The School of Geosciences
Prospective Honours Projects
2011

The following project descriptions are indicative of current research interests of staff in the School of Geosciences. The projects outlined are deemed suitable for the amount of time available to undertake the research and your current level of expertise.

You should peruse outlines in areas closest to your interests (bearing in mind that the projects are listed in no particular order). The idea is that you choose a research topic along the lines outlined below, subject to consultation with the project supervisor. You are however also free to formulate your own project proposal, in consultation with a prospective supervisor. The project descriptions outlined here may also give you some idea of what is involved in framing a research question for your Honours project.

The environmental and productive implications of farm consolidation and fragmentation in Australia
Supervisors: Bill Pritchard

The ownership of farm land in Australia is undergoing significant change. In some regions, it would appear that farms are consolidating to take advantage of the economies of scale afforded by larger size. In other regions, demand for lifestyle blocks and specialist agricultural pursuits is encouraging farm fragmentation. To date, however, limited work has been undertaken to examine these processes of change. The goal of this project is to investigate some of the social and/or environmental implications of land ownership change in NSW. The data employed depends on the final topic choice but may involve the manipulation of land ownership data using GIS technologies and the use of field-based surveys to assess the implications of changing farm ownership patterns.

Rural transformations, environment and climate change in India
Supervisor: Bill Pritchard

Bill Pritchard has ongoing research activities in India relating to the country’s rural transformations, as it undergoes fast-paced economic growth. Students interested in undertaking an Honours project in India should consult Bill Pritchard. Funding for fieldwork and travel cannot be provided, but Bill has an extensive network of contacts which would facilitate an Honours project in this, otherwise difficult-to-research, project area.

Any mutually agreed topic on food systems in either developed or developing countries
Supervisor: Bill Pritchard

Students interested in issues on agriculture. Rural restructuring, food trade, alternative food movements, environment and sustainability of food production/consumption, WTO issues etc should come and discuss these with Bill.

Any mutually agreed topic in human geography
Supervisor: Bill Pritchard

Bill welcomes any enquiries from students in the broad field of human geography.
Any mutually agreed topic in human geography with reference to development and/or environment in Southeast Asia  
Supervisor: Philip Hirsch

Phil Hirsch has supervised Honours theses on a range of topics related to human geography of environment and development in Southeast Asia and is open to suggestions for topics in this broad field.

Did obesity kill the arc?  
Supervisor: Geoff Clarke

The plate tectonic cycle involves a complex range of interactions and feedback between tectonic, sedimentary, igneous and metamorphic processes, producing a remarkable range of rock types and complex tectonic settings. Continent-ocean convergent boundaries involve the interplay between continental and oceanic lithosphere and mantle asthenosphere over geologic time and can be short-lived features at the timescales of the geological record. Convergent margins past and present represent the prime locus of generation of new continental crust. The ‘subduction factory’ is central to the plate tectonic cycle and there have been many detailed studies that have improved our understanding of the ‘steady-state’ processes in this setting (Eiler, 2004). The cessation of subduction and extinction of magmatic arcs remains largely unstudied and is commonly attributed to changes in far field stresses (e.g. far field influence of the Ontong Java Plateau on subduction elsewhere in the SW Pacific; Cooper and Taylor, 1985; Crawford et al., 2003) or buoyancy-driven impedance induced by blocking up of the subduction system by arrival of buoyant crust at the subduction trench (Cloos, 1993; Aitchison et al., 1995). Other models are scarce. We have new preliminary data from SW Fiordland, New Zealand that has lead to a new model for this region that may inform on the tectonic framework for the global magmatic arc system. We have identified a very high-P (20kbar), high-T(>850°C) root to the Fiordland arc involving inter-layered ultramafic rocks, eclogite and omphacitic granulites representing the Cretaceous crust-mantle transition, a situation exposed in just a few other locations around the world (e.g. Talkeetna arc, Alaska: hacker et al., 2008) and is unique within the long-lived Gondwanan margin subduction system. Preliminary isotopic data are consistent with these new exposures being the youngest magmatic phases that formed just prior to the cessation of magmatism and rifting of the Cretaceous Fiordland arc. These rocks contain distinctive petrologic and isotopic signatures that can be used to test our new model.

Methods: Field mapping and sampling; petrography; whole rock and mineral chemistry; electron microprobe analysis; phase equilibria modelling

Who's involved: Geoff Clarke, (Matthew DePaoli (PhD student), Nathan Daczko (Macquarie University), Luke Milan (Macquarie PhD student), Ian Turnbull (Institute of Geological and Nuclear Sciences, Dunedin), Andrew Allibone (Rodinia).

Detail? Can be shaped to your own interest – it could be field based work (field work in February) or primarily laboratory based; talk to Geoff.

Remote mapping of alteration in high-grade terranes to indicate mineralisation  
Supervisor: Geoff Clarke

Satellite-borne multi-spectral data is poised to form the basis of geological mapping, regional interpretation and mineral exploration, due to it being inexpensive, widely accessible and having recently improved spatial resolution and refined properties. This project will: (i) develop techniques to enable the mapping of geological rock units in representative parts of arid Australia using remotely sensed data; (ii) characterise the mineralogical and spectral properties of a recently identified pre-metamorphic alteration envelop to the Broken Hill orebody to define widely applicable hyper and multi spectral proxies for this type of mineralisation and demonstrate its potential as a vector to mineralisation; and (iii) integrate key rock identification signatures from satellite imagery and airborne geophysical surveys to rapidly extend these geological interpretations to areas peripheral to rock outcrop. It involves researchers from the University of Sydney and Western Australia, industry participants from Perilya, and government participants from the NSW Geological Survey and CSIRO to develop tools that will enable Australian mineral explorers to retain their international competitiveness and refine emerging technologies. It also addresses national training needs and relevant industry skills shortage.
Methods: Core logging and sampling; petrography; whole rock and mineral chemistry; electron microprobe analysis; measuring mineral spectral signatures
Who’s involved? Geoff Clarke, Virtue Scott (MSc student), Bill Reid (NSW Department of Primary Industries), Perilya staff, CSIRO links.
Detail? Can be shaped to your main interest; talk to Geoff.

Lakes as records of environmental change
Supervisor: Stephen Gale

The sediments trapped in lake basins may preserve high-resolution records of environmental change. These may yield evidence of changes in climate, in vegetation and water quality, and may preserve records of human environmental impacts such as soil erosion and pollution. A wide range of sites exist with the potential to tackle a host of environmental problems or to reconstruct how the environment has changed over time.

1421: The year China discovered Australia
Supervisor: Stephen Gale

This project aims to use the historical and geoarchaeological archive to test Gavin Menzies’ contention that Australia was discovered and explored by Chinese fleets centuries before the arrival of the first European.

Dendro-pollution
Supervisor: Stephen Gale

Long-term, high-resolution records of pollution are essential for understanding and solving the problems associated with environmental contamination. Yet such records are non-existent in Australia. This project seeks to explore the potential of tree rings as archives of atmospheric pollution. It focuses on trees from sites with a well-established and thus easily testable history of pollution, and aims to establish pollution event markers that may be employed in determining chronologies of environmental change.

Archaeomagnetism
Supervisor: Stephen Gale

The temperatures below an Aboriginal camp fire are such that, upon cooling, any pre-existing directional magnetism possessed by the underlying material is lost and a new magnetisation is imposed. This magnetisation reflects the direction of the Earth’s field at the time of the last heating episode. Placing this information in a chronological framework by radiocarbon dating of wood from the fire allows us to construct a picture of changes in the direction of the Earth’s magnetic field over time. The aim of this project is to use Aboriginal hearths from western New South Wales as a source of information on secular variations in the development of the Earth’s field during the Holocene.

Exploration Geochemistry of Archean Volcanic Belts, Yilgarn Craton (WA)
Supervisor: Derek Wyman

Honours-level studies in the Leonora area of the Eastern Goldfields, north of Kalgoorlie, WA. The projects will involve on-site research with a group of industry geologists, petrographic (thin section) analysis and the use of major and trace element chemistry in studies of volcanic and (or) sedimentary units in the vicinity of Jabiru Metals Ltd’s Teutonic Bore and Jaguar Volcanogenic Massive Sulphide deposits. Possible topics include establishing the tectonic setting of the deposits, the “chemo-stratigraphy” of volcano-sedimentary units between the two deposits, characterising alteration haloes, and chemical exploration in the regolith weathering profile. Summer employment for Honours students is possible.
Archean – Proterozoic Diamonds and Gold in Greenland  
Supervisor: Derek Wyman

Discussions with the Geological Survey of Denmark and Greenland indicate that Honours projects may be available for the study of samples from diamond-bearing lamprophyre dikes (dike and xenolith samples) and/or spatially associated vein gold mineralization. The study would involve petrography. Electron microprobe analysis and the assessment of geochemical data but would not entail fieldwork in Greenland (samples will be provided).

Gold in the Lachlan Fold Belt  
Supervisor: Derek Wyman

After decades of inactivity, the Majors Creek area (60 km SE of Canberra) is the site of significant exploration for gold. The style of mineralization, however, is not well characterized (“orogenic”, epithermal, or intrusion-related?). Honours-level studies of mineralization and associated igneous intrusions would help to resolve genetic models and clarify the controls on known mineralization in the area. Some field work would be required, which would be followed petrographic and geochemical studies of mineralization.

Oil migration within a Proterozoic basin  
Supervisor: Adriana Dutkiewicz

Global hydrocarbon exploration is restricted to fairly young (Phanerozoic) reservoirs and is extremely rare in rocks that are older than about 500 Ma (e.g., Late Proterozoic Huqf Group in Oman). It is generally assumed that even if hydrocarbons were generated in sufficient quantities, they would not have survived over such long periods of time given that most Precambrian basins have experienced structural reactivation and metamorphism. The aim of this project is to define regional-scale oil migration in a Precambrian sedimentary basin using preserved relics of ancient hydrocarbons. In particular, the project will explore the timing of fluid migration and the source of the hydrocarbons. The study will have implications for exploration in frontier basins as well as evolution of life on early Earth. The project will exploit oil-bearing fluid inclusions preserved in potential Proterozoic reservoir rocks (either the Witwatersrand Basin in South Africa or the Franceville Basin in Gabon) to determine the extent of oil migration, relative timing and conditions of oil entrapment and any possible association with mineralising fluids.

Precambrian bitumen nodules: how they formed and what they tell us about Earth’s early environments  
Supervisor: Adriana Dutkiewicz

Solid bitumen nodules form from the alteration of once-liquid petroleum through physical or chemical changes and are fairly common in most petroleum reservoirs. Most of the bitumens have formed through one of these processes: thermal alteration, deasphalting, and biodegradation. The Precambrian nodules are different in that many, though not all, appear to have formed around radioactive grains. The broad aim of this project is to compare bitumen nodules from a large variety of Precambrian Basins associated with different types of mineralization to formulate a hypothesis (or hypotheses) of how they may have formed and whether multiple phases of oil migration were involved. The project will use methods such as elemental mapping, scanning electron microscopy, non-destructive spectroscopy, micro-CT and carbon isotope analysis.
The origin of sedimentary opal deposits  
**Supervisors: Adriana Dutkiewicz and Patrice Rey**

Although Australia supplies over 90% of precious opal world-wide, very little is known about how sedimentary opal forms. The broad aim of this project is constrain the conditions under which precious and common (non-precious) opal and associated minerals form. Methods that may be used will include microscopy, X-ray diffraction, spectroscopy and stable isotopes and other geochemical techniques. The project will also include data collation and synthesis from the Great Artesian Basin, particularly concerning palaeoenvironments, structural reactivation and groundwater chemistry. Some fieldwork to the Australian outback will be involved, including attendance of the Opal Symposium in Lightning Ridge.

**Students are welcome to suggest their own research topic in the field of sedimentology/petroleum geology/sedimentary petrography, particularly involving industry and/or a government body such as CSIRO. These must have a scientific merit (i.e., address a scientific problem).**

The formation of Australian opals  
**Supervisors: Patrice Rey and Adriana Dutkiewicz (EarthByte Group)**

Opal is a very common form of hydrated silicon dioxide that forms under near surface conditions. In contrast to common opal which has a dull color and can be found in most sedimentary basins, precious gem-quality opal is rare and occurs almost exclusively in the Australian Great Artesian Basin. There has been a wealth of investigation onto the formation of this amorphous type of silica and its chemical and physical characteristics and properties. In contrast, studies on the formation of economic deposits of precious opal are remarkably absent with the exception of recent papers on the formation of opalized bones through tightly coupled dissolution-precipitation reactions. This project presents aims at characterizing microstructure in various opal deposits and to perform physical experiments on the formation of opal-bearing fractures. The Honours student will have the option to emphasise either structural or petrographic component of this project depending on background practical knowledge and interest.

How far can the lower crust flow?  
**Supervisor: Patrice Rey (EarthByte Group)**

Gravitational potential energy stored in an orogenic plateau can be strong enough to deform the surrounding region (foreland), hence contributing to both plateau growth and collapse. Gravity-driven channel flow from the plateau lower crust into the foreland lower crust, called channel extrusion, has been proposed as a main contributor to the eastward growth of the Tibetan plateau, possibly driving the lower crustal channel as far as 2000 km in 15 myr, at an average flow velocity over 10 cm/yr. However, isostasy-driven upward flow in response to either erosion focused on the plateau steep margins, or stretching of the plateau upper crust to produce domal structures (metamorphic core complexes), compete with horizontal channel flow extrusion. Using 2D and 3D thermal-mechanical modeling, this project aims at exploring the dynamic coupling among the various flow processes that take place during gravitational collapse and the assess the magnitude of channel extrusion in southeast Tibet.

The role of gravitational forces in the opening of back-arc basins: application of the opening of the Aegean Sea  
**Supervisors: Patrice Rey and Dietmar Müller (Earthbyte Group)**
Slab rollback, the oceanward motion of the subducting oceanic lithosphere, is a favourite amongst the processes leading to back-arc extension and detachment of micro-continents from continental mainlands. A different way to interpret the dynamic of back-arc extension involves gravitational forces that arise from the thinning of the lithospheric mantle. A recent set of numerical experiments show that gravitational forces can drive back-arc extension forcing slab rollback. Coeval extensional and contractional tectonics in the overriding plate is a key observable that can help to decipher between rollback-driven back-arc extension and back-arc driven slab rollback. This project aims at exploring further the link between gravitational forces and back-arc extension and to apply this new concept to the opening of the Tasman Sea and that of the Aegean Sea. The project involves 2D thermo-mechanical experiments, using a particle in cell numerical codes (Ellipsis).

**Continental Subduction: What happens to the continental crust once it has been subducted?**

**Supervisors: Patrice Rey (EarthByte Group), Christian Teyssier (Univ. of Lausanne) and Donna Whitney (Univ. of Minneapolis)**

Continental subduction is the process through which the continental crust gets dragged into a subduction zone burying the continental crust deep into the diamond stability field (>150km). The subduction of the continental crust is however limited by the buoyancy of the crust. It is not clear what happens to the continental crust once the maximum depth is reached. Does the crustal slab melt and rise through the overriding mantle wedge as a large crustal diaper that flattens out at the base of the overriding crust, or does the slab get exhumed back to the surface as a rigid buoyant slab? Also important is the question of how the growing gravitational force related to the subducting continental crust impacts on the converging continents.

This project aims at exploring the processes controlling the relaxation of subducted continental crusts. The project involves 2D thermo-mechanical experiments, using a particle in cell numerical codes (Ellipsis). The subduction of the Baltica continent under Laurentia (440-390 Mya) will be used as a prime example providing first order constraints on the timing of continental subduction as well as the PTt paths followed by exhumed high-pressure crustal eclogites.

**Seismic-structure Honours research projects with OilSearch**

**Supervisors: Patrice Rey and Dietmar Müller (Earthbyte Group) and Kevin Hill (OilSearch)**

Two projects are available; each involves workstation interpretation of 12-15 high quality seismic lines from the Gulf of Papua. Each project will require a student with an interest in resource exploration and an above average commitment in time and motivation to participate in data analysis and modelling. The successful candidate will, in part, be embedded in a professional and strongly goal-oriented research program at OilSearch, although the majority of the research will be carried out in the School of Geosciences at the University of Sydney. The reward will be a $1,000 Honours scholarship provided by OilSearch, the opportunity to experience “real-life” research during the Honours year in close collaboration with an industry partner, attendance of a professional Schlumberger seismic interpretation course in Adelaide, and a joint publication in an exploration journal. Students will be encouraged to apply for PESA scholarships and to attend the Eastern Australian Basins Symposium and other conferences supported by OilSearch. Students are expected to present their results to OilSearch and supply a copy of their thesis. Students will be co-supervised by Dr Kevin C. Hill, who was formerly at the University of Melbourne.

**Structural-stratigraphic evolution of a buttressed delta-front sequence**

**Supervisors: Patrice Rey and Dietmar Müller (Earthbyte Group) and Kevin Hill (OilSearch)**

This project involves workstation interpretation of a grid of 12-15 regional seismic lines across the collapsed Fly River delta sequence. The successful candidate will need to interpret and correlate the sedimentary sequences and determine the timing and amounts of extensional faulting. Students will have a seed line from OilSearch (with suggested interpretation), tied to the Orokolo well. It is proposed that the best seismic line be depth converted (a simple process in this basin) and the seismic data restored to demonstrate the structural evolution. The results may be presented as a poster at a conference.
Structural-stratigraphic evolution of an underwater mountain front
Supervisors: Patrice Rey and Dietmar Müller (Earthbyte Group) and Kevin Hill (OilSearch)

This involves workstation interpretation of a grid of 12-15 regional seismic lines across the formal structure of the submerged Aure fold and thrust belt. The successful candidate will to interpret and correlate the sedimentary sequences and determine the timing and amounts of compressional faulting. Students will have a seed line from OilSearch (with suggested interpretation), tied to the Orokolo well. It is proposed that the best seismic line be depth converted (a simple process in this basin) and the seismic data restored to demonstrate the structural evolution. The results may be presented as a poster at a conference.

Proposed Honours projects in Geology/Geophysics for 2010
Sponsored by Oil Search Ltd.
Supervisors: Patrice Rey and Christian Heine

Oil Search, based in downtown Sydney, proposes to sponsor one or two high quality students to undertake geology/geophysics Honours projects in 2010. The projects will involve geological interpretation of a grid of seismic data on a workstation at the student’s University. The two planned projects are:
1. interpretation of a suite of 10-20 seismic lines from the offshore Gulf of Papua to interpret sequence stratigraphy and structure
2. interpretation of a suite of 10-20 seismic lines from Yemen to interpret sequence stratigraphy and structure

The Gulf of Papua contains a well-imaged Pliocene-Pleistocene deltaic sequence that is up to 5 km thick and has prograded over widespread Miocene carbonates, including local reefs that contain gas. Extensional faults and rollover anticlines are common in parts of the deltaic sequence. Delta-top and –slope facies as wells as pro-delta beds with potential deep-sea fans can be interpreted. The subcrop of the Miocene carbonates is a gently tilted Jurassic to Cretaceous clastic sequence including the main hydrocarbon reservoir in the Papuan Fold Belt.

The Yemen project will analyse a Jurassic and Cretaceous clastic and carbonate sequence with occasional evaporites, overlying fractured basement. Extensional faulting is common, together with inferred minor strike-slip offset and/or inversion. The sequences include both shallow- and deep-water deposits.

Students will be supplied with a Geoframe, Landmark or Kingdom project containing seismic data and wells which they will load on their university workstation. They will be expected to prepare full stratigraphic and structural interpretation including surface and isochron maps and to write up a geological evolution of the area.

Oil Search expects the students to work as summer students (appropriately paid) within the Oil Search office over the summer preceding the commencement of Honours so that they can become familiar with the company, be taught some of the necessary skills for the project and define the details of the project. For high quality students with good CVs, transcripts and references, Oil Search will also pay a stipend of $5,000.00 each. This is to assist with their Honours costs and particularly to help pay for courses that are required out of Sydney, for instance the seismic interpretation courses at the Australian Petroleum Centre in Adelaide. Oil Search will supply a co-supervisor of the project, but the main supervisor will be at the University. The students will be required to regularly report results at Oil Search and to give a final 20
minute presentation to Oil Search in November 2010. A presentation at a PESA luncheon will be encouraged.

For further information and to apply, contact your Honours coordinator and Dr Kevin C. Hill at Kevin.hill@oilsearch.com. Oil Search will require a CV, transcript and references.

Thermal-mechanical modelling and coupled synthetic seismic modelling: A new exploration tool for hydrocarbon exploration
Supervisors: Patrice Rey and Leonardo Quevedo (Earthbyte Group)

Multi-million dollar drilling programs for oil and gas exploration rely on the accurate interpretation of seismic lines to constrain the location of potential hydrocarbon traps and understand their evolution. We propose to further constrain this interpretation by implementing a new iterative approach in which fully coupled thermal-mechanical models of oil and gas fields are converted into synthetic seismic sections to be confronted to real data for feedback into thermal-mechanical models until an acceptable match between synthetic and real seismic data is reached. The aim is to recover the exact architecture of hydrocarbon fields, to identify unseen trap structures and to constraint their temperature histories. This work builds upon two very successful previous honours projects.

Terrestrial Planet Evolution: Clues from Artemis giant structure on Venus
Supervisors: Patrice Rey (Earthbyte Group), Vicky Hansen (Univ. of Minneapolis), NASA project

Reconnaissance mapping indicates that Artemis, Venus’ unique 2400 km diameter feature, is much larger than previously recognized, including a wide outer trough (>5,000 km diameter), a radial dike swarm (12,000 km diameter), and a concentric wrinkle ridge suite (13,000 km diameter). Artemis likely represents the signature of a deep mantle plume on relatively thin lithosphere, a setting that may be analogous to the Earth first few hundred myrs. We aim to understand the extent and development of this unique feature and implications for both Venus evolution and that of the primitive Earth. The project consists of geologic mapping that will provide observable to constraint 2D and 3D geodynamic modeling in order to assess the formation and evolution of deformation belts, chasmata-coronae, shield terrain, and Artemis within the map area.
Controls on coral reef evolution: linking 4D numerical modelling and observational data.  
**Supervisor: Jody Webster (USYD) jody.webster@sydney.edu.au**

This project will investigate the relationship between biological and geological processes controlling the evolution (stratigraphic ages, residence times and geometries (‘architecture’) of coral reef systems. We will construct new 4D numerical models using state of the art software (eg., CARBONATE 3D) and compare them against observational reef data sets from the Great Barrier Reef, Hawaii, Papua New Guinea. We aim to assess the sensitivity of coral reef systems to various environmental stresses (eg. sea-level rise, subsidence and sediment flux) acting on different timescales, magnitudes and rates. The project may also involve field work to One Tree Reef in the southern GBR to calibrate model parameters and processes against real world sedimentary and biological examples. This project is part of the GeoReef groups larger ARC Discovery funded project to support work on Exp. 325  

Reconstructing paleoclimate variability using fossils corals in the western tropical Pacific Ocean  
**Supervisor: Jody Webster (USYD) jody.webster@sydney.edu.au**

The climate of the tropical Pacific has a far reaching influence on global climate, delivering large amounts of heat to the atmosphere, playing a leading role in driving global atmospheric circulation, and influencing climate far from the Pacific through the El Niño–Southern Oscillation (ENSO). This project will involve reconstructing short, seasonally resolved paleoclimate “windows” (eg., sea surface temperature and salinity) from fossil corals during the last deglaciation (20-10 ka). The project will be conducted jointly with Dr. Mike Gagan at the Australia National University and the student will learn advanced techniques in geochemistry (eg. paleo-climate proxies - stable isotopes and trace elements) and paleoclimate data analysis. This project is part of the GeoReef groups larger ARC Discovery funded project to support work on Exp. 325  

Modern sea surface temperate in the Indo Pacific (Mean annual SSS/SST: Levitus, 1994).
**Quantitative geomorphology of the modern Great Barrier Reef**  
*Supervisors: Jody Webster (USYD) jody.webster@sydney.edu.au and Rob Beaman (JCU) robin.beaman@jcu.edu.au*

The project will investigate new and existing high-resolution remote sensing data (LADS & multibeam bathymetry data, aerial photographic imagery) to understand the main processes controlling the geomorphic variation of reef and associated environments in Great Barrier Reef. Using advanced GIS and 3D visualization tools, we will develop a new quantitative morphologic characterisation of the reef and inter-reef areas (ie. Sediment wedges, banks, channels, shoals, sand wave/dunes). We will also explore the relationships between the benthic habitats/sedimentary facies, the quantitative geomorphic data and physical processes operating in the GBR. The project will have implications for improving our understanding modern reef environments and processes as well enhancing ancient carbonate petroleum reservoir models.

![High-resolution LADS bathymetry data from southern Great Barrier Reef showing reef and inter-reef areas (data source http://www.hydro.gov.au/aboutus/lads/lads.htm).](image)

**Sediment architecture and evolution of the upper slope of the Great Barrier Reef margin.**  
*Supervisors: Jody Webster (USYD) jody.webster@sydney.edu.au and Rob Beaman (JCU) robin.beaman@jcu.edu.au*

The project will investigate the sediment architecture and evolution of the upper slope (~150-500 m) of the Great Barrier Reef margin. The project will involve the analysis of new high-resolution multibeam bathymetry and seismic data from four different sites along the GBR margin. Multibeam bathymetry data will be used to generate high-resolution 3D maps of the upper slope and investigate morphologic characteristics of the margin. Seismic reflection data will be used to investigate the nature of the subsurface including internal structure and geometry of subsurface reflectors and large scale sediment slope architecture. We will use the state-of-the-art industry KINGDOMtm software suite to fully integrate all bathymetry, seismic, and available sediment core data sets. This will provide the comprehensive 3D spatial framework needed to build new models of the sediment architecture and evolution of the upper slope in response to sea level variations. This project is part of the GeoReef group's larger ARC Discovery funded project to support work on Exp. 325 [http://publications.iodp.org/preliminary_report/325/index.html](http://publications.iodp.org/preliminary_report/325/index.html).

![A high resolution Topas seismic reflection profile showing a cross section through the upper slope of the central Great Barrier Reef. Note the complex system of stacked fluvial channel systems.](image)
Reef habitat change in the Southern Great Barrier Reef over decadal timescales: analysis of high-resolution satellite remote sensing data.
**Supervisors:** Jody Webster (USYD) [jody.webster@usyd.edu.au](mailto:jody.webster@usyd.edu.au) and Dr Ana Vila-Concejo (USYD) [A.VilaConcejo@usyd.edu.au](mailto:A.VilaConcejo@usyd.edu.au)

The project will investigate if the nature and size of reef habitats at One Tree Reef have changed over the last five decades. This project is part of a larger project currently ongoing in the School of Geosciences to understand sediment and habitat dynamics operating on different spatial and temporal scales. The first stage of the project will apply advanced GIS techniques to accurately quantify the historical extent of the main reef habitats using newly acquired World View 2 high-resolution, multispectral (0.5 m, 8 band) remote satellite imagery. The second stage will involve an extensive field work program (funding provided) at the One Tree Island Research to groundtruth the remote sensing data, and conduct detailed investigation of modern reef habitats.

![Aerial photograph showing the leeward migration of the sandsheet on the southern reef flat of One Tree Reef.](image)

Seismic stratigraphy: platform architecture and development of the GBR shelf edge reef system.
**Supervisor:** Jody Webster (USYD) [jody.webster@sydney.edu.au](mailto:jody.webster@sydney.edu.au)

The project will investigate the platform architecture and evolution of the shelf edge of the Great Barrier Reef margin. The project will involve the analysis of new high-resolution seismic, multibeam bathymetry, surficial sediments and IODP Exp. 325 core data from the GBR margin. The seismic reflection data will be used to investigate the nature of the subsurface including internal structure and geometry of subsurface reflectors, particularly the relationship between the basement substrate of the fossil reefs and the modern and paleo-lagoon sediment characteristics (i.e. thickness, geometry) and influence of paleochannels that cross the shelf edge. We will use the state-of-the-art industry KINGDOMtm software suite to fully integrate all bathymetry, seismic, and available sediment core data sets. This will provide the comprehensive 3D spatial framework needed to build new models of the sediment architecture and evolution of the shelf edge in response to sea level variations. This project is part of the GeoReef groups larger ARCDiscovery funded project to support work on Exp. 325 [http://publications.iodp.org/preliminary_report/325/index.html](http://publications.iodp.org/preliminary_report/325/index.html).

![A bathymetric cross section across the shelf edge of the GBR showing a succession of fossil coral reef structures](image)
Understanding the Holocene “turn-on” of the Southern Great Barrier
Supervisor: Jody Webster (USYD) jody.webster@sydney.edu.au

As global climates change the modern Southern Great Barrier Reef (Capricorn Bunker Group) will likely record the first and most marked biologic and geologic changes. Therefore it is crucial, now more than ever, to develop a comprehensive geological framework with which to interpret these possible changes. The project will focus on a major event in the evolution of this sensitive region of the GBR – the Holocene “turn-on” between 8-9 ka. We will investigate a suite of fossil coral cores from the region to: (1) establish the precise timing of reef initiation and early growth using new C14-AMS and U/Th ages; (2) assess the sedimentologic and biologic composition (ie. corals, coralline algae) of the reefs; and (3) reconstruct the paleoceanographic conditions during this “turnon” period. The project may also involve field work to One Tree Reef in the southern GBR in order compare modern sedimentary and biological environments to those observed in the fossil reef cores.
The role of resuspension in estuarine contaminant transfer (or ‘Is Sydney Harbour cleaning up or getting worse?’)

Supervisor: Gavin Birch

Objectives:
- To determine processes governing transport of contaminated particles in estuaries under conditions of wind-generated resuspension.
- Construction of a verified, predictive contaminant transport model to assist managers design remedial strategies.
- To reduce degradation and maintain long-term sustainability of capital ports, such as Sydney Harbour.

Background: Effective management of an estuarine environment, especially of a contaminated system, requires knowledge of major physical and chemical processes governing the transport of fine particulate materials. A major physical process governing the transport of suspended particulate material (SPM) and associated particle-bound contaminants in estuarine environments is resuspension. Strong winds create surface waves, which, in shallow water (<5m), project energy to the water-sediment interface resulting in resuspension of fine sediment from the upper layers of the estuary floor. Once in suspension, fine material may be transported by tidal currents to other parts of the estuary and possibly to the ocean during multiple reworking phases.

The present proposal is to study resuspension processes to determine the fate of sediment-bound contaminants in of Sydney Harbour. Sediment resuspension takes place most days over summer and frequently during winter and it has been estimated to take place in up to 30% of the harbour at any one time (Taylor, 2000). If wind-generated resuspension is capable of removing contaminated sediment from embayments, then the rate of natural clean up (relaxation) will determine remedial strategies for large accumulations of contaminated sediment. The investigation will focus on dioxins escaping Homebush Bay and a suite of contaminants that appear to being trapped in Iron Cove. Knowledge of the behaviour of SPM during resuspension events will allow the construction of long-term strategic plans to remediate this iconic natural resource. Knowledge gained through this investigation will assist in management of similar estuaries influenced by wind-generated resuspension worldwide.

A considerable amount of information is available for Iron Cove, a small (1.56 km²), shallow (mean depth 6 m) embayment on the south coast of central Sydney Harbour. This embayment is mantled in highly-contaminated mud and is typical of many such areas of the harbour where resuspension occurs frequently. Iron Cove will be used as the major area of investigation in the proposed project and results will be used to determine whether similar processes are taking place in other small, highly contaminated embayments. It is proposed that a series experiments be set up during wind-driven resuspension events to determine whether current velocities are sufficiently strong to remobilise bottom sediment and to entrain resuspended material and transport it to deeper water (Schoellhamer et al., 2007). Stations comprising a pressure sensor, two optical backscatter sensors and tubing for water sampling will be attached to stainless steel poles arranged perpendicular to the shore in the inter- and sub-tidal zone. Wind speed, turbidity, wave height, total suspended solids will be measured simultaneously and metal concentrations analysed later to determine contaminant fluxes. Models will be developed so that resuspension episodes can be predicted directly from wind speed and tide height information. Turbidity resulting from resuspension will be measured in the cove by profiling the water column with a water quality monitor deployed from a boat. Three stationery current meters will be located along the axis of Iron Cove and Broad-band Acoustic Doppler Current Profiler (BB-ADCP) transects will be taken across and down the axis of the cove to determine whether tidal velocities are sufficient to transport SPM out of the embayment possibly during multiple resuspension events. Considerable contaminant loading data have been collected over a 5-year period for Iron Cove (Barry et al., Rochford, 2008; Davis and Birch, in press) and potential export flux determined in the present study will allow a contaminant budget and relaxation rates to be calculated for the embayment.

ARC-funded 2-D and 3D hydrodynamics models of Sydney Harbour have been developed and calibrated using BB-ADCP water velocity data (Lee and Birch, in press). This model will be used as the basis to develop a new model incorporating resuspension and tidal transport in shallow embayments. Additional data on maximum tidal velocities and water quality will be acquired in the lower estuary to assess trans-estuarine transfer and to determine the ultimate fate of resuspended sediments. The new model will be used to simulate observed behaviour of resuspended matter to assist in the understanding of transport processes in Iron Cove and the lower harbour. The results of the field study and the new, detailed model will determine whether SPM is ‘leaking’ out of other shallow embayments in the harbour, including the fate of dioxin-rich SPM remaining in Homebush Bay after remediation. This information is required to predict relaxation rates for contaminated parts of Sydney Harbour and to prepare long-term remedial strategies for the harbour.
A water and sedimentation model for Port Jackson
Supervisor: Gavin Birch

Objectives:
- Assess and categorise status of creeks and canals discharging to Sydney estuary
- Determining the amount of stormwater available within the Sydney estuary catchment for water harvesting
- Determining erosion rates and mass of contaminants exported to Sydney estuary
- Determining sedimentation rates in Sydney estuary

Background: Water resources have, belatedly, come to be realised as Australia’s most precious (and wasted) resource. This is not restricted to a rural/agricultural problem. Combined reservoirs serving Sydney were (September 2007) at a historical minimum, i.e. at 34% capacity. Sedimentation in Port Jackson is of vital importance to the management of the estuary. High sedimentation rates affect seagrass growth, smother fringe populations and prevent vessels from using large valuable marine facilities. Sediment, especially the finer fraction, is the major carrier of contaminants and in some parts of Port Jackson sediment contains concentrations of some chemicals that are adversely effecting benthic populations.

Yet to date no water budget is available for Port Jackson catchment and little is known about sedimentation rates in the estuary. Currently, an unknown quantity of re-useable stormwater is being discharged into Port Jackson and there are no plans for harvesting such resources. There is a desperate need to improve the quality of some surficial sediment in Port Jackson so that benthic populations can be re-established and yet there is no consideration on how this can be achieved. A very expensive (>$1m) program has been ongoing in Sydney for a considerable period to prevent sediment leaving construction sites without the success of the venture being evaluated.

The Project: The project aims to produce a runoff and sedimentation model for Port Jackson using data already acquired by the Environmental Geology Group. The environmental status of canals and creeks currently discharging to the Sydney estuary will be assessed and categorised to assist in management of these valuable resources. Theoretical water runoff and soil erosion/transportation models will use digital evaluation models, landuse, impervious surface data and rainfall information. Model outputs will be compared to flow rates and sedimentation rates in the estuary.

The second part of the project will include a detailed critique of water use in the catchment and how stormwater can be harvested to provide a valuable in situ resource for domestic use and recreational areas in some of the most densely urbanised areas of the city. This will link elegantly with a current PhD project which is aiming to optimise the efficiency of a filtration device to remediate stormwater discharging into the estuary. Storage of stormwater is an issue and there is a need to think ‘outside the square’. Can the (porous) Hawkesbury Sandstone underlying the city be used for storage, or can the Sydney storage tunnel be utilised for short term benefits? On-the-ground work will be undertaken to determine actual mass of sediment leaving a number of better known catchments and these data will be related to modelled information and sedimentation rates as determined from the receiving basin. Then theoretical sedimentation model may have to be calibrated for the Sydney estuary and catchment. We have already determined metal concentrations of soil in the entire Sydney estuary catchment and now we need to know how or if this material is being exported to the estuary. If soil is being delivered to the harbour in large amounts, is there a need to remove contaminated sediment from the estuary? If so, how should this be undertaken? Dredging is an option, but why is it not being considered?

This project will be integrated with other work being undertaken within the School, i.e. modelling catchment contaminant loading, stormwater runoff studies, stormwater remediation and building a science-based strategy for the long-term management of the harbour.

The role of sediment resuspension on metal uptake by estuarine filter-feeding animals
Supervisor: Gavin Birch
Overview
Sydney Harbour is the oldest working harbour in Australia, since first settlement in 1788 it has become heavily urbanised and industrialised, and as a consequence the harbour is heavily polluted with both heavy metals and organic contaminants. Aquatic fauna are susceptible to bioaccumulation of these metals from both the sediment and surrounding water. The current study aims to determine the rate and mechanism of bioaccumulation of metals in several aquatic species inhabiting Sydney Harbour. Filter-feeding organisms, such as oysters and mussels have long been used to monitor metal concentrations, it is thought that resuspension of sediments may impact on the bioaccumulation of the contaminants in these organisms. By developing laboratory experiments, the current study aims to measure the impact of resuspension may have on bioaccumulation processes in Sydney Harbour.

Aims

- Determine the metal concentrations in oyster tissue, water and sediment at selected sites in Port Jackson;
- Determine an appropriate methodology for measuring bioaccumulation in the monitored species;
- Determine an appropriate methodology for measuring the impact from resuspension on bioaccumulation in the field
- Determine bioavailability of metals in suspended particulate matter
- Replicate field condition in laboratory controlled microcosm studies and measure rate of bioaccumulation and the impact from of resuspension.

Background

Port Jackson is a major urban, industrial and commercial centre of Sydney. Over the past 200 years the harbour has been adversely affected by the intense concentration of people and activities; as a result much of the harbour is now heavily polluted with metals and organic pollutants. Extensive research has been carried out on the nature of metallic contaminants in Sydney Harbour; however only sediment and water in the harbour has been analysed, little research has examined the impact these contaminants have on the organisms that inhabit the harbour.

Birch and Taylor (2004) have found the surficial sediments of Sydney Harbour to contain mean concentrations of metals, organochlorine compounds and polycyclic aromatic hydrocarbons (PAHs), which are among the highest in the world. The sediments are found to have an average enrichment of Cu, Pb and Zn of around 10 times natural levels, with maximum enrichments around 100 times background levels for Cu.

Animals tend to bioaccumulate metals and organic compounds. Oysters are traditionally used to determine bioaccumulation as they are sessile organisms, and therefore only indicate contamination in their immediate environment. Several studies have been conducted in Australia on oyster contamination, though only one study included Sydney Harbour. Scanes and Roach (1999) found oysters in Sydney Harbour to be enriched in most metals, particularly in Cu, Zn and Pb, with the later enriched by a factor of 13 above mean background concentrations.
Baudrimont et al. (2005) determined the bioaccumulation of Cd, Cu and Zn in oysters in France and found that these metals could accumulate to significant concentrations within these organisms.

Studies have shown resuspension of sediments can lead to the reduced quality of seston (i.e. increased sediment in diet) of filter-feeders (Crandford et al., 1998; Fichet et al., 1998). Fichet et al. (1998) examined the bioavailability of Cd, Cu, Pb and Zn in resuspended particles on oyster larvae. They found resuspension may induce the release of bioavailable forms of these metals and in turn abnormal development in the larvae.

References


SCANES P.R. & ROACH A.C. 1999. Determining natural ‘background’ concentrations of trace metals in oysters from New South Wales, Australia. Environmental Pollution 105, 437-446.

Catchment control on receiving water quality in Sydney subcatchments – creating a system of report cards and targets

Supervisor: Gavin Birch

Objectives:

- Determine relationship between catchment condition and quality of receiving basin
- Create a system of environmental reports cards for subcatchments
- Set targets for subcatchments to assess progress towards an acceptable condition

Background: Substantial environmental information is now available for the Sydney estuary and catchment. Soil chemistry is known for the entire catchment and metal loading has been determined for all creeks entering the harbour. The chemistry of sediments has been assessed for all embayments of the estuary, anthropogenic contribution to estuarine sediments has been determined and all the effects on biological populations has been estimated and measured. The distribution of intertidal flora is known.
Now is an appropriate time to put all these data together to better understand how the catchment controls receiving basin condition.

The Project: A system of report cards has been devised for Moreton Bay (Qld) setting out the condition of contributing sub-catchments and the quality of adjacent embayments based on metrics e.g. seagrass distribution, water quality, sediment characteristics. A systematic and scientifically rigorous scheme of measuring a number of environmental indicators has evolved to provide a clear understanding of how the ecosystem health of this area is behaving temporally. Management of the Moreton Bay system is the most advanced in Australia and is well considered globally. The current project will use the Moreton Bay approach as a model. Although we do not have the funding to undertake repeat measurements on any temporal scale, we will establish the current condition and set targets for attaining an acceptable condition. It is anticipated that this project will lay the foundations for submitting a grant application to support post-graduate research in this topic. Students who may consider future studies and careers in this science/management area would be interested in this opportunity.

Bioaccumulation, biomonitoring and modelling contaminant uptake in degraded NSW estuaries using oysters
Supervisor: Gavin Birch

Objectives:

- Determine relationship between metals in estuarine sediments and oysters
- Use oysters as biomonitoring tools to assess estuarine condition
- Set up tissue burden guidelines
- Construct a biotic ligand model

Background: A considerable amount of chemical data is available for surficial sediments in NSW estuaries. However, these data have limited ability to predict adverse effects on living resources and in the absence of toxicological data, bioaccumulation will be used to assess the possible adverse biological effects of sedimentary contaminants in a range of NSW estuaries.

Oysters have been used extensively as a biomonitoring tool. These animals are sessile, their feeding habits are well known and they are an integral part of the food chain and thus are an appropriate sentinel organism for study. Oysters provide a time-integrated assessment of bioavailable elements.

An alternative approach to determine bio-sensitivity is to use sediment quality guidelines (SQG) to assess the biological significance of sediment-bound contaminants in the absence of direct biological effects data. SQG are providing useful management tools for screening sediment chemical data and to identify and prioritise problem areas in Port Jackson. However, the effects-based data are currently unavailable locally.

Selective chemical extraction procedures are another method being used to estimate the bioavailable proportion of total metals contained in sediment. However, the relationship between chemically-derived bioavailable fraction and metal uptake has not been established.

Other objectives of this project:

- Relate the spatial distribution of oysters to sediment contaminant concentrations.
- Determine the spatial and temporal variance in oyster metal concentrations.
- Investigate relationship of animal length, age weight to metal body concentrations.
- At specific locations, determine the relationship between metal concentrations in oysters and in ambient sediment.
- Relate metal concentrations in sediment and oysters to sediment quality guidelines.
- Compare metal concentrations in oysters to predictions using critical body burden theory.
- Relate oyster data to selective extraction results for ambient sediment.
Evaluating the efficiency of stormwater remedial devices and critique current remedial strategies in the Sydney estuary  
**Supervisor: Gavin Birch**

**Objectives:**
- Evaluate existing data on remedial devices to determine efficiency in removing contaminants from stormwater.
- Establish existing remedial strategy for Sydney estuary catchment.
- Determine most efficient remedial strategy for the catchment and re-model stormwater contaminant export to Sydney estuary.

**Background:** Over $60m has been spent over the last 10 years on providing stormwater remedial devices in NSW and $16m of this has been given to Councils within the Sydney estuary catchment. Ongoing work in this area has seen continued expenditure on providing advice to Councils regarding the remediation of stormwater. All these funds have been outlaid in almost the complete absence of information on the efficiency of these devices in removing contaminants moreover, the stormwater model used in making these decisions lacks any data on contaminant removal under any flow regime.

**The Project:** This project will assess data already collected by Councils and available in the literature on such devices as wetlands, retention ponds and centrifugal devices to determine remedial efficiency. Additional data will be collected as required. The objective of the programme will be to determine the efficiency of a number of remedial devices and undertake a cost-benefit analysis to assist in decision making by Councils, industry and government agencies.

The existing stormwater remediation situation in the catchment will be critiqued and a new whole-of-catchment solution will be provided and assessed.

Contaminant uptake by mangroves/seagrass in a highly polluted estuary  
**Supervisor: Gavin Birch**

**Objectives:**
- Relate the spatial distribution of mangroves/seagrass to sediment contaminant concentrations.
- Determine the spatial and temporal variance in mangroves/seagrass metal concentrations.
- Investigate relationship of length, age weight to metal tissue concentrations.
- At specific locations, determine the relationship between metal concentrations in mangroves/seagrass and in ambient sediment.
- Relate metal concentrations in sediment and mangroves/seagrass to sediment quality guidelines.
- Relate mangrove/seagrass data to selective extraction results for ambient sediment.

A considerable amount of chemical data is available for surficial sediments in Port Jackson. Some of the highest concentrations of heavy metals, organochlorins and polycyclic aromatic hydrocarbons of any capital port occur in sediments mantling shallow tributaries and embayments close to central Sydney. However, these data have limited ability to predict adverse effects on living resources and in the absence of toxicological data, bioaccumulation will be used to assess the possible adverse biological effects of sedimentary contaminants in the estuary.

Mussels have been used extensively as biomonitors in marine and estuarine environments: e.g. the ‘Mussel Watch’ programme is a world-wide project using mussels to assess environmental impact on coastal waters. Oysters have also been used extensively as a biomonitoring tool. Both these animals are sessile, their feeding habits are well known.
and they are an integral part of the food chain and thus are appropriate sentinel organisms for study. Mussels and oysters provide a time integrated assessment of bioavailable elements. Less research has been undertaken on the ability of mangroves to take up contaminants. However, it is known that under certain conditions heavy metals are concentrated in their leaves and roots. Whether they can be used as a biomonitoring tool is unknown.

An alternative approach to determine bio-sensitivity is to use sediment quality guidelines (SQG) to assess the biological significance of sediment-bound contaminants in the absence of direct biological effects data. SQG are providing useful management tools for screening sediment chemical data and to identify and prioritise problem areas in Port Jackson. However, no effects-based data are currently available locally.

Mussels and oysters are filter feeders and therefore uptake is by ingestion of particulates in the water column. Sediment resuspension is thus very important in the bioaccumulation process and this will be studied in detail using laboratory-controlled experiments.

Selective chemical extraction procedures are another method being used to estimate the bioavailable proportion of total metals contained in sediment. However, the relationship between chemically-derived bioavailable fraction and metal uptake has not been established.

Industrial and urban development in Port Jackson catchment and impact on estuarine sediments
Supervisor: Gavin Birch

Objectives:
- Locate and map individual industrial development in the Port Jackson catchment
- Map urban development in Port Jackson catchment
- Determine products and waste discharge practices
- Core adjacent to industrial location to assess impact
- Create a spatial time series of changing sediment quality

This project fits neatly within the School of Geosciences ambit as it straddles both the Human Geography and the Science parts of the School. The shorelines of Port Jackson have been extensively reclaimed and previous work done by this Group has shown that his process has had a considerable impact on quality of adjacent estuarine sediments. We need to extend this work to determine the effects of urbanization and industrialization. These changes will be related to increasing contamination of adjacent estuarine sediments. The project would involve mapping the development of industry in the catchment of Port Jackson using aerial photography and GIS. Sediment adjacent to industrial sites will be cored for evidence of impact. Removal of industry from the catchment, so prominent in the last 10 years, will also be documented. This rise and fall of industry will be related to temporal impact as detected in cores from the estuary. Different vintages of chemical data for harbour sediments will be entered into a GIS and residual concentrations will be assessed against vertical metal profiles obtained from coring.

Total catchment management – Cooks River and upper Middle Harbour catchment
Supervisor: Gavin Birch

Objectives:
- Build a comprehensive contaminant model for the catchment.
- Determine major geochemical and physical processes involved in transportation and accumulation of pollutants in a total catchment.
- Develop tools and methodologies for environmental management.
The Environmental Group has been determining contaminant inputs from canals and creeks into Port Jackson for some time. However, we do not have any information from catchments that are relatively pristine and which could provide a ‘control’ to assess the severity of impact from other catchments that are heavily urbanised and industrialised. Information from the Upper Middle Creek would provide this control information as it is the least developed sub-catchment in the Port Jackson area and the Cooks River is one of the most impacted. This project would involve setting up auto-samplers in creeks of the catchment, determining land use areas and sampling bedload material from creeks. It would suit a student living in the upper shore area or in the south of Sydney for convenience to the research sites.

A total fluvial catchment system will be assessed in terms of contaminants in relation to various types of land use. The study will concentrate on the effects of different types of industry, commercial activities, urban development, as well as recreational areas and parkland on contaminants in the fluvial system.

The study will be mainly for heavy metals, but a limited number of organic contaminant analyses will be undertaken in selected areas. Background and baselevel concentrations will establish enrichment and to assess impact for subcatchments. Dependent on funds, core metals data will provide information on the contaminant history of the catchment. Bioavailability will be assessed by sequential extraction techniques and specific desorption analyses. Dependent on results, some metals analyses of the water may also be undertaken.

Data generated by the project will be georeferenced and entered into a GIS along with other data, e.g. land use, soils, geology etc, to build a comprehensive contaminant model for the catchment. The objective of the project is to determine the major geochemical and physical processes involved in transportation and accumulation of pollutants in a total catchment, as well as to develop tools and methodologies for environmental management.

**Contaminant concentrations in urban and market vegetables**

**Supervisor: Gavin Birch**

**Objectives:**

- Determine concentration of metals in vegetables grown in urban settings
- Compare metal concentrations of urban and market vegetables
- Relate tissue concentrations to health guidelines
- Model human uptake potential

An increasing number of vegetable gardens are being constructed in urban settings, especially in areas such as Sydney. Metal atmospheric deposition models developed by USEEG show that a significant mass of contaminants is settling in extensive parts of metropolitan Sydney. No information currently exists in relation to the concentration of metals in urban vegetable soils or in the tissue of plants being grown in these soils. It is therefore important to determine the processes governing the uptake of metals by plants being increasingly grown in these settings.

Large capital cities, such as Sydney, are rapidly expanding into areas traditionally used for market gardening. With urban expansion comes increased road infrastructure and industrialisation which in turn elevates the production and deposition of heavy metals. Soils in these areas are expected to have increasing concentrations of heavy metals. Currently, there is no information as to the changing nature of these soils, nor are there any data on possible increasing metal concentrations in vegetables that have been grown in these areas.

**Heavy metals in roof and domestic dust**

**Supervisor: Gavin Birch**

A pilot study undertaken by an Honours student in 2004 has shown that roof dust is highly contaminated by a wide range of heavy metals. Roof dust provides an estimate of the contribution by atmospheric processes of heavy metal emissions from a variety of sources, e.g. vehicles, industry, incineration, etc. Information from roof dust will be
related to metal modelling of atmospheric contributions undertaken in 2004, as well as to data now being generated on soil chemistry in the Port Jackson catchment. Roof dust also provides an estimate of contaminant loading over time, which will be very useful as input parameters for catchment modelling now being carried out within the Group.

Domestic dust is a useful biomonitor of atmospheric conditions within domestic homes, as well as other premises e.g. working environment. It is therefore a method of assessing the potential threat facing humans within their homes and places of work. The origin of these contaminants will provide important information for determining methods for source control and remediation.

**Partitioning of heavy metals in contaminated estuarine sediments**  
**Supervisor: Gavin Birch**

A deeper understanding of the effects of contaminants can be gleaned by determining the major phases with which the contaminants are associated. There are many selective and sequential extraction methodologies which can provide such information, but after some experimentation in conjunction with other groups, one technique is being used by this Group. This information can be augmented by undertaking further extraction procedures with different mixtures and concentrations of acids and chelating agents. The dominance of sediment sulphides in controlling metal bioavailability is well recognised for some sediments. Sulphides can complex with metal ions to form water-insoluble precipitates and it is the extent to which this sulphide component is soluble in cold acid that is important in controlling toxicity of some heavy metals. This so called ‘AVS’ technique needs to be tested against other methods. Another common approach is to characterize the chemical composition of pore water. The assumption here is that it is the nature of the interstitial fluids that is important in the uptake by infauna. Again there are several methods by which the chemistry of the pore waters can be determined, including removal of the sediment and centrifugation, in situ diffusion, or filtration techniques, etc. and some of these will be attempted. Several other techniques for assessing sediment quality currently in use should be tested, including SEM, EDAX techniques, equilibrium partitioning, etc.

Ultimately, the optimum approach is to express contaminant concentrations as a function of the capacity of the sediment to bind them. This involves the size, mineralogy and chemistry of the sediment, as well as the physio-chemical characteristics of the ambient sediment. This is a complex area of environmental science, but it is one of the most important problems which need to be dealt with urgently, and it is one for which there may not be a unique solution. The results of this study will hopefully lead to an improved sediment quality assessment technique.

**Any mutually agreed environmental (marine and geoscience) topic**  
**Supervisor: Gavin Birch**
Urban Geography and Political Geography  
Supervisor: Kurt Iveson

Kurt Iveson welcomes honours proposals in the fields of urban geography and political geography. He has a particular interest in the politics of urban public space, so ideas for topics in this area are particularly encouraged. Also, the following topics are also waiting for a keen honours student:

Surveillance in Sydney  
Supervisor: Kurt Iveson

The literature on urban fortification and surveillance is vast and expanding, but it is primarily based on the experience of US and European cities. What is the extent of everyday surveillance in cities like Sydney, and what are its implications for urban life and citizenship? Have our cities become 'surveillance societies'? 

Mobile media and public space  
Supervisor: Kurt Iveson

While there is now a growing geographical scholarship on mobile phones and the city, the addition of computing capacities to mobile phones has opened up a range of new possibilities. How are people using the new processing capacities of blackberries, iPhones, etc, as they gradually diffuse throughout society? In particular, are commentators like Adam Greenfield right to argue that we are witnessing the birth of new forms of urbanism, as urbanites and urban authorities make increasing use of locative media and ubiquitous computing?

Movie-going in Sydney  
Supervisor: Kurt Iveson

The geography of cinemas and movie-going in Sydney has changed dramatically in Sydney in the past two decades. However, while we have some quantitative data about this change, we don't have much qualitative data about how the experience of going to the movies has changed at the same time -- either from the perspective of cinema owners or movie-goers. There is great potential for someone to follow in the steps of Hubbard, who has undertaken such a study in the UK, and Canclini, who has undertaken such a study in Mexico City.

Citizenship of the internet  
Supervisor: Kurt Iveson

Over the past few years, some terrific honours projects have been conducted about the new kinds of citizenship that are taking shape in internet communities -- so far, there have been in-depth studies of Wikipedia and Facebook. There are plenty of other internet communities/social networking sites to explore. How is citizenship online related to citizenship offline? What are the continuities, what are the novelties?

Legal graffiti walls  
Supervisor: Kurt Iveson

While the provision of legal graffiti walls and graffiti education programs has been proposed as an alternative solution to zero tolerance responses to graffiti, the effectiveness of legal graffiti opportunities is highly contested and these spaces are currently under threat. What are the strengths and limitations of legal graffiti walls, from the perspectives
of graffiti writers, youth and community service providers, and urban authorities? Should legal walls still form an important part of the suite of policy responses to graffiti in Sydney?

Bathymetric evolution of the flood-tide delta in relation to beach changes

PORT STEPHENS
Supervisor: Ana Vila-Concejo

This project will involve going to the field to Port Stephens and measure bathymetry on the flood tide delta. The data will then be compared to existing measurements from 2007 to assess morphologic and volumetric change in the area. Finally, the analyses of the evolution of the flood tide delta will be coupled with the evolution of both shorelines and the current pattern in the estuary.

*As this projects involves a significant field component it will be better for the student to start doing the measurements in late 2010 before the Christmas break.

Wave climate in One Tree Reef

ONE TREE REEF
Supervisor: Ana Vila-Concejo (co-supervised by Jody Webster and DHI)

This project involves using existing wave data and numerical modelling to characterise the wave climate in One Tree Island. This project will use data from two wave buoys, one offshore OTI (IMOS recent data) and another one onshore, near Gladstone (decades of data). Numerical modelling (DHI) will be used to propagate waves between the two buoys. The objective of this project is to hindcast offshore wave data using the data from the wave buoy near Gladstone. The student undertaking this project will use numerical models from DHI (Danish Hydraulic Institute) which is an excellent skill for career development.

Characterisation of Sydney Harbour beaches. Management issues in relation to Climate Change.

COASTAL MANAGEMENT
Supervisor: Ana Vila-Concejo (co-supervised by Jo Gillespie)

This project mixes physical processes on low-energy estuarine beaches with the social aspects of coastal management. The student will monitor a few beaches located in the Sydney Harbour area and will assess its vulnerability to erosive events related or not to climate change. The student will also identify hazards or vulnerabilities in each of the beaches studied. Part of this project will involve an investigation of the regulatory framework that applies to the selected site. The student will be expected to demonstrate an understanding of the policies and rules that regulate site-specific coastal management

BYO Honours Project

Supervisor: Ana Vila-Concejo

Students are also welcome to “bring your own project”. Please come and see me if you have any honours ideas that you wish to pursue under my supervision.

Genocide and climate: what role did ENSO play in the Khmer Rouge genocide, 1975-1979?

Supervisor: Dan Penny

The rise in political instability within Cambodia, intensified regional hostilities, and the illegal US bombing of Cambodia were precursors to the revolution of 1975, and the subsequent genocide under the Democratic Kampuchea regime (the Khmer Rouge). These events were set against the backdrop of a major El Niño event in 1972, and a further, relatively weak, event in 1975. This research project will consider, using archival historical and climatic data, what role these climatic phenomena may have played, if any, in shaping the course of Cambodia’s history during this catastrophic period. Under what circumstances do social and environmental conditions intersect to produce such
disastrous outcomes? If there is a link between environmental stress (such as ENSO related drought) and the duration or magnitude of genocide, what implications does this have for Australia’s regional security in light of predicted climate change impacts?

The Environmental impact of the American bombing of Cambodia
Supervisor: Dan Penny

Between October 1965 and August 1973, the United States of America dropped 2.7 million tons of ordnance in Cambodia, more than the gross tonnage dropped by the Allies in World War II, in an effort to destroy mobile Viet Cong/North Vietnamese Army strongholds in Cambodia. The environmental consequences of this campaign (and the use ‘Agent Orange’ herbicide in Cambodia in late 1965), ranges from the immediate impact of deforestation to the movement of heavy metals and other pollutants, and can be observed in sediments accumulated during and since the bombing in closed-catchment lakes in north-eastern Cambodia. This project will use the geochemistry of shallow sediment cores (< 1 m) from these lakes to evaluate the environmental impact of the American bombing, and assess the lasting implications (if any) for the environmental health of the region.

Water Management in Mahendrapura.
Supervisor: Dan Penny

The medieval city of Angkor, Cambodia, was the world’s largest city of the pre-industrial period, and was characterised by its vast and complex water management infrastructure. The royal capital that immediately preceded Angkor, called Mahendrapura, was located in the Kulen Hills to the north-east of alluvial plains were Angkor would later be established. Here, too, water management played a critical role in the success of the settlement, and many broad river valleys were blocked by earth dykes (called thnal in Khmer) to create large reservoirs that would support the population and, presumably, the flourishing ceramics industry that developed there. The age of these reservoirs, however, is unknown, and this is important because it can tell us a great deal about the relationship between the Khmer and their environment in the latter years of the first millennium C.E. (were they, for example, constructed early as a pre-requisite for sustained settlement, or later, to feed the ceramics industry?). The impact of settlement on the environment is also unknown. Were the Kulen Hills de-forested? What impact did this have on water flows, or soil mobility? This project will use sediment records taken from several ancient reservoirs to date their construction and observe the impact of people on the environment since that time. The project will be conducted in collaboration with the Department of Archaeology, the Australian Nuclear Science and Technology Organisation, and the Archaeology and Development Foundation. (http://www.adfkulen.org/)

Angkor: archaeology, ecology and climate change.
Supervisor: Dan Penny

Several opportunities exist to conduct research as part of the Greater Angkor Project, a large multi-national ARC-funded project coordinated by the School of Geosciences and the Department of Archaeology (see http://acl.arts.usyd.edu.au/angkor/gap). The World Heritage site of Angkor, located in north-western Cambodia, was once capital to a vast Empire which reached its zenith between the 11-13th centuries AD. The reasons for the demise and eventual collapse are unclear, and the Greater Angkor project uses numerous approaches to better understand this process and the reasons for it.

Example of Honours projects currently available include:

The use of sedimentary charcoal as an indicator of abandonment and collapse. Sediments that have accumulated in cultural features such as moats and reservoirs preserve a record of micro- and macroscopic charcoal particles that have blown or washed into the site over time. These charcoal records reflect changes in fire-regime around the site, which can in turn reflect changes in land-use. This project will examine several sedimentary cores from Angkor for changes in charcoal concentrations over time, and offer an interpretation of these data that may help to resolve the mystery of Angkor’s demise.

Reconstructing water flow within ancient canals. Angkor’s water management network – comprising canals, reservoirs and earthen embankments – was both prodigiously large and overwhelmingly convoluted. It has long been suggested that Angkor’s demise was intimately related to the failure of this system, but there have been no empirical
studies to test this hypothesis. Many Angkorian canals are now filled by sediment. It is possible to utilise the size of sedimentary particles to infer flow velocity. This project will measure the particle size characteristics of canal sediments to reconstruct changes in water flow within the canal over time. Evidence of periodic ‘extreme’ events in the latter part of the Angkorian period, and/or evidence of an abrupt decline in water flow over the same period, will be instructive as to the history of the water management system and, potentially, its role in the collapse of the city.

Several other projects are available and potential candidates are encouraged to discuss their specific interests with Dan.

Geodynamic controls on ore-deposit formation
Supervisors: Dr Tom Landgrebe, Dr Simon Williams

Relationships between metal deposits and both divergent and convergent margin processes have been known for many decades. However, the challenge still remains to understand the way in which “geodynamic niches” such as slab windows, rapid convergence, or phases of flat-slab subduction, control the formation of ore deposits. The project will make use of the Earthbyte Group’s global plate model and plate tectonic reconstruction software ‘GPlates’. In particular, new methodologies being developed within GPlates to model continental deformation and apply data mining methodologies to analyse the relationship between ore deposit formation and the geodynamic evolution around the eastern margins of the Pacific (Andes and North American convergent margins).

Numerical models of continental rifting – application to the south East Brazil rift system
Supervisors: Dr Nicolas Flament, Dr Christian Heine, Prof Dietmar Müller

Despite their importance for the hydrocarbon industry, the mechanisms controlling the thinning of the continental lithosphere at magma poor margins remain poorly understood. We will develop a suite of dynamic models that fully account for the stretching of the crust and lithosphere, including the development of normal faults, using the 3-D numerical code Gaie. We will use borehole and total sediment thickness data from our industry partner Statoil to constrain acceptable rheological parameters and initial conditions for the evolution of the oil-rich Santos Basin, South-East Brazil.

Using mantle convection modelling to better constrain plate kinematics and lithosphere deformation in a frontier hydrocarbon exploration region, SW Pacific
Supervisors: Dr Maria Seton, Dr Christian Heine, Prof Dietmar Müller

The Tonga-Kermadec subduction system is a type example of oceanic subduction and is often used to test theoretical models of subduction initiation and evolution, back-arc basin formation and the development of volcanic island arcs. Furthermore, extended continental crust of the Lord Howe Rise which reaches from New Zealand northwards to New Caledonia, is a high-interest frontier hydrocarbon exploration region with a proven resource potential of about 4.5 billion barrels oil equivalent (boe), whose tectono-stratigraphic evolution is not well understood (Geoscience Australia, 2008; Vially et al., 2001). Although the plate tectonic history of the region is well constrained for times after 40 Ma, the late Cretaceous to Eocene plate boundary configuration and kinematics are hotly debated with the existence of a variety of alternative models (Yan & Kroenke 1993; Hall, 2002; Sdrolias et. al. 2003; Crawford et. al. 2003; Schellart et. al. 2006). Disagreements between models arise from the limited amount of in-situ geological samples, the inherent complexity in the arrangement of submarine blocks and basins and the mismatch between geological indicators and our understanding of plate tectonic theory.

The aim of this project is to test end-member scenarios for the tectonic evolution east of Australia from the late Cretaceous to the present day, and to incorporate lithospheric deformation through deforming plates into a revised regional kinematic model. You will use a novel methodology, which involves comparing geodynamic model output from Terra software using alternative plate kinematic scenarios and comparing with seismic tomography. The ability to match signatures of prior subduction in the present day mantle from seismic tomography with the predicted
location of subduction will allow us to constrain regional plate kinematics, basin evolution and subduction history of
the region more accurately than before.

This project involves close collaboration with our research partners at the University of Munich, Germany and
industry partners Shell Exploration & Production International and TOTAL.

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**Integrating deep-Earth and lithosphere dynamics for frontier basin exploration in the Arctic
borderlands and Australasia - Shell/Total ARC Linkage project**

**2 Honours projects**

**Supervisors: Dr Christian Heine, Prof Dietmar Müller**

The ARC Linkage research project aims at investigating the links between plate tectonics, mantle dynamics,
lithosphere deformation and basin evolution. The ultimate goal is to better constrain and quantify the impact of
vertical motions on basin architecture and ultimately petroleum system evolution, focusing on basins in the Arctic
borderlands/northern Pacific Rim and Australasia. Your honours project will be embedded in this 3-year industry-
sponsored research and partly cover some of the aims of this technically challenging project. The work will require the
assimilation of geological and geophysical data, integration with existing plate kinematic, and numerical geodynamic
models to revise existing models and develop and test new workflows as building blocks for future holistic, 4D
regional scale basin modelling in frontier exploration.

**Topic #1: Deforming plate models for the Arctic borderlands and ground-truthing of vertical motions.**

Much of the plate kinematic evolution of the Arctic, a primary frontier resource exploration region, is still heavily
debated. This includes the timing and opening of the Amerasia basin, the location of diffuse lithosphere deformation
and the subduction dynamics along the northern Pacific Rim. Your work will focus on revisiting existing plate
kinematic models, drawing on the experience of previous EarthByte research projects, and integrate lithospheric
deformation into the existing revised plate models. This will provide the base for large-scale geodynamic models,
which can in turn be used to iteratively refine the plate models. If time allows the results of the mantle convection
models using the Terra software will be used to construct simple dynamic surface maps for potential focus areas.

**Topic #2: Post-Trassic Unconformities of the Australian North West Shelf and northern margins: Plate kinematic
and mantle dynamics contributions**

The primary hydrocarbon exploration province of Australia, the North West Shelf and related basins on the Australian
northern margin and Irian Jaya show evidence of extensive, regional unconformities indicating uplift and erosion.
Timing and magnitude of uplift has severe effects on the evolution of petroleum systems. The cause of the these
regional events has usually been attributed to rift processes along the north-eastern Gondwana margin, however, the kinematics and distribution of paleo-plate boundaries in this region - the primary control on large scale tectonic events - is still not understood. You will revisit existing kinematic scenarios with the help of mantle convection models to construct a plate tectonic model of the northern Australian margin/ Arafura Sea/PNG for post Triassic times and assimilate geological and geophysical observations, accounting for lithosphere deformation. You will also attempt to integrate these results with mantle convection models to derive dynamic surface maps for first-order control on mantle convection -induced vertical motions in the area of interest.

Necessary prerequisites for both Honours projects will be knowledge of GIS/working with geospatial data, Linux/Unix/Mac OS environments, structural geology, geophysics, and/or plate tectonics.

Both projects will involve close collaboration with our industry partners Shell Exploration and Production International in Houston/USA and Total Exploration Production in Paris/France as well as with academic collaborators at the Ludwigs-Maximilians Universität in München/Germany. These projects will also provide you with insights into the problems of frontier/regional exploration in the hydrocarbon industry. Research assistant positions are available within the scope of this project for suitable candidates.

**Origin and evolution of the Solomon Sea and Rennell Trough, offshore NE Australia**

*Supervisors: Dr Maria Seton, Dr Jo Whittaker, Prof Dietmar Müller*

Plate tectonic reconstructions of the SW Pacific and SE Asia are often derived separately even though these two complex regions share a common plate tectonic history since the early Mesozoic. Embedded in the geological and geophysical data from the seafloor north of New Caledonia, west of the Solomon Islands and south of New Britain are clues as to the type, location and behaviour of the plate boundaries that operated in the past to connect the SW Pacific and SE Asian regions. This “Solomon” area contains several enigmatic basins such as the Rennell Basin/North D’Entrecasteaux Basin, Solomon Sea and Santa Cruz Basins. These basins are believed to be floored by oceanic lithosphere but with an unknown age of formation and are also remnants of what were much larger basins in the past. Understanding the evolution of these basins and the plate boundary configurations during their formation has implications for the tectonic development of both the SW Pacific and SE Asia and the basic tectonic controls in the surrounding ore-rich volcanic islands.

In addition, this region has undergone dramatic changes since the collision of the Ontong Java Plateau (the world’s largest oceanic Large Igneous Province) with the Melanesian Arc sometime in the Miocene. How the collision of the Ontong Java Plateau affected the development of the basins in the region and the location of subduction is controversial but can be addressed by examining the history of the neighbouring regions and interpreting the mantle structure beneath this area.

This project will involve the analysis of traditional marine geophysical datasets such as gravity, magnetic and bathymetry data to reconstruct the evolution of the oceanic crust in this region. In addition, GPlates software will be used to place the Solomon Sea, Rennell Basin and Santa Cruz Basin in their regional plate tectonic context. Seismic tomography will be used to image the slab generation in the area and constrain the collision of the Ontong Java Plateau with the Melanesian Arc.

**Secular Variation of the Length of the Day**

*Supervisors: Dr Gabriele Morra, Dr Nicolas Flament, Dr Leonardo Queuevedo*

The Length of the Day (LOD) has not always been constant, but has been varying within timescales that extend from milliseconds to billions of years. While a very intense effort has been devoted in the last decades toward the investigation of the short term variations, the secular evolution of the LOD, and therefore the evolution of the rotational speed of the earth remains elusive. Since the 60’s many geological studies have extrapolated paleo estimates on LOD clearly showing that in the past 400 million of years the LOD has increased from 21.9 hours to 24 hours. It is believed that most of this variation is due to the momentum exchange between the Earth the Moon.
However, very intriguingly, if one assumes that the energy that flows today from the Earth to the Moon was the same as in the past, this would result in a breakdown at 1.5 Ga. This implies that the dynamics of the coupled Earth-Moon system was different in the past. Because the coupling between the Earth rotation and the Moon trajectory depends simultaneously on the overlying atmosphere and oceans as well as the Earth’s core, both the liquid outer core and the solid inner core, it has not yet been possible to propose a definitive theory of such coupling.

In this project the student will follow a practical approach, considering and testing several hypotheses on the origin of the secular evolution of the LOD. The availability of precise reconstructions of plate motion, sea level and basins for the past 200 Ma, available at the School of Geosciences in Sydney, will allow the student to practically calculate the contribution of solid earth and ocean response, using already available computational tools. In particular the goal of the project is to extrapolate a conceptual theory of how the rotational spin of the Earth might have crossed different stages during the Earth evolution, justifying the strong increase of LOD in the past 400 Ma while only slowly varying during the evolution of the early Earth (Archean, from 4.3 to 2.5 Ga).

**Numerical Investigation of the Origin of the Oceanic Seamount Dots**  
*Supervisors: Dr Gabriele Morra, Dr Leonardo Quevedo*

The downwelling slabs of the Earth are compensated by thin hot upwellings called plumes, many coming from the core mantle boundary, others from mid mantle sources. The goal of the project is to model such sources, understand their origin and size and whether their pulsating behaviour originates from the core mantle boundary, from a mid-mantle discontinuity or from plume-surface interaction. The student will employ already existing numerical tools developed in-house in the School of Geosciences of the University of Sydney. Such tools allow a large number of high resolution models of the evolution of a plume in a spherical Earth to be performed. A comparison with observed and reconstructed Large Igneous provinces (LIPs) will allow the student to make inference about the origin of the enormous ocean seamount population (composed by about 10,000 seamounts).

**Geo- and Planetary-Dynamics with Computational Boundaries in a GPU Environment**  
*Supervisors: Dr Gabriele Morra, Dr Leonardo Quevedo*

Several recent revolutions are changing the way in which we model physical systems. Until today, a strong limitation in the investigation of the dynamics of the Earth and Planetary sciences was the impossibility to reach high resolution while maintaining high computationally efficiency. The problems we face numerically have become so complex that they necessarily require huge supercomputers with thousands and even tens of thousands of processors, making it impossible for the average researcher to access to such computational power.

These limitations have however stimulated the search for an alternative. This is represented by two main innovations: 1) new hardware: instead of using expensive and huge Beowulf clusters, many users now deviate toward much more viable parallel systems based on the hundred of processors that exist in our graphic cards. 2) new software: instead of voluminous memory expensive Finite Difference, Finite Volume and Finite Element approaches, new meshless systems based on particles and boundary meshes allow us to solve the same equations with much less computational and memory requirement. In turn the software indicated in (2) is the most suitable for running on the hardware (1). This triggered literally a revolution in computational physics and all the related branches toward the research of the best algorithms able to match requirements (1) and (2).

In this project the student is expected to focus on the most mathematically fundamental aspect of the development of meshless software, which consists in the calculation and employment of Boundary Integral for the main problems that exist in planetary science, comprising the solution of the heat flow equation for the non-linear convection that characterises the long term evolution of terrestrial planets. This project has an enormous possibility to develop in a very robust research program, focused on the prediction of large earthquakes on the Earth, on the formation of new planets, on the understanding of how the Earth-Moon system evolves and controls the evolution of the Earth’s spin in its irregular secular evolution. Finally all the results will be compared with the exceptional existing database compiled by the Earthbyte group of the University of Sydney.
Geospatial databases and information models for incorporating lithosphere dynamics in plate models.

Supervisors: Dr Christian Heine, Dr Simon Williams, Dr Tom Landgrebe, Prof Dietmar Müller

Unlike astrophysics or biomolecular sciences, very little concerted effort exists in Geosciences to unify data exchange and automated processing. It is partly explained by the massive differences in scale the sub-disciplines in Geosciences work with --- from molecular processes to global ones --- but also because until recently not many software applications have been around which can cope with this task. The GPlates project, an open-source, interactive plate tectonic reconstruction software is such an effort which aims at building a platform that allows geodynamic modellers, researchers and the resource industry to assimilate spatio-temporal data and derive new, frontier data products for better understanding the complex solid Earth dynamics of our planet.

Your honours project will aim to utilise existing initiatives on unifying spatio-temporal data collection and assimilation on geological scales, such as GeosciML, the GPlates Markup Language and GML in order to build up new datasets and information models which can be utilised in the GPlates software and geospatial databases. It will provide a base for researchers in the EarthByte Research Group with new ways of extracting, storing and processing geospatial information related to the dynamics mantle convection and/or lithospheric deformation. The project will connect to ongoing research projects the group has with Shell International Exploration & Production, Total Exploration & Production, and Statoil, the national Norwegian oil company and our efforts on building a Virtual Geological Observatory (VIRGO) funded through an Australian Laureate Professorship for Mueller.

Knowledge of XML, geospatial databases (Postgresql/PostGIS), information models, some knowledge about geological processes and materials is required for this project. A research assistant position is possible for suitable candidates.

Paleo-geography and Paleo-topography of Indian Ocean Islands

Supervisors: Dr Jo Whittaker, Dr Maria Seton, Prof Dietmar Müller

Unravelling the complex history of the breakup and dispersal of western Gondwanan continents and terranes is of particular interest to biogeographers, paleontologists and others who study the global distribution of biota. There are multiple geological and biological ramifications of the disruption of continuous land connections between South America, Antarctica and India-Madagascar during the Mesozoic and early Cenozoic. Continuous land-bridges ceased to exist between India/Madagascar and Antarctica at ~120 Ma a wealth of biological and paleontological data indicates that a connection persisted well into the Late Cretaceous. A number of Large Igneous Provinces (LIPs) and seamounts are found throughout the Indian Ocean and if these were sub-aerial in the geological past they may have provided island ‘stepping-stones’ that enabled biota to hop their way across the early Indian Ocean.

This project will test the hypothesis that oceanic plateaus that are currently below sea level were sub-aerial in the past and provided a connection between India/Madagascar and Antarctica. You will reconstruct paleo-heights of a number of key Indian Ocean seamounts e.g. Kerguelen Ridge, Broken Ridge, and the islands of the Ninety East Ridge. Reconstructions will be computed using a variety of geophysical and geological data including, plate tectonic reconstructions, relationships between the age and depth of the ocean floor, mantle driven dynamic topography, and drill core data.

Specialty coffee value chains between Australia and Indonesia

Supervisor: Jeff Neilson

Opportunities exist to explore the value chain linkages between specialty coffee roasters in Australia with producer communities in Indonesia. Various aspects of this relationship could be explored, including: i) impacts on farm
livelihoods in Indonesia; ii) the importance of intellectual property rights such as Geographical Indications and trademarks in determining who benefits from industry growth, and iii) exploring marketing-based representations of place and quality in Sydney’s growing specialty coffee industry.

A travel grant of $2000 is available to assist a student conduct field research in Indonesia.

**Sustainability in the Indonesian cocoa industry**  
**Supervisor: Jeff Neilson**

The sustainability of the Indonesian cocoa industry is threatened by limitations of forest land for expanded cultivation and infestation of pests and disease that limit farm productivity. Multinational cocoa companies (such as Mars inc) are now introducing supply chain certification schemes (such as Rainforest Alliance) to encourage sustainable farm production. Can these programs induce positive changes in farm income and sustainable land management?

A travel grant of $2000 is available to assist a student conduct field research in Indonesia.

**Deforestation, landuse change and climate change**  
**Supervisor: Jeff Neilson**

Deforestation currently contributes around 25% of annual global greenhouse gas emissions and, in Indonesia, this amounts to 85% of its annual GHG emissions from human activities, making Indonesia the third highest emitter of greenhouse gases in the world. The likely inclusion of an avoided deforestation mechanism (often referred to as Reducing Emissions from Deforestation and Degradation or REDD) within a successor to the Kyoto Protocol, and the recent emergence of a ‘voluntary’ carbon market outside this framework, makes this a particularly dynamic field of research. Students are encouraged to develop an Honours project (desk-based, field-based of GIS-related) that coordinates with a current research activity on this topic being conducted through the University of Sydney’s Institute for Sustainable Solutions.

A travel grant of $2000 is available to assist a student conduct field research in Indonesia.

**Traditional farm systems and the cash economy in the Papuan highlands**  
**Supervisor: Jeff Neilson**

The Baliem Valley of Indonesian Papua has supported highly-developed agricultural systems for up to 10,000 years. Unlike culturally similar societies in Papua New Guinea, however, the Dani communities in Baliem continue to resist the adoption of apparently lucrative cash crops, such as coffee. An exciting opportunity exists to conduct semi-ethnographic research on evolving farm systems and development discourses in the Baliem in response to economic and cultural globalisation.

A travel grant of $3000 is available to assist a student conduct field research in Papua.

**Estuarine wetland management and sea level rise: monitoring and modelling the relationship between sedimentation, elevation, vegetation and sea level**  
**Supervisor: Eleanor Bruce**

Ecosystems which form the transition zone between land and sea, such as mangroves and salt marshes are highly vulnerable to rises in sea level. Complex biophysical interactions induced by sea level rise and associated processes of inundation and erosion will influence the type and rate of ecosystem response. An understanding of ecological response and the importance of sedimentation in maintaining relative elevation will enable the impacts of sea level rise on estuarine wetland environments to be predicted. This project combines fine scale monitoring data with
elevation records to develop a GIS-based model for predicting coastal wetland change under varying scenarios of climate change.

**Modelling Blue Gum High Forest distribution patterns**  
**Supervisor: Eleanor Bruce**

This research project involves investigating the role of spatial modelling and remote sensing in mapping remaining Blue Gum High Forest (BGHF) areas within Ku-ring-gai Council area. Spatial analysis and predictive modelling would be applied to examine relationships between selected environmental parameters and the distribution of BGHF. Various remote sensing techniques will be adopted to examine whether multi-spectral satellite imagery can be used to identify patches of BGHF within an urban environment. This project will be conducted in close collaboration with Ku-ring-gai Council.

**Monitoring changes in the distribution of salt marsh and mangrove in the Georges River area**  
**Supervisor: Eleanor Bruce**

Detailed historical mapping of estuarine vegetation has been completed for the Georges River. Results of this mapping and field assessment indicate significant changes in estuarine habitat. There is a need to examine the influence of natural events and human activity (dredging and reclamation) on these changes. This project provides an opportunity to work closely with researchers from Aquatic Ecosystems Research Unit, NSW DPI.

**Other topics: Modelling patterns of habitat fragmentation in world heritage areas; marine protected area planning, GIS and environmental modelling**  
**Supervisor: Eleanor Bruce**

**Sea level rise & wave refraction changes**  
**Supervisor: Peter Cowell**

Work is under way on separate geomorphic effects of sea level rise and changes in wave climates. The wave climate effects relate to directional changes in the wind regime associated with climate variations in the past, and what this tells about the future. The possibility also exists, however, that changes in sea level may affect wave refraction patterns, thus inducing changes in wave directional statistics in the surfzone. Such changes can be expected to produced changes in coastal alignment, with some segments of the coast thus eroding and others accreting. The question is how significant are the changes in wave refraction patterns likely to be. The answer requires quantification through wave refraction modelling.

**Bedrock truncation modelling.**  
**Supervisor: Peter Cowell**

The shoreface translation modelling has been developed for application to coasts where rock outcrops are significant. We have data sets and previously published results on beach and inner-continental shelf sand deposits that provide strong indications of coastal evolution involving interactions between effects of sea-level rise, shoreface change, and bedrock truncation of the shoreface.
**Moruya sidescan data**  
**Supervisor: Peter Cowell**

Lag deposits of coarse sand on the inner-continental shelf are now known to be the product of shoreface lowering that resulted in the winnowing of fine sand onshore to supply sand for barrier progradation over the past few thousand years. The prograded barrier at Moruya Beach in southern NSW is one of the best studied examples in the world. We recorded sidescan sonar data over the inner continental shelf and shoreface more than a decade ago, but these valuable data are yet to be analysed. Various simplistic generalisations are well entrenched in the literature about the spatial distribution of these coarse lag deposits. The sidescan records however show that the spatial patterns are much more complex than previously thought.

**Sydney Harbour tidal delta and beaches and vulnerability to sea-level rise.**  
**Supervisor: Peter Cowell**

The iconic status of Sydney Harbour attracts a great deal of political and media interest in relation to the coastal impacts of climate change. In addition, we now believe the vulnerability of semi-protected estuarine beaches is very different from open coast beaches. This project would seek to quantify the risk of Harbour beaches due to the effects of sea-level rise and associated changes to sediment budgets through application of the Shoreface Translation Model. The results would be compared to corresponding predictions for open ocean beaches to evaluate response differences.

**Tidal deltas and sea-level rise... rates of response from existing dates: Eysink effects**  
**Supervisor: Peter Cowell**

Tidal deltas have been a sand sink since sea level stabilised c.6000 years ago. Several geological investigations provide data that can be used to quantify, through downscaling, the response rate of these deltas to sea level rise. The response involves upward growth and landward translation of the tidal delta with increasing sea level. These data would be analysed to provide a basis for quantify the sand demand that tidal deltas are likely to place on surround coastal deposits, including beaches. Modelling results from the Netherlands will also be useful in the study. The model used in the Netherlands (ASMITA) may also be of use in this study.

**CO3 beach dune volume, production rates, Pleistocene depletion.**  
**Supervisor: Peter Cowell**

SE Australia has well preserved, horizontally stacked barriers of Pleistocene and Holocene age. Pleistocene barriers typically have had their carbonate content depleted or eliminated by organic acids produced during the extend periods of lower sea levels when these relic barriers were covered with soil forming climax vegetation (i.e., forests). The much younger Holocene barriers have their carbonate contact intact. Volumetric comparison of carbonate:quartzite ratios for the two chronological classes of barriers will allow reconstruction of surface elevations of the Pleistocene barriers. This not only has significance for interpretations of highstand sea levels in the Pleistocene. It should also provide indications of sea-level responses of relevance to evaluation of imminent impacts of climate change.