School of Geosciences:

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.

Academic Researcher:	**Professor Dietmar Muller**
Project Title:	**Research Scholarship in Spatio-Temporal Data Mining for Mineral Exploration**
Project Summary:	The research focus for this project will be on spatio-temporal data mining for mineral exploration. The emerging suite of machine learning tools have enabled data scientists to make sense of big and complex data. Given the abundance of open-access geological and geophysical data, these tools are gaining traction in the geosciences to unearth hidden relationships in global data collections. With the rising demand for critical minerals to power the renewable economy, a data-driven framework is required to map these resources through time. Spatio-temporal data mining will provide new insights into the formation and preservation potential of: • Subduction-related deposits – porphyry copper deposits form in arc settings. The formation of this commodity is sensitive to subduction convergence kinematics. • Sediment-hosted deposits – concentrated by mineral-bearing fluid flow, these deposits are sensitive to extension rates that drive sedimentary basin evolution.
Project Synopsis:	The EarthByte Group is developing plate reconstructions, coupled plate-mantle models and spatio-temporal data analysis technologies, adding a deep-time dimension to ore deposit data analysis. This project aims to assimilate plate kinematic and geodynamic information, using pyGPlates, with the formation ages of mineral deposits for better understanding the tectonic niche environments of ore deposits. The candidate will develop a data-driven machine learning framework to target

	critical mineral exploration by: 1. Constructing training datasets from deep time variables, e.g. plate kinematic parameters, crustal ages, geophysical data, regional geology, etc. 2. Supervised machine learning on known deposits, tailored to specific commodities. 3. Predicting the location and potential grade of resources that have not yet been discovered.
Additional Information:	The candidate will be co-supervised by a geologist at Geoscience Australia and will have the opportunity to interact with data scientists from the Sydney Informatics Hub (SIH). The SIH will offer courses on programming in Python and machine learning, covering relevant know-how for the project, and provide broad, transferable skills for industry, government organisations or academia after the completion of the PhD.

Academic Researcher:	[Dr Maria Seton]
Project Title:	**Plate-plume interactions in the seas off eastern and southern Australia**
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 your interests and skill-set, the project can be tailored more towards plate reconstructions, numerical modelling of plumes or a combination of both.
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 in the Tasman and Corals seas. Depending on your 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. As the project does not require in-person lab work, this project can start remotely.

Academic Researcher:	**Associate Professor Jody Webster**
Project Title:	**Controls on the Holocene evolution of the Great Barrier Reef: linking 4D numerical modelling and observational data.**
Project Summary:	This project will investigate the biological and geological processes that control the evolution of coral reef systems (e.g. reef communities, stratigraphic ages and growth rates, reef geometries ('architecture'). We will construct new 4D numerical models using state of the art software (eg., pyReef, pyBadlands) and compare them against rich observational reef data sets from the Great Barrier Reef (GBR) that grew during the Holocene (10,000 years to now). We aim to assess the sensitivity of coral reef systems to various environmental stresses (e.g. sea-level rise, hydrodynamic energy, sediment flux) acting on different timescales, magnitudes and rates. The project may also involve field work to One Tree Reef/Heron in the southern GBR to calibrate model parameters and processes against real world sedimentary and biological examples
Project Synopsis:	Predicting how the GBR will respond in the face of future global climate changes is both poorly constrained and controversial. This relates to our incomplete understanding of how reef systems respond to environmental changes but also the lack of baseline data — particularly on centennial to millennial time scales. In this project, you will integrate existing sedimentologic, biologic, geochemical, and chronological data sets from a unique suite of fossil reef cores recently collected from the southern GBR. Then you will use sophisticated modelling software (pyReef-Core, pyBadlands) that predicts reef core stratigraphy, facies, communities and geometries, and in combination with innovative data sciences tools (BayesReef - bayesian inference computational algorithm) to optimize model inputs/parameters, to explore the past evolution of the GBR in response to major global climate and environmental changes. This will improve our understanding of the sensitivity of the GBR to multiple environmental stresses and help improve predictions about the future fate of the reef. This project is part of a new $4 million ARC Industrial Transformation Training Centre grant called DARE (Data Analytics for Resources and Environments Centre) and will enable researchers and PhD students to apply their data science models against real world challenges, such as water storage, biodiversity loss and the extraction of mineral resources. https://sydney.edu.au/news-opinion/news/2019/08/27/4-million-for-data-science-research.html

Academic Researcher:	**Associate Professor Jody Webster**
Project Title:	**Past climate and environmental impacts on Great Barrier Reef paleoecology over the past 9,000 years**
Project Summary:	This project will investigate the links between environmental stress/disturbance, climate, and coral reef composition, diversity and structure by investigating episodes of reef growth and demise over the past 9,000 years. To do this we will use fossil reef cores from across the GBR and log: changes in the down-core genera, and species where possible, of coral and algae assemblages; note their growth position context, the percent volume of coral and algae components, algal crust thickness, and log the presence or absence of other important reef biota (e.g. vermetid gastropods, benthic foraminifera). Hiatuses in reef growth will be identified down core, and between adjacent cores, as major time gaps and changes in the reef communities. High-precision U-Th dates will pin down the precise timing of hiatuses and will be used to accurately calculate accumulation rates for the reef successions. In a novel addition to our study, we will use 3D CT scanning, X-ray and SEM imaging, to quantify long-term bioerosion rates as a measure of reef stress during the early Holocene when the most recent phase of reef growth 'turned-on', and for

	periods leading up to and after major Holocene reef growth hiatuses. We will ensure reproducibility and spatio-temporal extent of our down-core results by investigating cores from multiple regions, multiple reefs within each region, and multiple zones within a given reef will investigate the biological and geological processes that control the evolution of coral reef systems (e.g. reef communities, stratigraphic ages and growth rates, reef geometries ('architecture').
Project Synopsis:	The future of the iconic Great Barrier Reef (GBR) under threat. The mass coral bleaching events in 2016 and 2017 have raised alarm at the prospect of more mass bleachings in the future due to more frequent extreme sea surface temperatures (SST) under global warming scenarios. Further, sharp declines in coral cover across the GBR between 1985-2002 highlight concerns for the reef's ability to withstand the cumulative impacts of ocean warming, acidification and regional threats, including tropical cyclones, crown-of-thorns starfish predation, and water quality. Recent paleoclimate and paleoenvironmental studies show that the GBR experienced several cycles of reef growth and death over the past 20,000 years. These past reef death and recovery cycles offer the tantalising prospect of understanding the causes of reef death events and crucially the nature and rate of reef recovery after these events. Therefore, our goal is to study how the GBR changed in the past to determine distinct ecological thresholds and causal climate and environmental factors for reef death and recovery. This project is part of a newly funded ($418,000) ARC Discovery project that will involve an extensive network of Australian and International collaborators as well as other related research students. Based at USYD, you will join the Geocoastal Research Group (GRG) – an active and dynamic research cluster in the School of Geosciences.