GEOSCIENCES

Academic Researcher:	Associate Professor Eleanor Bruce
Project Title:	**Developing an evidenced-based response to climate change impacts on maritime zones**
Project Summary:	Coral reefs provide important ecosystem services that have environmental, social and legal implications for millions of people worldwide. Coral reef islands are made of bioclastic carbonate sediments formed from the skeletons of reef organisms (corals, foraminifera, calcareous algae) Waves are the primary mechanism that transport sediments (sand, shingle or rubble) to form reef islands and island morphology (shape, size, exposure) can vary greatly between different reef types (e.g., atolls, platforms) (Hopley, 1982). Islands are traditionally categorised on a scale ranging from unconsolidated sediment accumulations (banks, ridges) through to vegetated examples (McLean and Kench, 2015). In a way it could be said that they all start as storm deposits and their later evolution depends on accommodation, sediment availability and wave energy, which in turn can be modified by climate change. These basic categories in which we classify reef islands do not consider vulnerability to changes in climate, sediment budgets or ocean chemistry. Sea-level rise (SLR), increased storminess, ocean warming, marine heatwaves and acidification are projected by IPCC reports to be key threats to the future survival of coral reefs and islands. These threats are becoming more frequent and commonly occur simultaneously, proving to be a challenge for carbonate producing reef organisms that support island sediment budgets. Reef island morphology evolves on event (e.g., storm, cyclone) through to decadal timescales. While this variability is within natural limits, reefs are rapidly approaching a tipping point that could have devastating effects to islands and other geomorphic features that define maritime boundaries. This project will examine the eco-morphodynamic nature of important coastal features that support baselines (coral reef islands) to examine island behaviours (accretion, migration and erosion) under shifts in available sediment supply and wave energy associated with climate change. State-of-the-art remote sensing and spatial modelling methods will be applied to detect and map key indicators of vulnerability including presence of coral gravel ridges, cemented rubble and beach rock (lithified sand). These methods will be ground-truthed using sediment archives, hydrodynamic and geomorphic survey data. This project will establish the resilience and possible tipping points of these important ecological systems used to define maritime boundaries.

Project Synopsis:	The United Nations Law of the Sea Convention (UNCLOS) was established in 1982 to ensure cooperative use of the sea. Under this convention, the outer reef margin reefs with islands form a baseline, defined by the low-water line, to measure territorial seas (12 NM) and exclusive economic zones (EEZ) (200 NM). This international agreement establishes a relationship between land and sea and defines natural coastal features and the maritime zones they can generate. Establishing maritime zones under UNCLOS, such as the Exclusive Economic Zones (EEZs), enables countries to maximise rights over critical resources, including seabed mining and fisheries. The natural coastal features used to generate maritime zones are often low elevation islands, sand cays, rocks, and associated reef structures. The permanence of these coastal features, and their ability to generate maritime zones are at risk due to climate change. Under changing climate regimes, coral island baselines may move, or no longer meet the convention definition, for example if submerged by rising seas. The major hazards, or change drivers, are sea level rise, erosion of land, ocean acidification, extreme events, loss of habitat and decreasing biodiversity. The compounding impacts of these hazards may lead to features disappearing or decreasing in their persistence over time or in the same location. Vulnerable based point features are not only of critical concern for Pacific island nations, but relevant to other countries whose EEZs are delimited by these features including, Australia, France, USA and UK. This multidisciplinary project aims to determine the biophysical drivers influencing the vulnerability of these coastal features, predict timelines of change under different scenarios in the context of international legal response frameworks and identify potential indicators of change.
Additional Information:	The candidate will need a solid understanding of coastal processes and environments, GIS-based spatial modelling and remote sensing. This research is funded through Geoscience Australia in partnership with the Marine Studies institute at the University of Sydney, Australia. We acknowledge the indigenous people as the traditional custodians of the lands on which this research will be undertaken.

Academic Researcher:	Dr Maria Seton
Project Title:	**Deep-time reconstructions of Earth's surface environments and elevations**
Project Summary:	The topography of the continents and bathymetry of the ocean basins is a first-order Earth observation, largely shaped by plate tectonics. While the present-day topography and bathymetry is well-known, reconstructing past elevations is more problematic. In this project, you will generate paleo-elevation models that extend back at least 400 million years, which will be used to predict ocean basin volumes and global sea-level through time.

Project Synopsis:	Reconstructing the past shapes and sizes of the continents and ocean basins through geological time is important for understanding some of the most fundamental processes occurring on our planet, such as those related to global climate, seawater chemistry, the emergence and resilience of life. However, in order to reconstruct the elevations of the continents and bathymetry of the ocean basins, we must account for a variety of processes including continental stretching and seafloor spreading, mountain building, large-scale volcanism and sedimentation. In this project, you will use a combined plate tectonics and geodynamics approach, using pyGPlates and a coupled GPlates-CitcomS workflow, to model the past elevations of our planet through deep time. You will additionally assess uncertainties through end-member comparisons between alternative paleo-elevation and tectonic models. Finally, your models will form the basis for predicting ocean basin volumes and global sea-level fluctuations through time and how these relate to supercontinent cycles.
Additional Information:	Applicants need to have a background in geology, geophysics, marine science, or related fields. Past experience in processing and visualising geospatial data using GIS and other tools, as well as coding in Python will be helpful in completing this project. Applicants will need excellent written and oral communication skills, a high level of ethics and team-work abilities, and time management skills. This PhD program will support a funded industry project, and will involve international academic and industry collaborations. In addition to the academic requirements set out in the Science Postgraduate Handbook, you may be required to satisfy a number of inherent requirements to complete this degree. Examples of inherent requirements may include: • Confidential disclosure and registration of a disability that may hinder your performance in your degree; • Confidential disclosure of a pre-existing or current medical condition that may hinder your performance in your degree (e.g. heart disease, pace-maker, significant immune suppression, diabetes, vertigo, etc.); • Ability to perform independently and/or with minimal supervision; • Ability to undertake observatory, sensory and communication tasks; • Meet initial and ongoing immunisation requirements (e.g. COVID-19, Q-Fever, Vaccinia virus, Hepatitis, etc.) You must consult with your nominated supervisor regarding any identified inherent requirements before completing your application.

Academic Researcher:	Dr Maria Seton
Project Title:	**Plate-plume interactions in the southwest Pacific**
Project Summary:	A major challenge in the earth sciences is to understand how the Earth's deep interior communicates with the surface and how this interaction causes major planetary-scale disruptive events. You will use newly collected samples and data from ancient volcanoes in the Tasman and Coral seas to explore the inter-relationships between plume activity, plate boundaries and plate tectonic motions. Depending on interests and skill-set, the project can be tailored towards plate tectonics reconstructions, numerical modelling of plumes or a combination of both. Optional fieldwork on marine scientific vessels is a possibility for interested candidates.

Project Synopsis:	One of the world's most extensive but little explored intraplate volcanic fields, encompasses eastern Australia, Zealandia and Antarctica and includes three age-progressive trails offshore and the world's longest continental hotspot trail. These trails record the motion of the Australian plate over persistent sources of magma within the mantle, providing an excellent natural laboratory to explore the inter-relationships between plume activity and plate tectonic motions. Using advanced plate modelling workflows with an unprecedented dataset of volcanic rocks from three age-progressive seamount chains in the waters off eastern Australia, you will develop new detailed reconstructions of the numerous blocks and basins that were involved in the last stages of continental break-up between Australia-Antarctica-Zealandia and assess the interplay between continental rifts, mid-ocean ridges and plume activity. Depending on interest and skill-set, the project could also involve numerical modelling of plate-plume interactions.
Additional Information:	You should have a background in geology, geophysics or a related field and have excellent communication skills. You will be trained in the software needed for this project but python programming skills are a plus. This forms part of an Australian Research Council Discovery Project involving colleagues from the University of Tasmania (Australia), Northwest University (China), Ecole Normale Superieure (France) and Oregon State University (USA). Cross-institutional travel will be encouraged and supported when Covid-19 restrictions are lifted. Fieldwork on marine research expeditions may be available as part of this project for interested candidates.

Academic Researcher:	Dr Adriana Dutkiewicz
Project Title:	**Deep-sea sediments and paleoclimate**
Project Summary:	Deep-sea sediments record changes in climate, paleogeography, surface environments and biogeochemical cycles through geological time. In this project ocean drilling data will be used in combination with paleobathymetric maps, paleoclimate models and machine learning tools to reconstruct the accumulation rates of key components of deep-sea sediments, with a focus on deep-sea carbonates, organic carbon and the global carbon cycle.
Project Synopsis:	Deep-sea sediments record changes in climate, paleogeography, surface environments and biogeochemical cycles through geological time. In this project ocean drilling data will be used in combination with paleobathymetric maps, paleoclimate models and machine learning tools to reconstruct the accumulation rates of key components of deep-sea sediments, with a focus on deep-sea carbonates, organic carbon and the global carbon cycle. The EarthByte Group is a leader in developing spatio-temporal data analysis tools. In this project a range of open-source tools including pyGPlates, pyBacktrack, and machine learning tools will be applied to understand how major changes in ocean basin configurations and paleoclimate are reflected in the history of deep sea sedimentation and carbon storage. This project is part of an ARC Future Fellowship and will involve the Sydney Informatics Hub, offering broad expertise in data science, python scripting and workflow development. This project is perfectly suited to Covid-19 and post-Covid-19 times because it relies on an enormous wealth of existing analytical data and it uses data analysis methods that can easily be applied in other fields, leading to broad employment opportunities.