FK210206

# Seafloor to Seabirds in the Coral Sea

February 6 - March 6, 2021

**Names and affiliations of all Principal Investigators and Co-PIs**

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| PI Dr Derya Guerer | University of Queensland | Marine geoscientist |
| Co-PI A/Prof Helen Bostock | University of Queensland | Oceanographer |
| Co-PI Dr Robin Beaman | James Cook University | Marine geoscientist |
| Co-PI Prof Jody Webster | University of Sydney | Marine geoscientist |
| Co-PI Dr Brendan Brooke | Geoscience Australia | Marine geoscientist |
| Co-PI Kim Picard | Geoscience Australia | Marine geoscientist |
| Co-PI Prof Colin Woodroffe | University of Wollongong | Marine geoscientist |
| Co-PI Dr Maria Seton | University of Sydney | Marine geoscientist |
| Co-PI Dr Eric Woehler | University of Tasmania | Seabird ecologist |
| Co-PI Dr Will White | CSIRO | Ichthyologist |
| Co-PI Kevin Mackay | NIWA/Seabed2030 | Marine geologist |
| Co-PI Prof Roi Granot | Ben-Gurion Univ. Negev | Marine geoscientist |
| Co-PI Prof Carmen Gaina | University of Oslo | Marine Geoscientist |

**The aim of this voyage was to map the Coral Sea Marine Park to collect data for improved management of the park, including specific fisheries regions and to complete previous *Falkor* voyage mapping efforts around Kenn and Wreck reefs. Another aim was to understand the geological evolution of oceanic basins along the eastern Australian margin that contributed to the separation of the submerged continent of Zealandia from the Australian landmass. Magnetic profiles in the Cato Trough region of the Tasman Sea basin were collected to help identify a now extinct tectonic spreading ridge. Microplastics were another focus of the science team, who tested and refined novel techniques with 100 microplastic samples collected from surface and deep waters using R/V *Falkor*'s underway system and CTD casts. The final aim was to observe and count the seabirds in the region, which contributed to the ongoing initiative to understand Australia's open ocean seabird populations.**

Note: The voyage plan was developed as an addendum to a previous voyage (FK201228) in a short period (two weeks prior to sailing). The on-board science team (consisting of predominantly undergraduate and PhD students) was assembled and mobilised by PI Gürer at short notice.

**Project outcomes**

The objectives and outcomes of this voyage were:

1) **Multibeam mapping.** The multibeam mapping was conducted over the northern extent of the Tasman Sea and its connection to the Coral Sea, as part of the Schmidt Ocean Institute's contribution to the Seabed 2030 Project and the start of the United Nations Decade of Ocean Science for Sustainable Development (2021-2030). The mapping area was chosen based on the scientific objectives and included priority areas for the Coral Sea Marine Park. The FK210206 voyage surveyed 38,289 km$^2$ of the seafloor (5189 line nautical miles or 9723 line km of ship track), covering the Cato Trough, Wreck Reef, Kenn Reef, Coriolis Ridge and Selfridge Bank. The area lies within the Coral Sea Marine Park, one of the largest marine parks in the world, and so the new mapping data contributes to a greater understanding of the southern area of this extensive marine park. When combined with the previous cruise, over 70,000km$^2$ of seafloor has been mapped in the Coral and Tasman seas. The multibeam data have been submitted to AusSeabed for publishing/download in the AusSeabed Marine Data Portal, and internationally to the GEBCO database for contribution to the Seabed 2030 Project.

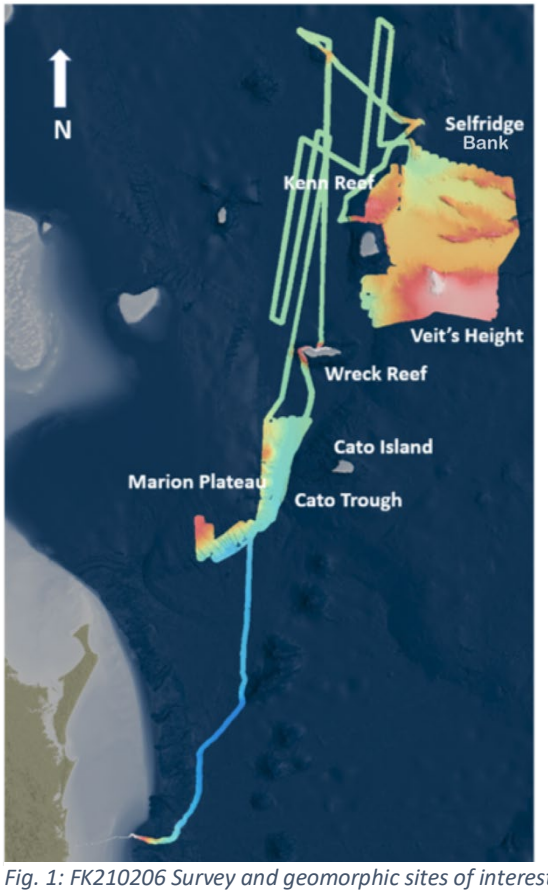

*Fig. 1: FK210206 Survey and geomorphic sites of interest*

The new mapping data revealed submarine landslides, mass wasting, faults, channels, sand waves, scour marks, volcanic pinnacles (cinder cones), and pock marks. The multibeam data will be used by a number of student projects looking at the seamounts, combined with rock samples that were previously collected by other vessels (e.g. R/V *Investigator*) to understand the evolution of the Tasmantid Seamounts and associated magmatic hotspot. Further, the seafloor channels and sand waves provide new geomorphic information about the influence of deep water flows in the region, which have not been previously studied.

Wreck Reef was the first geomorphic site of interest reached during the FK210206 research voyage (*Figure 1*). A shallow northern section of the reef, close to where the reef breaches the sea surface, had not yet been mapped during previous *Falkor* voyages and so the aim was to complete the map of the reef.

Kenn Reef rises 3000m above the Cato Trough and has a shallow coral reef with a large, extended deeper bank to the north. Faulting and cinder cones are present on this deeper bank, making it one of the most geomorphically complex areas surveyed. Previous airborne lidar bathymetry data existed over the shallow reef and earlier multibeam surveys had been conducted around the deeper flanks of Kenn Reef. So FK210206 focused on mapping the data gaps and northern extent of the Kenn Reef bank. The overall geology of the Kenn Reef bank was largely known, however, the detailed spatial extent of each rock group was unknown. New features of the Kenn Reef bank

include satellite vents and a significant fault scarp along the eastern side. This fault has a surface expression trace length of 20.5 km running on a northeast bearing and scarp height of ~200m .

Coriolis Ridge was a priority as it is a commercial fishing area – IUCN V1 Special Purpose Zone (Trawl). While mapping the ridge, a new relatively shallow feature was uncovered, unofficially named "Veit's Height", after R/V *Falkor's* Marine Technician Veit Huehnerbach. This feature is a raised platform 400m tall, 20km long, and 13km wide on its the summit. The summit is 200m below sea level. It is not large enough to be classified as a seamount or guyot, however, it does have a flat top, which could suggest a calcareous origin. Veit's Height has significant evidence of mass wasting and slumping on the northern and western sides. Other significant features on the seafloor of Coriolis Ridge include large sediment waves.

Selfridge Bank, lying to the east of Kenn Reef was surveyed with the aim to characterize steep-sided ridges that are oriented in a ~E-W direction. These features are tilted fault blocks. Selfridge Bank is marked on marine charts with a shoal depth of 44 m, which was investigated and disproven.

Cato Trough is significant in the region as it is the narrowest point between Zealandia and Australia. Cato Trough also connects the Tasman Sea basin (to the south) with the Coral Sea basin (to the north). Much of this area had previously been surveyed with multibeam, however, FK210206 filled in gaps of about 4,700km$^2$ within the pre-existing data for Cato Trough and the eastern margin of Marion Plateau, which forms one side of Cato Trough. Contour parallel slumping of sediments was observed off the eastern margin of the Marion Plateau into the Cato Trough.

2) **Magnetic survey.** The onboard SeaSpy2 magnetometer was deployed for 2487km over 22 separate transects. The lines were collected in E-W and N-S directions (orthogonal to each other) to better understand the tectonic spreading history of the northern Tasman Sea basin. The connection between the Tasman and Coral Seas lies within the Cato Trough, which separates Australia's continental crust and the continent of Zealandia by only 15km. Little was known about this region, making it an area of significant interest for bathymetric mapping and magnetometer deployment on FK210206. Prior to the voyage the nature of the crust underlying the Cato Trough was unknown, however, the magnetometer readings confirm that it is oceanic crust. Furthermore, all previous magnetic data from the Coral Sea basin have been collected in an E-W direction, which is not the optimum orientation for identifying the extinct spreading ridge. The new N-S magnetic data are currently being worked on by Chief Scientist/PI Guerer and PIs Gaina and Granot. These results will be published in due course. The data are to be used as part of a research proposal that has been submitted to the Australian Research Council in 2022.

3) **Oceanographic data (CTD/ADCP).** Four CTD casts were deployed and the Acoustic Doppler Current Profiler (ADCP) was operated continuously to determine current vectors and velocity down to 750m depth. From the deployed CTD casts, water samples were collected just above the seafloor, the at 800m, 50m and 5m depth. The deepest depths obtained were: 3860 m (CTD01, south of Cato Trough), 2200 m (CTD02, Selfridge Rise), 3000 m (CTD03, northernmost Kenn Plateau), and 4000 m (CTD04, north of Cato Trough). The CTD data were also used to confirm the water masses and to ensure that the sound speed profiles used for the multibeam systems were accurate. The CTD data from FK210226 (along with those from FK201228) were used as part of the deep water flows student project by Megan Jeffers at the University of Queensland, supervised by PIs Bostock and Gürer.

4) **Seabirds.** About 3,300 seabirds were sighted, with 17 different species identified. This region of the Tasman and Coral seas had never been surveyed in such a systematic way before and the data will help the management of the Coral Sea Marine Park. The seabird observation data contributes to a much larger database of Australian seabirds that PI Woehler has been developing in order to understand these protected species in the waters around Australia.

5) **Microplastics.** 140 microplastic filter samples were collected using the ship's underway system and seawater recovered in CTD casts. The sampling protocol originally developed on FK201228 was significantly refined by implementing control samples for water and air samples. Filtering was done under the fume hood. CTD casts were flushed with Milli-Q water to minimize contamination. Preliminary results suggest that there are visible microfibers present in every (but one) sample from the surface down to depths of 4000m. These opportunistic microplastic samples have not yet been worked on but we hope to do this in 2022 as a student project with Lauren Huet, supervised by PIs Gürer and Bostock.

6) **Outreach.** 11 blogs were produced by the science party for the Schmidt Ocean Institute, SciBlogs NZ and University of the Sunshine Coast blog. Two 'ship to shore' outreach calls to schools in the United States and Israel took place. 15 seminars were hosted whilst aboard by the science party, with two of those being hosted online by external PIs Gaina and Granot.

**Publications**

Jeffers (2021). Intermediate and deep-water circulation of the Tasman Sea and Cato Basin based on oceanographic and seafloor bathymetric data. Unpublished undergraduate project using data from FK201228 and FK210206. (Aim is to publish as a paper in 2022).

Bradshaw (2021) - The controls on the life cycle and evolution of the Kenn Seamount, Coral Sea. Unpublished undergraduate project using data from FK201228 and FK210206.

Johnson (2021). Bathymetric exploration of the Tasman and Coral Seas aboard the R/V *Falkor*. Quaternary Australasia, Vol. 38, No. 1, July 2021: 11-13. (Report on student experience on the R/V *Falkor*).

**Conference presentations**

Beaman, R.J., 2021. Schmidt Ocean Institute RV *Falkor* Australia campaign 2020-2021, Queensland–Smithsonian Fellowship Speaker Series. Oceans: life on the edge, 16 November 2021. Queensland Department of Environment and Science - Smithsonian Institution, Remote conference, pp. 13. (Available at: https://www.deepreef.org/2021/11/17/soi-rv*Falkor*-australia/)

Beaman, R.J., 2021. Schmidt Ocean Institute RV *Falkor* Australia campaign 2020-2021, Sub-Committee on Regional Undersea Mapping (SCRUM), GEBCO Week, 11-15 January 2021. General Bathymetric Chart of the Oceans (GEBCO) www.gebco.net, Virtually from Paris, France. (Available at: https://www.deepreef.org/2021/01/13/soi-*Falkor*-campaign/)

Johnson, A., et al (2021, May 11). Preliminary Interpretation of Multibeam Bathymetry R/V *Falkor* The Tasman and Coral Seas 2021 [Specific Mapping Case Study]. 2021 GeoHab, Canberra, Australia. (Abstract submitted for the 2022 Ocean Science Forum).

Johnson, A. (2021 April 20). Voyaging aboard the R/V *Falkor*. Guyots and reefs in the Tasmantid Seamount Chain. University of Queensland Centre for Marine Science Seminar Series. Brisbane, Australia.

Johnson, A., et al., (2022 Feb) Geomorphology of the Tasmantid seamounts, guyots and carbonate reefs. AGU Ocean Sciences presentation.

**Public talks**

Gürer (April 2021) UQ-Women in Science Research Networking Night, From microplates to microplastics.

Bostock (June 2021) - UN Ocean Decade - talk for World Ocean Day.

Gürer (June 2021) - *Falkor* voyages - talk for World Ocean Day.

Gürer (July 2021) Fig Tree Pocket Kindergarten, Brisbane: What is at the bottom of the ocean?

Bostock (July 2021) - Queensland Marine Teachers Professional Development.

Bostock (Sept 2021) - Queensland Marine Teachers Association Annual Conference.

Bostock (November 2021) Plastic pandemic - University of Queensland outreach program - Young Change Makers 2021.

**Datasets**

Multibeam data (Robin Beaman):

All multibeam data have been provided to AusSeabed, and a 64 m resolution bathymetry grid published and available on the AusSeabed Marine Data Portal.

Multibeam bathymetry and ship track data have also been uploaded by Robin Beaman to an AARNET CloudStor group drive, called '*Falkor*Australia', set up in October 2021. This is to allow the sharing of data files from the various *Falkor* surveys in north-eastern Australia for all participants from the voyages, which includes the voyage FK201228 ' Pinging in the New Year: Mapping the Tasman and Coral Seas'.

Access is via a password-protected link to voyage participants to view, download and upload the contents of the drive.

Within each survey folder, e.g. \FK201228_PingingNewYear, are the subfolders:

\googleearth (hillshaded multibeam bathy as kml/kmz files)

\image (hillshaded multibeam survey bathy and individual ROV dive bathy, as geotif files)

\samples (combined and individual CTD sample data, as Excel files)

\shiptrack (full shiptrack position data at 1min, as Excel files)

Wherever possible, Excel data files now have consistent datetime records, e.g. 2020-10-05T23:23:28 (UTC), and are converted to point shapefiles for use in a GIS. All shapefiles use the WGS84 (unprojected) horizontal datum. The aim is that these standardised and common file types can be used for research projects, particularly by students.

Seabird data (Eric Woehler):

The FK201228 seabird observation data have been have been published by CSIRO and are available at: https://www.marine.csiro.au/ipt/resource?r=*Falkor*_201228_wov

**Media**

There was a lot of media interest during the voyage as the *Falkor* was one of the first vessels to collect seabed mapping data at the start of the UN Decade of Ocean Science for Sustainable Development (2021-2030). These various media contributions are incorporated in the media report provided by SOI.

There have been a number of public talks (listed above) given to a wide cross section of the public, to highlight the valuable data collected and the incredible opportunities provided by the SOI to onboard researchers and students.

Following the voyage, Dr Eric Woehler had a radio interview with ABC Hobart. Dr Eric Woehler also received a Medal in the Order of Australia (OAM) for his services to conservation and the protection of seabirds.

Chief Scientist Dr Derya Gürer was featured in the *Orion Magazine* – Fieldnotes section.