catastrophic failure. This research will use a combination of field mapping, 3D numerical modelling (3DEC) and structural geology to understand the controls on failure in this area. There is also a possibility of constraining the numerical models by using cosmogenic dating on some slope failures.