

Schmidt Ocean Institute Expedition Report

Seamounts, Canyons and Reefs of The Coral Sea

Chief Scientist Dr. Brendan Brooke

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1 Overview

SOI Expedition ID	FK200802
Vessel	<i>R/V Falkor</i>
Expedition Name	Seamounts, Canyons and Reefs of The Coral Sea
Expedition Dates	2020/08/01 - 2020/08/30
Departure Port	Cairns, Australia
Termination Port	Brisbane, Australia
Ocean	Pacific Ocean

1.1 Expedition Overview

As ocean temperatures increase, a pressing global challenge in marine science is to better understand the distribution and characteristics of the critical habitats that support mesophotic and deep-water coral communities. Following the previous Visioning the Coral Sea Marine Park expedition, a similar team of scientists led by Drs. Brendan Brooke, Geoscience Australia, Robin Beaman, James Cook University, and Scott Nichol, Geoscience Australia, will return to this frontier region applying a suite of cutting-edge technologies to explore the remote canyons, platform reefs and seamounts of the Coral Sea and Great Barrier Reef Marine Parks. The goals of this expedition are to understand the biodiversity supported by these large-scale features and the role they may play as refuges for coral as well as other animal communities in a warming ocean. The science team on board *R/V Falkor* will continue to map and characterize underwater features, the habitats they provide, and the biota they support. This will enable predictions of similar environments that support critical deep-water biological communities. The surveys will greatly expand the knowledge base for sustainable management of these unique features and establish environmental baselines by building on previous mapping in the Marine Parks.

1.1.1 Project Description

The overarching goal of this project is to identify the influence of long-term environmental processes on the geomorphology and spatial distribution of benthic biological communities in the northern Great Barrier Reef (GBR) and adjacent Queensland Plateau, important but poorly known regions of Australia's marine area (Figure 1). The geophysical, geological, biological and oceanographic data and samples acquired on our research cruise are generating unique environmental information on mid-ocean platform reefs and submarine canyons on the outer margin of the GBR, across their full depth range. In particular, we are vastly improving our knowledge of changes in reef growth patterns driven by long-term changes in sea level; reef-sediment source areas and transport pathways; reef and canyon benthic habitat distribution

patterns; and coral, sponge, jellyfish and fish diversity associated with these key ecological features of the Great Barrier Reef and Coral Sea marine parks.

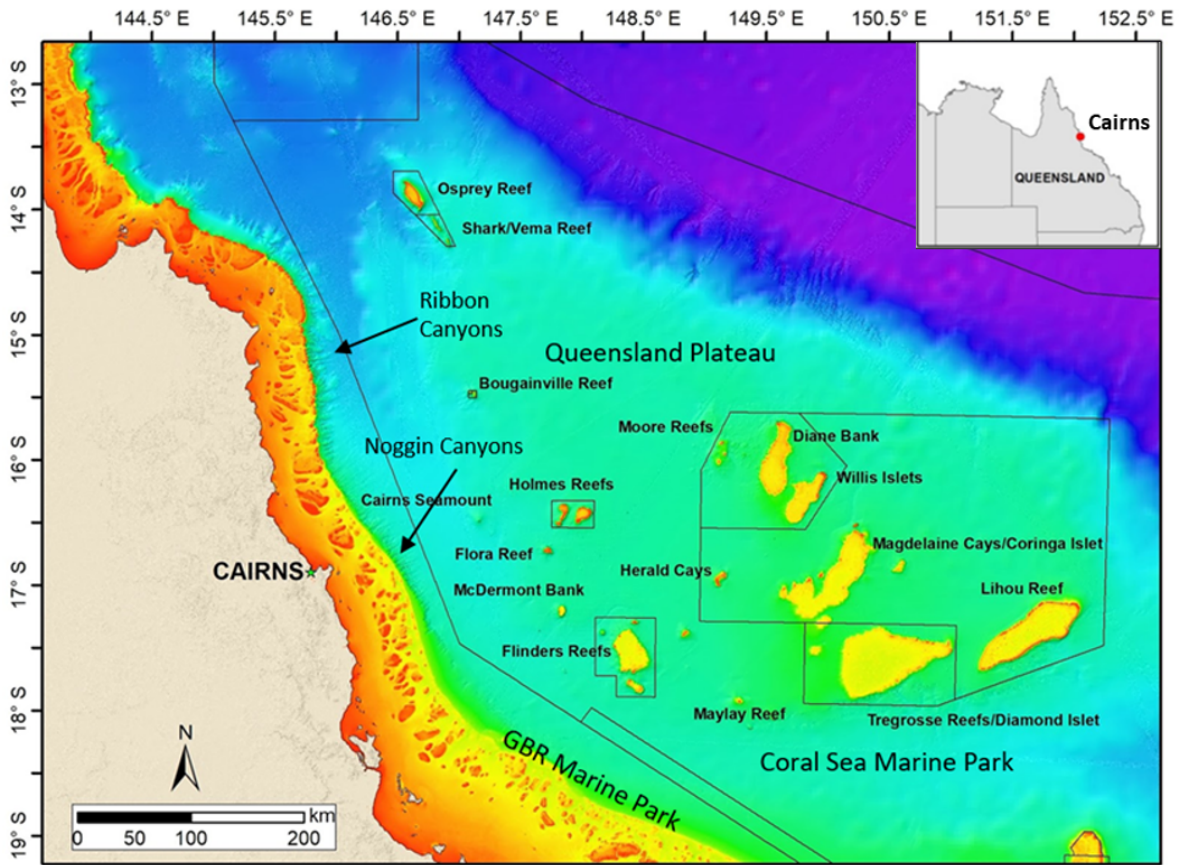


Figure 1: Location of canyons visited in the northern GBR and platform reefs mapped on the Queensland Plateau in the northern Coral Sea.

1.1.2 Opportunities & Challenges

Our expedition provided a range of science opportunities as well as operational challenges. We gained invaluable experience in the use of leading-edge ROV technology that was not otherwise available in Australia. Coupled with advanced multibeam echo sounders and underway oceanographic measurements, the ROV dives captured key physical and biological features of extensive areas of the GBR and Coral Sea marine parks. A major challenge for SOI and the science team has been undertaking the expedition and subsequent data and sample analysis during the COVID19 pandemic. Sample analysis, in particular, has been delayed as laboratories were closed during a number of lockdown periods following the expedition.

1.1.3 Expedition Timeline

The survey was undertaken from the 1st to 30th August 2020, in two legs. The first leg, 1st – 12th August, started in Cairns and visited Cairns Seamount, Flinders Reef, Herald Cays and Malay Reef in the Coral Sea Marine Park. The second leg, following a science crew change in Cairns, ran from the 14th – 26th of August and surveyed canyons offshore the Ribbon Reefs in the GBR Marine Park, and Osprey Reef, Tregosse Reefs and Lihou Reef in the Coral Sea Marine Park (Figure 1). The survey concluded on the 30th August following the transit from Lihou Reef to the port of Brisbane. Details of the activities undertaken each day of the expedition are provided in the Appendix.

1.1.4 Authorizations and Permitting

Permit Authority	Permit Focus	Permit #
Great Barrier Reef Marine Park Authority permit	ROV, AUV, CTD; coral; other macrofauna; sponges	G20/43974.1 Version 2
Australian Marine Park Activity Permit	MBES, SBES, ADCP, SVP, XBT, CTD, ROV	PA2019-00131-12
Parks Australia Access to Biological Resources in a Commonwealth Area for Non-Commercial Purposes	Plankton/Jellyfishes	AU-COM2020-484
Parks Australia Access to Biological Resources in a Commonwealth Area for Non-Commercial Purposes	Corals and Sponges	AU-COM2020-483
Australian Marine Park Activity Permit	ROV images & coral and sponge samples; AUV images	PA2020-00040-1

1.2 Proposed Objectives

We are addressing two key interrelated objectives in this project:

1. Explore the spatial distribution of seabed substrates and benthic communities in submarine canyons on the outer margin of the northern GBR shelf. By acquiring unique biological data and comparing them with geomorphic, geological, planktonic (jellyfish)

communities and oceanographic data, we aim to identify the features and processes driving biodiversity patterns in these deep-water settings.

2. Identify the geomorphological processes shaping mid-ocean platform reefs on the Queensland Plateau and the characteristics and distribution of seabed, epibenthic and plankton communities on the margins of the reefs, from the mesophotic to deep water areas. This will provide new insights into spatial patterns of biodiversity and the potential of the reef structures to provide refuges for communities impacted by a rapidly warming marine environment.

2 Expedition Accomplishments

2.1 At-Sea Accomplishments

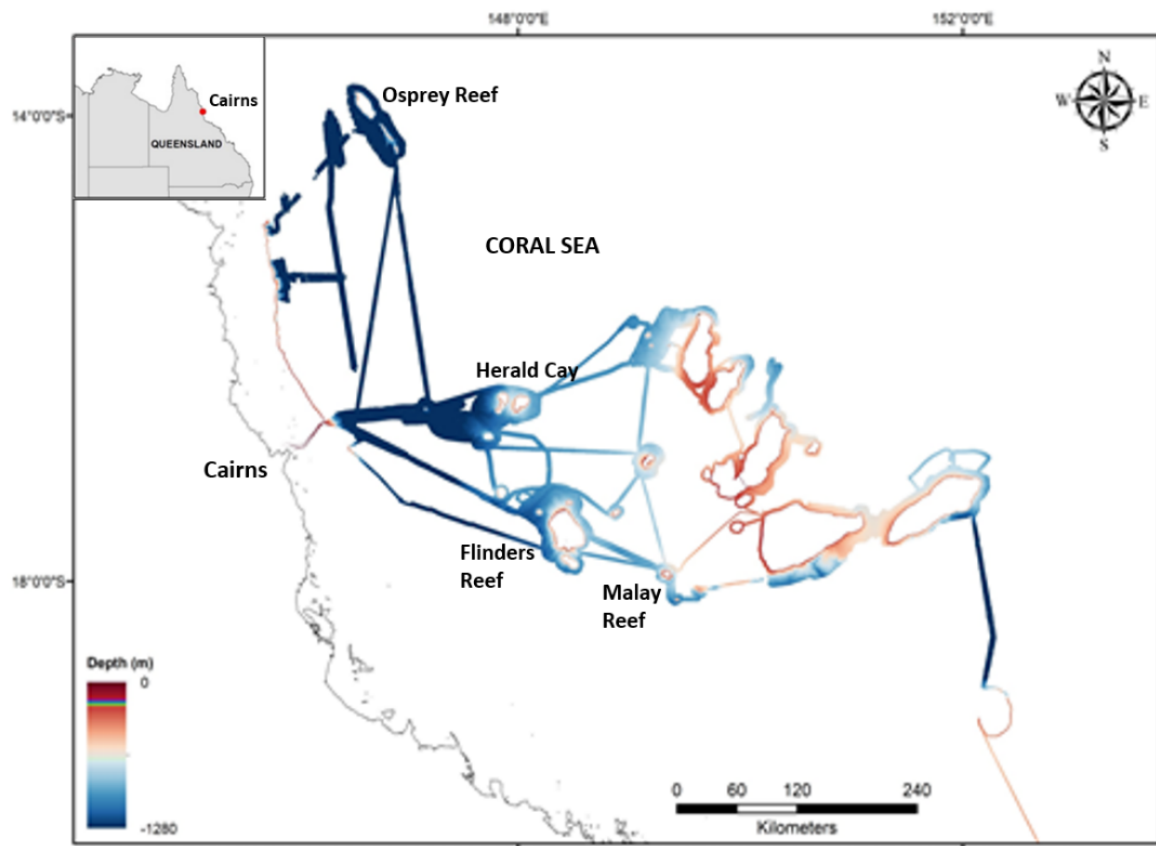


Figure 2: The extent of MBES mapping completed in research cruises FK200429 and FK200802

2.1.1 Science

We experienced exceptionally good sea conditions throughout the two legs of the expedition, enabling the acquisition of 8,850 km² of bathymetry (MBES; Figure 2), seabed imagery (ROV dives on 5 reefs, AUV dives on 4 reefs), 137 biological samples (collected by ROV), 89 geological samples (ROV) and 10 CTD casts. The focus of leg 1 was the reefs on the Queensland Plateau (Flinders, Herald, Malay Reefs) and Cairns Seamount (Figure 3). Leg 2 examined the GBR canyons offshore the Ribbon Reefs (Figure 4), NE of Cairns, and also visited Osprey Reef and Tregrosse Reef.

Sampling within the GBR canyons was designed to compare the benthic communities for canyons that are directly connected to the shelf (shelf-connected canyons) with canyons that are blocked at their head by a reef (reef-blocked canyons), and blind canyons that are confined wholly within the slope (slope-confined canyons). This was achieved with ROV dives in six canyons that traversed the full depth range of each canyon type (~2000 m to ~60 m). ROV dives also collected seabed sediments and rock outcrop samples. At Osprey Reef and Tregrosse Reefs two ROV dives were completed at each site.

2.1.2 ROV

Twenty one *ROV SuBastian* dives were completed across the full depth range of five platform reefs and six canyons, recording 112 hours of high definition underwater video of seabed geological characteristics (Figure 5), and benthic species and communities from depths ranging from ~1,800 m to the mesophotic zone (~100 – 60 m depth).

Using the unique imaging and mid-water sampling systems on *ROV SuBastian*, we captured high-resolution images and samples of jellyfish through the water column during the descending phase of eight ROV dives (Figure 5). Dr Dhugal Lindsay participated virtually from Japan in several mid-water *ROV SuBastian* dives during which he selected jellyfish and other planktonic specimens for high-resolution imaging and collection. This innovative application of ROV technology has provided unique images and well-preserved samples of very delicate organisms that are enabling the identification of undescribed species and new information on species distributions.

2.1.3 Innovative Technologies

Seven AUV dives on four reefs (Flinders, Herald, Malay Reefs, and Cairns Seamount) acquired high-resolution, continuous image transects across mesophotic zones (Figures 6, 7, 8). The 91,186 images acquired provide the first quantitative assessment of mesophotic biodiversity on these reefs. An experimental hand-held AUV was also trialed at the reefs as part of a PhD project by Jackson Shields (University of Sydney).

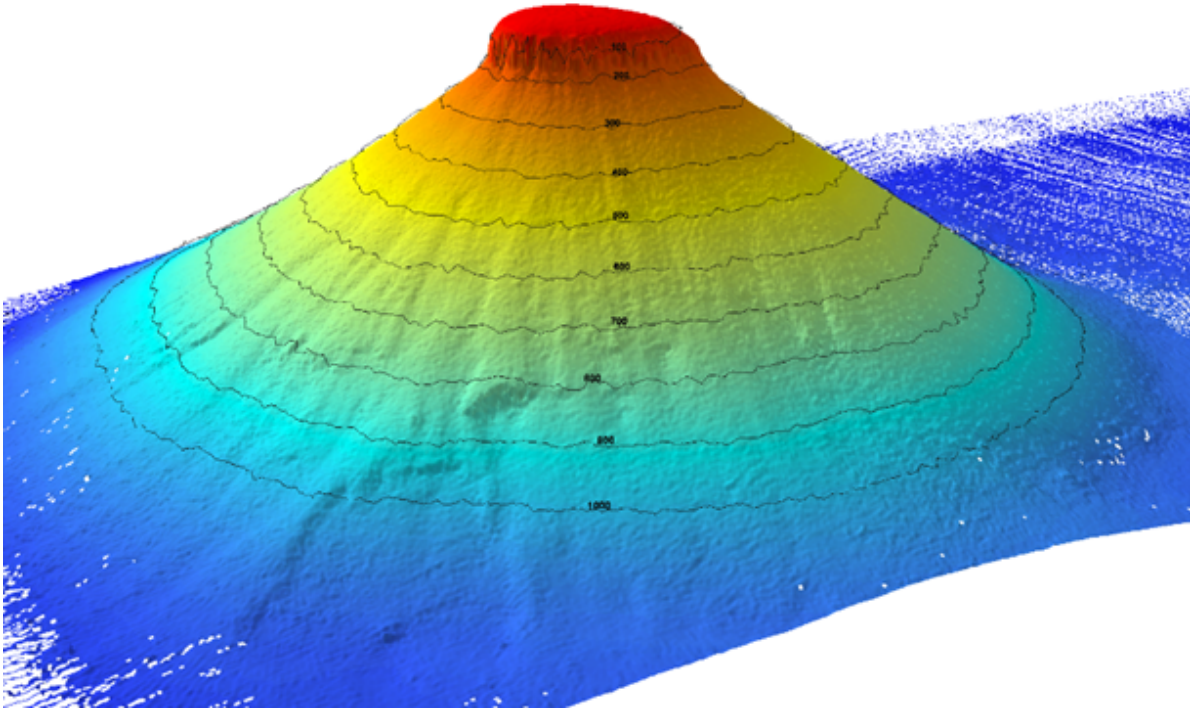


Figure 3: A 3D perspective view of Cairns Seamount, based on high-resolution, multibeam mapping (35 m to 1,200 m) during cruise FK200802.

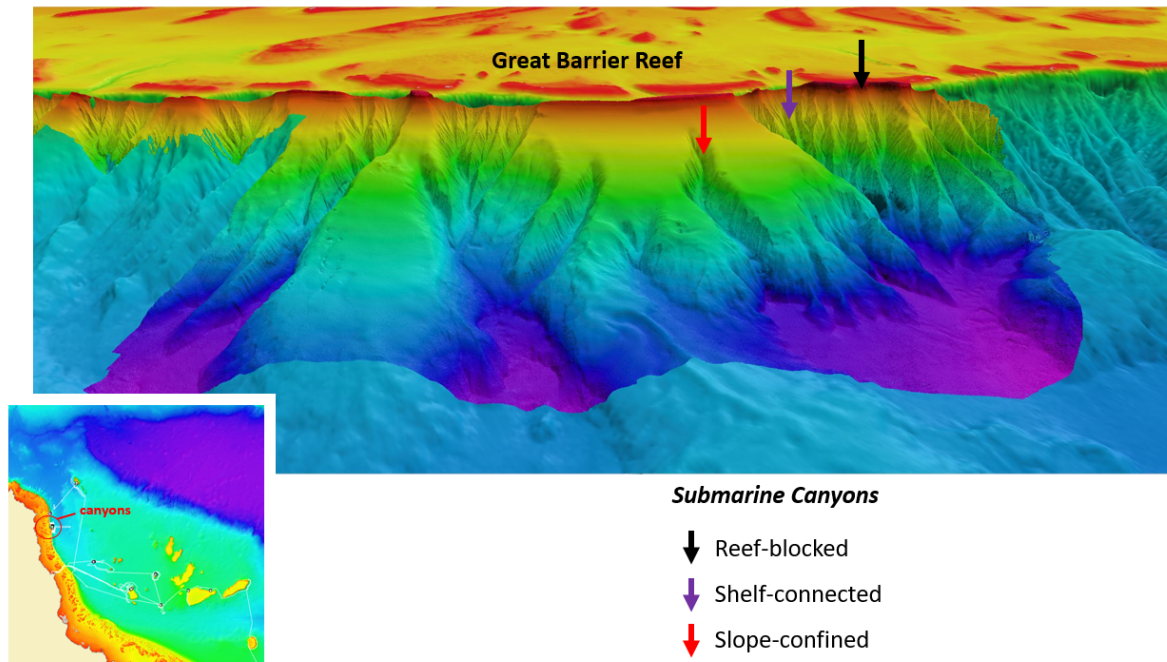
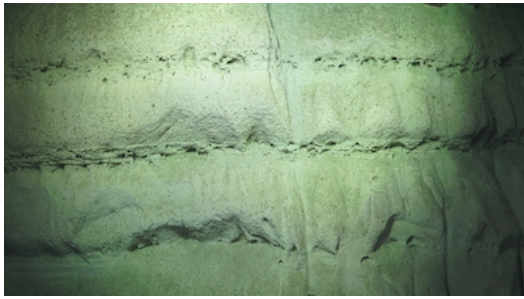
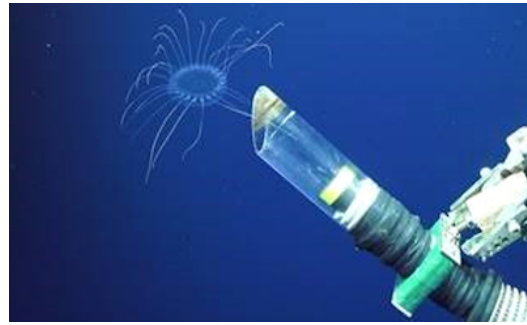


Figure 4: A 3D perspective view of submarine canyons within the Ribbon Reef canyon group mapped during cruise FK200802.



(a) Ribbon Reef : Cliffed exposures of ancient, horizontally bedded marine limestone several hundred metres below the modern reef.



(b) Cairns Seamount: Mid-water sampling of a delicate jellyfish, *Solmissus incisa* (Narcomedusae), by *ROV SuBastian* during the descending phase of a dive.

Figure 5: Screen-grab images from *ROV SuBastian* video footage of dives at Cairns Seamount and Ribbon Reef



Figure 6: AUV image of the diverse coral cover on the mesophotic seabed of Malay Reef.

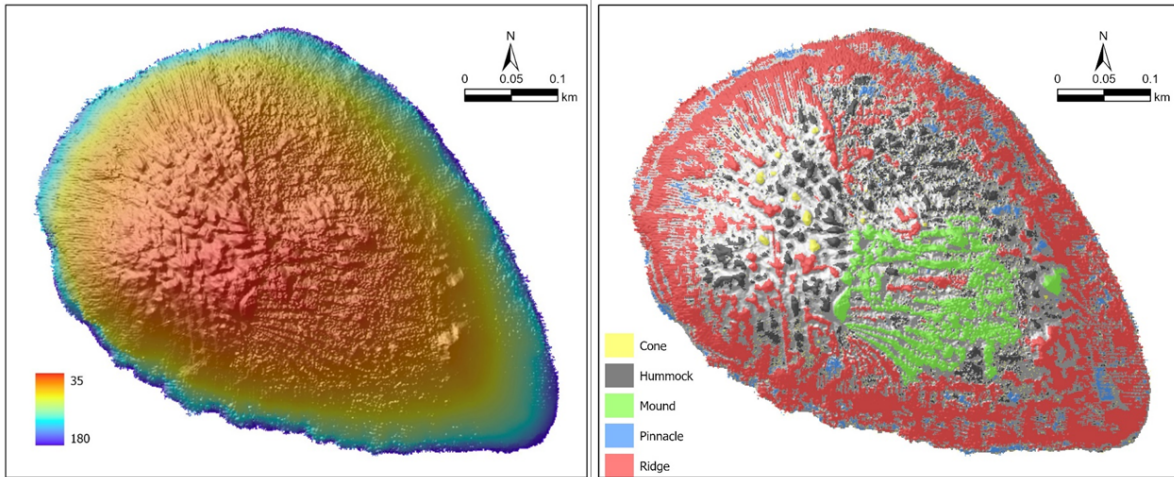


Figure 7: Image on left is a high-resolution (1m², multibeam data) bathymetry model of the crest of Cairns Seamount within the mesophotic zone (35 – 180 m). Image on right shows the geomorphological classification of the seamount crest, which incorporates a semi-automated classification method (from Huang et al., Ocean Sciences Meeting, 2022).

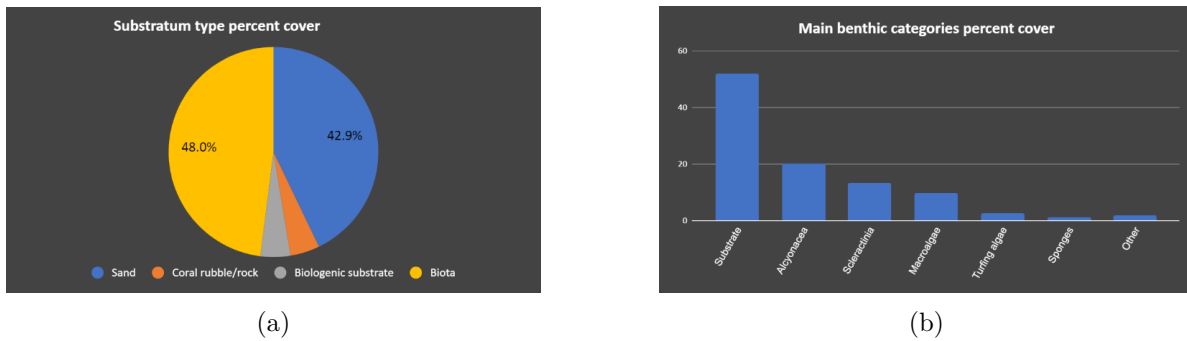


Figure 8: Cairns Seamount crest seabed cover type, based on analysis of the AUV images. The histogram shows the biological components of mesophotic seabed cover on the seamount (from Huang et al., Ocean Sciences Meeting, 2022).

2.2 Post expedition activities and accomplishments

2.2.1 Sediment samples

Sediment samples were collected using *ROV SuBastian's* push coring system. A 22 cm push core was collected from the seafloor at the beginning of each ROV dive, at the beginning and end of each 500 m benthic transect, with additional opportunistic sampling throughout dives informed by vision from *ROV SuBastian's* 4K science camera.

Samples were assigned IGSN numbers at Geoscience Australia, and metadata uploaded to the [Geoscience Australia's Marine Sediments \(MARS\) database](#). Sediment sample data are also accessible via the [AusSeabed Marine Data Portal](#) (Table 3). Initial sample processing included colour (Munsell), pre-cleaning to remove organics, grain size and %CaCO₃. Planned laboratory analyses include mineral phase identification, and major and trace element composition.

Additionally, samples are currently being analysed for microplastic abundance and polymer composition. This Queensland University of Technology student project will form the first such deep-sea sediment microplastics study from the GBR Marine Park. The study will provide valuable information towards understanding sediment transport pathways from the continental shelf to ocean basin via submarine canyons, and testing the concept of microplastics utility as sediment tracers.

2.2.2 Rock samples

A total of 44 rock samples were collected using *ROV SuBastian's* manipulator arms. This method allowed for collection of specifically targeted samples, based on water depth (e.g., past sea level paleobathymetry) and varying textures and compositions (Figure 9). Samples were obtained on 18 ROV dives across the full depth range and from a variety of depositional environments and geomorphological features.

The rock samples are valuable archives of past oceanographic conditions that prevailed during the Great Barrier Reef's complex geological history. The fossil composition of older limestones provides insights into changing marine biota assemblages (e.g., calcareous algae, corals etc) over time. Additionally, the geology underlying the present-day coral reefs, slopes, and canyons provides the substrate for further geomorphology and benthic habitat characterisation studies. In addition, several grab samples of deep, fossil cold-water coral skeletons were collected for carbon isotope analysis at the University of Tokyo.

A single continental rock sample was collected from 1,347 m depth in the Ribbon Reef 5 canyon (ROV dive S0379). This sample is of significant scientific value as it may represent the ancient Australian continental margin that underlies the origins of the Great Barrier Reef. Compositional and chemical analysis will be undertaken to provide an age constraint and correlate this sample with Queensland's onshore sedimentary basins (BSc Honours student Kate Whitton is working on rock samples from Ribbon Reef 5 canyon, and describing biota



Figure 9: Reef Limestone composed of cemented flakes of Halimeda (flakes are green when algae is alive), a calcareous green alga, from Herald Cay (depth 68m).

that grows on the tops of the samples). The rock samples are currently held at the University of Sydney, School of Geosciences, where a selection of subsamples are being prepared for thin sectioning and to send to the University of Tokyo for C14 and Uranium/Thorium dating.

2.2.3 Biological sample taxonomic and genomic work

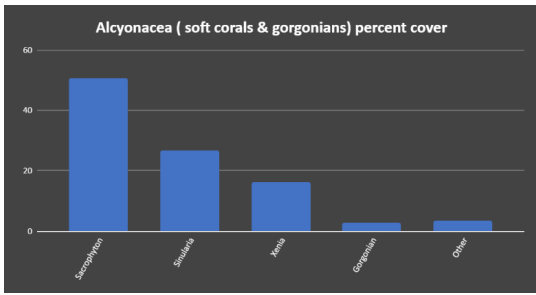
Fifty sponges were collected comprising all three classes of sponges, i.e. the Hexactinellida (the glass sponges), Calcarea (the calcareous sponges) and Demospongia. This contained six orders and seven families, mainly the delicate glass sponges. 59 black corals collected on *R/V Falkor* represent six families, 14 genera, and 23 species. We also collected 23 zooxanthellate scleractinian corals, 54 jellyfish, three ctenophores, two crustaceans, two epizooanthids, one hydroid and a thaliacea. All these specimens have received preliminary identifications from relevant taxonomic experts (e.g. Figure 10) and are currently undergoing more detailed microscopy, scanning electron microscopy and DNA molecular analysis to further elucidate their identification and descriptions of new species (Table 3).

2.2.4 Multibeam bathymetry data products

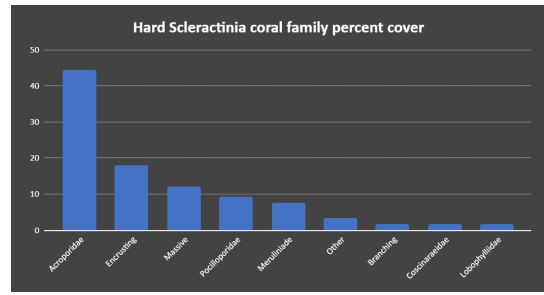
The multibeam bathymetry data acquired during FK200429 and FK200802 (Figure 2) have been further processed and the full extent of the survey data are available as a 64m grid on the AusSeabed Marine Data Portal: <https://portal.ga.gov.au/persona/marine>. Two finer-scale bathymetry grids have also been generated at 16 m (areas <2,560 m depth) and 32 m (areas >2,560 m). In addition, multibeam backscatter images have been generated for these survey areas. Metadata and bathymetry grids are available for visualisation and download from the portal: <http://pid.geoscience.gov.au/dataset/ga/144385>.

2.2.5 Collation of LADS and multibeam data for Coral Sea reefs

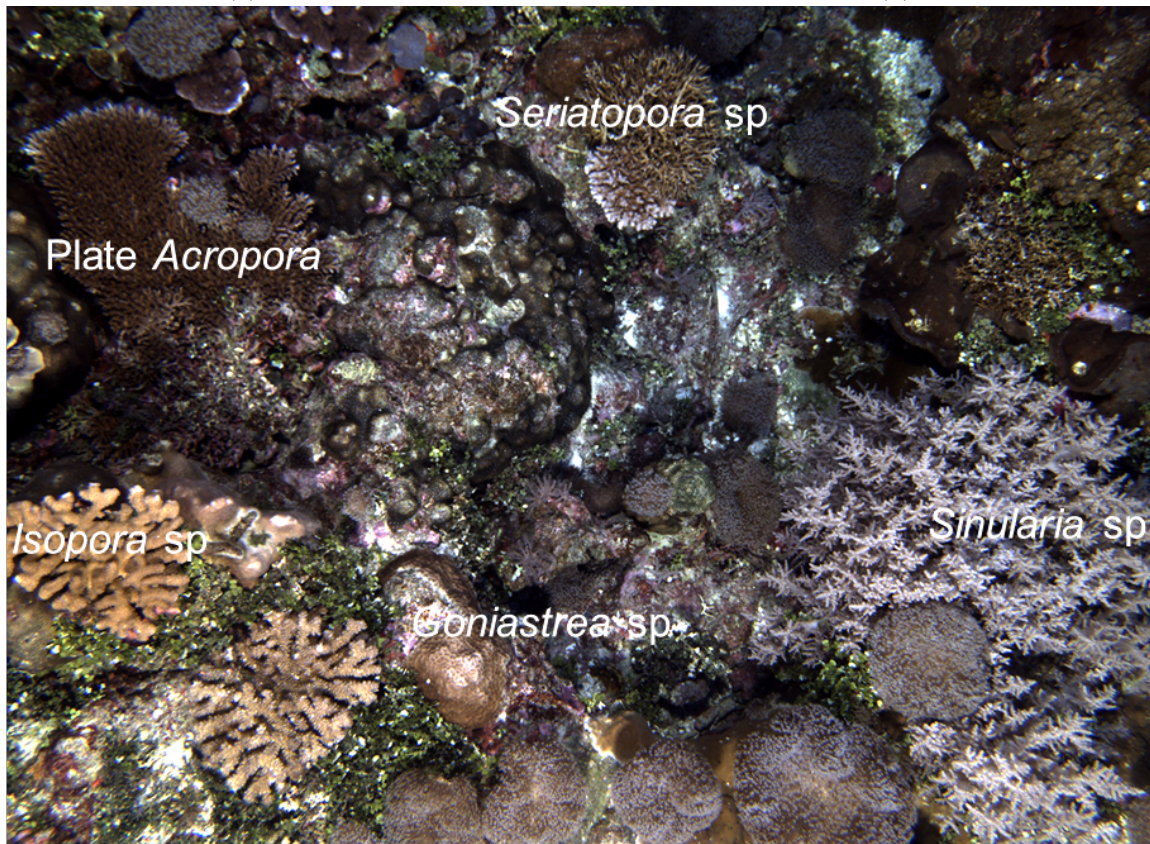
Laser Airborne Depth Sounder (LADS) bathymetric data for the shallow areas inboard of the edge of the reefs examined (approximately <70 m depth; Flinders, Malay, Herald Reefs) were acquired from the Australian Hydrographic Office (under license to Geoscience Australia). These data were integrated with the multibeam data acquired during these cruises to produce unique, full depth range digital bathymetry models of the reefs and will be available via the GA website (examples in Figure 11). The new bathymetry models are being used to classify the geomorphological features and processes on the reefs and for the generation of 3D depth models and visualizations.



(a)



(b)



(c)

Figure 10: Histograms showing percent cover of hard and soft coral categories in the mesophotic zone of Cairns Seamount derived from AUV images. The image provides an example of stony (i.e. hard scleractinian) and soft (Alcyonacea) corals identified in the AUV images (from Huang et al., Ocean Sciences Meeting, 2022)

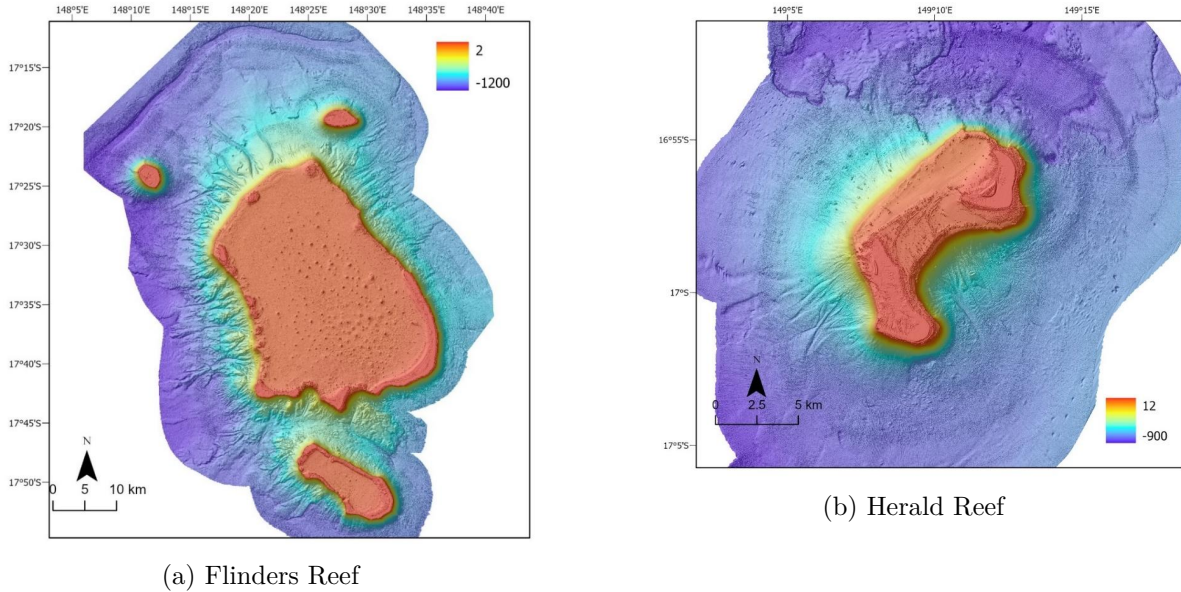


Figure 11: Digital bathymetry models of Flinders and Herald reefs incorporating multibeam data acquired during FK200429 and FK200802 and LADS data from the Australian Hydrographic Office. These models provide unique views of the full extent of the reef platforms (0 – ~1,000 m depth range) and surrounding deep seabed.

3 Societal Impact

3.1 Overview

The outputs of this project include unique, new high-resolution data and information on the physical characteristics, habitats, biology and seabed processes for large-scale deep-water features in the Great Barrier Reef and Coral Sea marine parks. This new information on the reefs and canyons is generating greater public awareness of the environmental assets the marine parks are designed to protect. Our multidisciplinary approach and utilization of the technology available on *R/V Falkor* (SuBastian; live streaming; vlogs; blogs) is greatly increasing the public's knowledge, awareness and appreciation of major environmental assets in the Coral Sea and Australia's marine environment more broadly.

3.2 New Discoveries & New Species

3.2.1 Corals, Sponges & Fish

Using *R/V Falkor* specimens we are now describing five new species of black corals, which is expected to be published this year. These specimens also support the creation of two new

families and three new genera; however, these new families and genera will not be published for at least one year because we will collect some topotype specimens of related species to pair with *R/V Falkor* specimens (i.e. we need to confirm the identity of the type species in various genera etc.). We are also working on worms that were found on the black corals, which will lead to a publication about associates on black corals in the deep Coral Sea. This research on the Antipatharia has been carried out by PhD student, Jeremy Horowitz, who has been awarded a prestigious Buck Postdoctoral Fellowship at the National Museum of Natural History – Smithsonian Institute in Washington DC, where he will continue his research on the systematics and evolutionary history of black corals.

Two specimens from the genus *Acropora* have already been sequenced using targeted capture as part of a worldwide revision of the genus. An additional 20 specimens from other genera are about to be sent for phylogenomic analysis as part of the Queensland Museum’s CoralBank project <https://projectdig.qm.qld.gov.au/research/Coral%20Bank>, which aims to understand the systematics and diversity of Australian reef corals. The final specimen had tissue snap frozen, and will likely be sent to the Sanger Institute for full genome sequencing as part of the Aquatic Symbiosis Genome Project <https://www.sanger.ac.uk/collaboration/aquatic-symbiosis-genomics-project/>. The specimen will be the only member of the genus *Leptoseria* and the only specimen from mesophotic depths sequenced as part of this project.

The collection of sponges, in particular the glass sponges, greatly increased the range extensions of many species. With the exceptional capability afforded by the *ROV SuBastian* on this expedition, we were able to concentrate on the collection of the delicate diminutive carnivorous sponges. These sponges (usually about 4 cm in length) were only discovered to have adapted from a filter feeding to a carnivory lifestyle due to the absence of food at bathyal depths in 1996. Four new species of carnivorous sponges are currently being described from this expedition and will be published later this year.

The remaining specimens of *Hexacorallia* and *Octocorallia* are in the process of being registered into the State Collection of the Queensland Museum. Many of these specimens have received preliminary identifications from relevant taxonomic experts, but have not been studied in detail at this stage.

ROV SuBastian images of fish encountered during the expedition are revealing major range extensions of several species. For example, significant media interest was generated by the discovery of the extremely rare ‘walking’ fish *Rhinopias agroliba* in the deeper waters of Tregrosse Reef, the first record of this fish in Australian waters.

3.2.2 Jellyfishes

Ribosomal 16S sequencing in Japan of samples collected on *R/V Falkor* suggests that only one of the species sampled during the present expedition belongs to a known species. Most of the collected jellyfish have enough variation in the 16S sequences to be cryptic sister species to known and described species. Due to travel being restricted between Japan and Australia,

the formalin-preserved specimens in the State Collection of the Queensland Museum still need to be examined for morphology to discover diagnostic characters differing from the known described species. Closely-related taxa in the JAMSTEC sample database are currently being sequenced to determine the degree of worldwide 16S variation in the sampled taxa.

The ROV video surveys identified multiple new distribution records for many gelatinous zooplankton taxa. These videos are currently being analyzed and the distribution records will be output in DarwinCore format and supplied to OBIS. Linkage of images to distribution records is currently not supported in OBIS so we are investigating other possible pipelines to preserve an image voucher for each new distribution record.

3.3 Impact

3.3.1 For policymakers

The cruise outputs are better informing management actions that aim to conserve environmental assets in the Great Barrier Reef and Coral Sea marine parks, including the regular review of GBR park zoning. Additionally, preliminary results have been used to identify key natural values (e.g. mesophotic coral reefs) for the Coral Sea Marine Park, as input to the design of a national system for monitoring the effectiveness of Australia's network of marine protected areas (Hayes et al. 2021). More broadly, the methods we utilised demonstrate that advanced technology (*ROV SuBastian*; AUV, multibeam) greatly increases the effectiveness and efficiency of marine surveys, providing robust baselines and sites that can be revisited for monitoring. Importantly, we highlighted the very low (strategic sampling by ROV) or negligible (ROV and AUV video/images) environmental impact of our approach.

3.3.2 Local communities

New information on reef features and habitats can support the regions sustainable tourism industry as the shallow reef features identified could potentially be suitable new destinations for tour operators. The Cairns Aquarium (<https://www.cairnsaquarium.com.au/>) is developing a large wall-sized poster of the deep Great Barrier Reef reflecting the various zones from shallow photic zone to the deeper 'midnight' zone and representative animals found there. Information from this cruise helped inform the visual artist's design. The poster is expected to be displayed in late 2022.

4 Appendix

All information below is up to date as of July 2022

4.1 Publications

- McNeil, M. (2021). No Pandemic-pause for Multi-disciplinary Reef Exploration in 2020. Reef in Review, 50, 8-10. [This article is published as OPEN ACCES]. Annual magazine of the Australian Coral Reef Society.
- Scientific journal publications are underway that report on new insights into the geomorphology and habitats of the Coral Sea reefs, utilising the FK200802 seabed mapping and oceanographic data. Unique aspects of the biodiversity of corals and sponges derived from samples and images acquired on the expedition are also the subject of scientific papers being prepared.

4.2 Data

Table 3: Datasets acquired during expedition FK200802 and data derived from the analysis of survey data and samples, and their location (*Shared at time of Report Publication*).

Data Type	Curator	Completed
ADCP	University of Hawaii	Y
Environmental sensor data collected by <i>R/V Falkor</i>	Rolling Deck to Repository	Y
Bathymetry data (raw)	AusSeabed	Y
CTD, Navigation, Oxygen, Images and Eventlogger data collected by <i>ROV SuBastian</i>	Marine Geoscience Data System	Y
Imagery from AUV Sirius (raw)	AODN - Campaign Name CoralSea202008 & Squidle+	Y
Imagery from AUV Sirius (annotated)	TBD	
Images collected from <i>ROV SuBastian</i> (annotated)	Squidle+	In Progress
Metadata of seabed sediment and rock samples	Geoscience Australia	Y
Seabed sediments and rock samples given International Geo Sample Numbers	IGSN	IGSN numbers have been assigned to samples. Sediment samples are currently being analyzed for textural properties.
3D models and flythrough animations of seamounts created	Geoscience Australia or AMP Science Atlas	

Data Type	Curator	Completed
Name and identification of new species	WoRMS, World Porifera Database, Queensland Museum, Vernon, Atlas of Living Australia.	Taxonomic work is in progress. Registration of Specimens in Queensland Museum Database is complete.
Molecular data for collected specimens	National Center for Biotechnology Information . NCBI Bioproject: PRJNA644402	Some data have been uploaded - more will be uploaded in 2023.

4.3 Cruise Blogs

- A series of [Cruise Log Videos](#) are available
- *ROV SuBastian* performed dives 370-392. [Livestream Dive List](#)

4.4 Conferences/Presentations/Posters

- Huang, Z., Carroll, A., Siwabessy, J., Dalton, S., Monk, J., Pizarro, O., Williams, S., Brooke, B., Nichol, S., 2022. Geomorphology and benthic biodiversity of Cairns Seamount in the Coral Sea, Northeast Australia. Abstract, Ocean Sciences Meeting, Session DS02 Wonder and Discovery in the Great Barrier Reef, Coral Sea, and Beyond: New Research and Exploration from Australia.
- Brooke, B., Nichol, S., Carroll, A., Beaman, R., Lindsay, D., McNeil, M., Horowitz, J., Bridge, T., Webster, J., Post, A., Huang, Z., McLennan, S., Przeslawski, R., Siwabessy, J., Picard, K., Ekins, M., Cresswell, B., Yokoyama, Y., Williams, S., Barrett, N., Monk, J., Pizarro, O., Galbraith, G., Henderson, D., Reeks, C., Marais, W., Shields, J., 2022. The geomorphology of coral reefs on the remote Queensland Plateau. Abstract, Ocean Sciences Meeting, Session DS02 Wonder and Discovery in the Great Barrier Reef, Coral Sea, and Beyond: New Research and Exploration from Australia.
- Andrew Carroll, Brendan Brooke, Scott Nichol, Robin Beaman, Dhugal Lindsay, Mardi McNeil, Jeremy Horowitz, Tom Bridge, Jody Webster, Alix Post, Zhi Huang, Stephanie McLennan, Rachel Przeslawski, Justy Siwabessy, Aero Leplastrier, Kim Picard, Merrick Ekins, Benjamin Cresswell, Yusuke Yokoyama, Stefan Williams, Neville Barrett, Jacquomo Monk, Alysha Johnson, Oscar Pizarro, Colin Woodroffe, Gemma Galbraith, Lauchlan Toohey, David Henderson, Christian Reeks, Wilhelm Marais, Jackson Shields, 2021. Seamounts, Reefs and Canyons of Australia's Coral Sea and Great Barrier Reef Marine Parks: A Comprehensive Deep Sea Study. ICRS 2021 - 14th International Coral Reef Symposium, Abstract no.: ICRS2021-2115.

- Brendan Brooke, Scott Nichol, 2021. Coral Sea Marine Survey, Section in the Spotlight Presentation, Geoscience Australia, 19th April, 2021.
- Beaman, R.J., Picard, K., Miller, A., 2022. RV Falkor surveys in Australia 2020-2021. In: Maschke, J. (Editor), Hydrosatial 2021 Conference, 16-18 Feb 2022. Australasian Hydrographic Society, Cairns, Australia.
- Horowitz, J. 2021. Recent explorations of the depths of the Northern Great Barrier Reef. Webinar Feb 2021. Environment Institute of Australia and New Zealand Inc.

4.5 Community Outreach

Presentations were given by FK200802 scientists to high school students at the annual Townsville schools career expo and to undergraduate marine biology students at James Cook University, Townsville, Queensland. This included ROV footage highlights from the voyage, career advice on multiple pathways to working in marine science (geological, biological, marine robotics) and experiences of the scientists from the cruise. Outreach activities Quotes from FK200802 scientists and survey images were provided to the Australian National Maritime Museum for their Ocean Wonders exhibition and social media posts: <https://www.sea.museum/whats-on/exhibitions/ocean-wonders>; and the One Ocean – Our Future exhibition: <https://www.sea.museum/whats-on/exhibitions/one-ocean-our-future>

4.6 Student Projects/Thesis/Dissertations

- Ella Sinclair, Queensland University of Technology Honours student (Supervisors Luke Nothdurft and Mardi McNeil): Microplastic abundance from reef-related deep-sea sediments.
- Kate Whitton, University of Sydney (Supervisors Jody Webster and Robin Beaman): Controls on benthic distribution within submarine canyons with a focus on Ribbon Reefs Canyons, GBR.
- Coursework masters students MARS5007 (Coral Reefs and Climate Change), University of Sydney (Supervisors Jody Webster): *ROV SuBastian* data (imagery, oceanographic sensors) from FK200802 were used in several coursework Masters level student research projects (March-June).

4.7 Science party information

4.7.1 Scientists aboard *R/V Falkor*:

Scientist	Institution
Brendan Brooke (Principal Investigator)	Geoscience Australia
Scott Nichol	Geoscience Australia
Andrew Carroll	Geoscience Australia
Zhi Huang	Geoscience Australia
Alix Post	Geoscience Australia
Stephanie McLennan	Geoscience Australia
Mardi McNeil	Queensland University of Technology
Robin Beaman	James Cook University
Jeremy Horowitz	James Cook University
Gemma Cresswell	James Cook University
Benjamin Cresswell	James Cook University
David Henderson	University of Sydney
Lachlan Toohey	University of Sydney
Christian Reeks	University of Sydney
Jackson Shields	University of Sydney
Wilhelm Marais	University of Sydney
Antonella Wilby	University of Sydney

4.7.2 Onshore science team:

Scientist	Institution
Dhugal Lindsay	Japan Agency for Marine-Earth Science and Technology
Jody Webster	University of Sydney
Oscar Pizarro	University of Sydney
Stefan Williams	University of Sydney
Merrick Ekins	Queensland Museum
Tom Bridge	Queensland Museum and James Cook University
Colin Woodroffe	University of Wollongong
Alysha Johnson	University of Wollongong
Yusuke Yokoyama	University of Tokyo
Aero Lepplastrier	Geoscience Australia
Kim Picard	Geoscience Australia
Rachel Przeslawski	Geoscience Australia
Justy Siwabessy	Geoscience Australia
Luke Nothdurft	Queensland University of Technology

4.8 Media

- BBC News: Great Barrier Reef: Uncovering the secrets of Australia’s deep waters, 30th September, 2020. This is an online BBC News video story on the discovery of a rare walking fish and the importance of survey FK200802 for science and environmental management, with comments by Brendan Brooke and Robin Beaman. <https://www.bbc.com/news/av/world-australia-54322760>
- There was a range of media engagements during research cruise FK200802 and these impressions and impacts are summarised in Table 6 (below) that was prepared by the SOI media team shortly following the cruise:

Table 6: Summary of media engagements, impressions and impacts during research cruise FK200802, from the SOI FK200802 Social Media and Press Report.

Section	Highlight
Website	<ul style="list-style-type: none"> • Nine written blogs posted on the site. • 18,202 users from 161 Countries. • 24,824 sessions and 52,145 page views during the cruise. • 4 expedition update videos • 3 science story videos • 2 special videos • 1 ROV Highlights 4K video • 1 by-the numbers video • 27 Livestreams resulted in 75.4k views on YouTube and more than 148k video views on Facebook
Programs	<ul style="list-style-type: none"> • We had no artist or student program due to COVID-19
Press	<ul style="list-style-type: none"> • A press release was issued during the finalization of this report on 9/7/20. • We had well over 30 articles spotlighting the expedition from such outlets as: Science Daily, The Sunday Times (UK), ABC (Australian broadcasting corporation) News, Geology Guides.com, MSN, and The Australian Times See pages 5-12 for list.
Community Events	<ul style="list-style-type: none"> • We continued to connect with Explore by the Seat of Your Pants with a Ship-to-Shore video call reaching over 100 viewers • We connected with Western Australian Maritime Museum as part of Sydney Science Trail 2020 and had an audience of nearly 350 (including live views and sessions after archiving on YouTube)

Section	Highlight
Facebook	<ul style="list-style-type: none"> • 3,358 page views • 421,529 people reached • 541,613 impressions from posts, including 41,836 shares, likes and comments; 10,080 of which were Likes on Posts. • Total of 148k Video Views; 156K Minutes of Video watched overall • 25,871 engaged users
Twitter	<ul style="list-style-type: none"> • Month of August: 91 Tweets 374,036 impressions over 31 days • 2,668K Likes, 3,375 clicks, 1,117 retweets
Instagram	<ul style="list-style-type: none"> • 14 Videos with 19.2k views and 32.2k minutes watched • 24 posts - 13 photo-based (some multiple photos in post), 11 videos • 6277 likes and 107 comments
YouTube	<ul style="list-style-type: none"> • 12,866 video views • 75.4K views • 8k hours watched (approximately 335 days, 483k minutes) • 4 Expedition Updates • 3 Science Stories • 1 ROV Highlights video posted in 4K resolution • 1 by-the-numbers video • 2 broadcast Ship-to-Shore • 2 special videos • 81:47:14 of video posted - 79:32:00 from Live ROV streaming

4.9 Software Utilized

- Bathymetry data were processed using Caris HIPS & SIPS.
- Processed bathymetry data were analysed and visualised using ArcGIS Pro and QPS Fledermaus.
- AUV images were annotated using Squidle+.
- Eventmeasure-Stereo and CAL (SeaGis) were used to analyse mid-water survey footage.

4.10 Technology Update

Development work is continuing on adding modules to Squidle+ to facilitate post-cruise video annotations, extraction of the data, and export into public repositories.

4.11 Log of Daily Science Activities on *R/V Falkor* – Expedition FK200802

4.11.1 Leg 1: Chief Scientist – Brendan Brooke

Science team: Andrew Carroll, Zhi Huang (GA), Mardi McNeil (QUT/SYD), Jeremy Horowitz (JCU), Christian Reeks, David Henderson, Jackson Shields, Wilhem Marais, (USYD)

- Saturday August 1, 2020
 - Departed Cairns 5 pm Saturday Aug 1 for North Flinders Reef
- Sunday August 2 – Transit to N Flinders Reef
 - Delay reaching N Flinders Reef due to rough seas, arrived 2pm Sunday.
 - Test dive SuBastian to 300m (ROV Dive 370)
 - AUV preparations
 - MBES mapping overnight
 - Overall, a pretty rough night and morning (some sea sickness) with conditions improving in the afternoon at N Flinders Reef. Waves 2.5m, wind 20 knt
- Monday 3rd August – N Flinders Reef
 - overnight multibeam mapping of area immediately N of N Flinders Reef.
 - mapping of shallow area (45- 30 m depth) on NE margin of the reef for AUV testing
 - short ROV dive (371) including 500 m transect, and sampling (Part 8a Permits arrived in time)
 - weather improved enough to allow AUV testing - completed successfully
 - further MBES mapping at night along W margin of N Flinders Reef
 - All science party well and happy; waves ~2m; wind 15 knt.
- Tuesday 4th August – N Flinders Reef
 - completed MBES mapping of W and N margins of N Flinders Reef at 7.30am
 - AUV testing/calibration on shallow ground at N end of Flinders Reef was successful (now setup for all future sites)
 - AUV successfully deployed at two sites in this area
 - Short ROV dive (372) from 350m depth in remaining daylight, several biology and geology samples collected
 - CTD deployed in 600m depth offshore ROV dive site 372 at 6.30 pm.
 - Departed Flinders Reef ~8.30pm for transit to Cairns overnight to change *R/V Falkor's* crew.
 - All science party well and happy; waves ~2m; wind 15 knt.
- Wednesday 5th August – Cairns
 - Mapping overnight to the north west of N Flinders Is and then on to Cairns, adjoining the existing transit data.

- Crew change and new crew aboard at Cairns, ~11am
- Transit to Cairns seamount via Flora Reef to fill data gaps and add to existing tracklines
- Due to arrive at Cairns Seamount ~5.30 am
- Thursday 6th August – Cairns Seamount
 - completed overnight MBES mapping and CTD cast, 06.00
 - AUV deployment on Cairns Seamount – unsuccessful due to strong N current
 - ROV deployment (Dive 373) at Cairns Seamount. Slow descending dive to image and sample jellyfish for Dhugal Lindsay, who joined the online feed to advise on imaging and sampling. Sampling was successful; image files still to be checked; dive up the side of the seamount, collecting coral and a few sediment samples, from 1200 m to 60 m completed, 19.30.
 - Night time mapping gap to NE of Cairns Seamount and remapping seamount to improve resolution of MBES data.
 - Science team well and happy; low swell, light wind.
- Friday 7th August – Cairns Seamount
 - completed overnight MBES mapping on and around Cairns Seamount; CTD cast, 06.00
 - AUV deployment on Cairns Seamount – delayed due to battery issue.
 - ROV deployed (Dive 374) at Cairns Seamount – descending dive to image and sample jellyfish for Dhugal, who joined the live feed – sampling was successful; image files still to be checked; dive up the side of the seamount, collecting coral and a few sediment samples, from 600 m to 60 m completed, 15.00.
 - AUV deployed 15.30, AUV failed/submerged ~16.30 and retrieved using *ROV Subastian* (Dive 375)
 - Night time MBES mapping to expand coverage
 - Transit to Herald Cay
 - All science team well and happy. Weather – 1.5 m swell, 10 knt wind.
- Saturday 8th August – Herald Cay
 - completed overnight MBES mapping and CTD cast, 07.30.
 - ROV (Dive 376) deployed north western margin of Herald Cay reef – descending dive to 600, imaging and sampling jellyfish for Dhugal – sampling was successful; dive up the margin of the reef, collecting coral and a few sediment samples, from 500 m to 60 m, completed 15.00.
 - AUV repaired and deployed 15.30, AUV unable to detect bottom/strong current – retrieved with workboat from surface.
 - Night time MBES mapping to expand coverage around Herald Cay.
 - All science team well and happy. Weather: 1.2 m swell, 10 knt wind.
- Sunday 9th August – Herald Cay

- completed overnight MBES mapping around Herald Cay and CTD cast, 07.30.
- AUV deployed 08.00, AUV damage/wiring issue and retrieved with workboat; repaired and redeployed; data acquired on two missions on NE margin of Herald Cay, ~50 – 90 m depth, finished 17.45.
- Began transit to Malay Reef after completion of AUV operations
- All science team well and happy. Weather: 1.5 m swell, 17 knt wind.
- Monday 10th August – Malay Reef
 - completed overnight MBES mapping around Malay Reef and then CTD cast just N of reef, 07.30.
 - ROV (Dive 377) deployed 08.30, N margin of Malay Reef; 630 – 90 m depth, including mid-water dive with Dhugal online; finished 17.00.
 - AUV preparations for dive tomorrow early
 - acquired a couple of SBP lines across N margin of Malay Reef.
 - MBES mapping overnight around Malay Reef and south to complete cover over partially mapped deep reef.
 - All science team well and happy. Weather: 1.5 m swell, 15 knt wind.
- Tuesday 11th August – Malay Reef
 - CTD cast just N of Malay Reef, 07.30.
 - AUV deployed 08.30, N margin of Malay Reef; completed one long mission 60 – 100 m depth; AUV back on deck 11.30. AUV cleaned and packed up.
 - began transit to Cairns 12.00, MBES mapping along margin of existing tracks.
 - All science team well and happy. Weather: 1.5 m swell, 18 knt wind.
- Wednesday 12th August – Transit to Cairns
 - Labs and cabins cleaned
 - Data back up
 - ETA Cairns 13:00
 - Survey suspended due to unwell crew member, requiring implementation of COVID-19 incident management plan (including COVID-19 test of the affected person).
- Thursday 13th August – Survey Suspended, in Port
 - All science crew restricted to cabins

4.11.2 Leg 2: Chief Scientist – Scott Nichol

Science team: Rob Beaman (JCU; Co-Chief Scientist), Alix Post, Stephanie McLennan (GA), Mardi McNeil (QUT/USYD), Ben Cresswell, Gemma Cresswell (JCU), Jeremy Horowitz (JCU), Antonella Wilby (USYD)

crew remained onshore for Wed and Thurs night COVID-19 test result returned as negative QLD Health gave clearance for Leg 1 science crew to depart, and Leg 2 to join *R/V Falkor*.

- Friday 14th August – Survey resumed, Transit to Ribbon Canyons
 - Handover from Leg 1 to Leg 2 team completed by 10am
 - Leg 1 crew disembarked and went direct to Cairns airport for 12 noon flight home
 - *R/V Falkor* departed Cairns at 11:00 to begin transit to Ribbon Reef 5 canyons (north of Cairns, eta 22:00)
 - Leg 2 crew completed ship induction and muster drill for abandon ship
 - Afternoon spent settling in and familiarising with the vessel, plus very pleasant welcome on board reception in the outdoor lounge
 - Acquired MBES data along the upper slope / shelf break to fill in a key gap in bathy coverage of the GBR.
 - Science team well and happy. Weather: 1 m swell, 15 knt wind

- Saturday 15th August – Ribbon Canyons
 - Overnight MBES mapping across mid to lower reaches of Ribbon Reef 5 canyon system to improve grid resolution of existing coverage (and add backscatter) and support ROV dive planning.
 - CTD cast at 07:00 to 08:30 to 1400 m water depth, toward mouth of Ribbon Reef 5 canyon system. A key site to document the major water masses that characterise the western Pacific (Antarctic Intermediate Water, SubAntarctic Mode, Subtropical Mode and Surface Waters) – that set the context for jellyfish sampling
 - Timed Midwater Dive with ROV from 200 – 1200 m to observe and sample jellyfish. Commenced 09:30, ended ~13:00
 - ROV transect (Dive 378) across the floor of the Ribbon Reef 5 canyon system commencing 1800 m then tracked up the north facing side of the canyon to 1500 m; collected push cores at two sites, with full recovery to 25 cm in firm silty clay. Sampling of sparse epibenthos (sponges, octocorals, black corals). 13:00 to 18:30
 - Evening spent processing bio samples and core samples.
 - Science team well and happy. Weather: 1 m swell, 10-15 knt wind

- Sunday 16th August – Ribbon Canyons
 - Overnight MBES mapping in vicinity of Ribbon Reef 5 canyons continued, improving and extending coverage over canyons and lower slope. This has given us a fresh 10m bathy grid to better inform dive planning.
 - One ROV dive completed today: Dive 379 to characterise the mid reaches of the main axis of Ribbon Reef 5 canyon (northern arm; reef blocked). An excellent dive that included sampling of exposed bedrock from the lower flanks of the canyon wall. To collect this sample the crew manufactured a drill bit that was used to recover a small (15x10 cm) slab of mudstone. The ROV transect also revealed the canyon walls are mantled by very cohesive muds (four pushcore samples collected), that support infauna and sparse epibenthos (small number of corals collected on the dive).

- Dive 380 was planned for the headwall of the same canyon but was aborted due to a power supply issue to the main science camera on Subastian. Two attempts to redeploy failed, with reoccurrence of issue. Decided to cease ROV ops at 17:00 to allow time for the crew to trouble shoot the fault.
 - Dives 381, 382, 383 all aborted dives undertaken during testing of repairs to science camera; operational following dive 383
 - Commenced transit to outside the 12Nm to discharge waste tanks, then returned to Ribbon Reef 5 canyons to resume MBES mapping overnight.
 - Science team well and happy. Weather: <1 m swell, 10 knt wind
- Monday 17th August – Ribbon Canyons
 - Overnight MBES mapping in vicinity of Ribbon Reef 5 canyons continued to the south of previous night, improving and extending coverage over canyons and lower slope. This has given us a fresh 10m bathy grid to better inform dive planning.
 - ROV dive 384 completed today, commencing at 10:00 (following further trouble shooting with the science camera) and running all day to 17:00. The dive aimed to characterise the upper reaches and headwall of Ribbon Reef 5 canyon (northern arm; reef blocked). A fascinating dive that traversed the muddy, bioturbated upper canyon floor, a scree slope of coral rubble at the base of the canyon headwall, then a vertical rise up the headwall from 200m water depth, crossing the shelf break at 90m and ending on the outer shelf reef in 60m w.d. Collected samples of coral from likely outcrop at the base of the headwall, and at 130m depth (last glacial maximum sea level position). Also collected black coral at several sites on the headwall, and hard corals within the mesophotic zone.
 - Also during todays dive, Rob Beaman and Jody Webster provided an online commentary that was filmed for a National Geographic doco on the GBR.
 - MBES mapping overnight to south of area mapped last night, commencing with a shelf edge line in 200m water depth.
 - Science team well and happy. Weather: <1 m swell, <10 knt wind
 - Tuesday 18th August – Ribbon Canyons
 - Overnight MBES mapping in vicinity of Ribbon Reef 5 canyons continued to the south of previous night, improving and extending coverage over canyons and lower slope. ROV dive 385 completed today, commencing at 09:00 and running all day to 17:00. The dive aimed to characterise the upper reaches and headwall of Ribbon Reef 5 canyon (canyon 8b; southern arm; shelf connected). A broadly similar dive to the previous site (dive 384), traversing muddy sandy substrate from 600 m to 200 m before reaching the canyon headwall. Some evidence of sediment transport from the GBR lagoon, with wood fragments (small logs) and coral rubble increasing in concentration upslope. Collected fossil coral material at 200m, 130m, 110m depths from the exposures in the canyon headwall. Also collected hard corals at several sites on the headwall, and corals within the mesophotic zone at 90-60m depth.

- MBES mapping overnight to north of canyon 8a, commencing with a shelf edge line in 200m water depth.
- Science team well and happy. Weather: No swell, calm
- Wednesday 19th August – Ribbon Canyons
 - Overnight MBES mapping to the north of Ribbon Reef 5 canyons continued, completing our mapping in this area.
 - ROV dive 386 completed this morning, commencing at 09:00 and running to 12:30. The dive aimed to characterise the mid reaches of Ribbon Reef 5 canyon (canyon 8b; southern arm; shelf connected) between 1400 m and 1000 m water depth. A successful dive that traversed the canyon floor where an extensive area of bedrock is exposed, to the mud draped canyon wall. Collected a small sample of rock using the drill bit, recovering small chips of mudstone. This is the same lithology exposed at a similar water depth in canyon 8a. Also collected cup corals attached to the mudstone outcrop. ROV dive 387 completed in the afternoon, commencing at 15:30 and continuing to 17:30. This dive traversed from the valley floor to southern wall of the slope-confined canyon to the south of Ribbon Reef 4 (canyon 10) between 950 and 700 m water depth. The dive revealed the canyon floor and walls are mantled by a continuous cover of muddy sand, with no bedrock outcrop observed. Benthic biota dominated by infauna with numerous burrows and crawling traces (observed active trace activity by sea urchins); only very occasional sea pens. Collected push cores at start and end of transect, in 900m and 700 m water depth – all cores recovered muddy medium carbonate sands.
 - MBES mapping overnight during the transit north to Ribbon Reef 9/10 canyon; including mapping the upper reaches of the canyon.
 - Science team well and happy. Weather: No swell, calm
- Thursday 20th August – Ribbon Canyons (north)
 - Overnight MBES mapping during transit to Canyon 1 offshore from Ribbon Reef 9/10, including mapping of upper reaches of the canyon
 - CTD deployment to 1200 m at location of ROV dive, from 07:00 to 08:30
 - ROV dive 388 completed in canyon 1, commencing at 09:30 with timed midwater plankton transect to 1000 m and followed by seabed transect from 1500 m to 1300 m up the southern wall of the canyon. The dive traversed the lower 100 m of the northern canyon floor where several metres of outcrop of interbedded sandstone and mudstone was mapped and a sandstone block collected. The dive then crossed the canyon floor (two push cores collected; muddy sand with coarse sand/gravel interbeds), and then climbed the southern wall to 1300 m. Highlights included exposure of interbedded coarse sand/gravels and muds in a low section at base of canyon – likely turbidite sequence (grab sample collected); and acorn worms (one sample collected; only small fragment retained).
 - MBES mapping overnight during the transit north to Osprey Reef, gap filling within the Queensland Trough.

- Science team well and happy. Weather: <0.5 m swell, wind 5-10 knots from SE
- Friday 21th August – Osprey Reef
 - MBES mapping overnight during the transit to Osprey Reef, gap filling within the Queensland Trough.
 - CTD deployment to 1200 m at location of ROV dive, from 07:00 to 08:30
 - ROV maintenance 09:00 to 10:00 to deal with broken o-ring (not a major issue)
 - ROV dive 389 completed on western side of Osprey Reef, from 10:20 to 18:00. Commenced dive with timed midwater plankton transect to 600 m, followed by seabed transect from 1500 m to 1200 m depth, traversing a large block that sits detached from the main structure of Osprey Reef. This site was selected as a down slope extension of a previous ROV at this site (from Visioning the Coral Sea Voyage on *R/V Falkor* in June 2020);. Dive highlights included: extensive areas of exposed hard rock as boulder fields on the lower slope, transitioning to very steep to near vertical rock walls; evidence of large scale bedding and slab failure along high angle bedding planes; increased abundance of epibenthos toward the crest of the block at ~1200 m where fine scale complexity of rock outcrop provides microhabitat for sessile biota; patches of coral debris (sub-fossil) in highly weathered condition but of a species much more robust than modern corals at this depth (two samples collected); and a nesting octopus with eggs under a ledge. Also collected push cores at base of slope in muddy sands (pelagic ooze); two samples of rock debris loose on the seabed; and corals.
 - Science team well and happy. Weather: <0.5 m swell, wind 5-10 knots from SE
- Saturday 22nd August – Osprey Reef
 - MBES mapping overnight along the western margin of Osprey Reef, Shark Reef and Vema Reef to extend deep water coverage at the foot of slope.
 - ROV dive 390 completed on western side of Osprey Reef as a shallow water extension to a previous dive at this location (from Visioning the Coral Sea Voyage on *R/V Falkor* in June 2020); on bottom at 09:00, off bottom at 13:45. Commenced seabed transect at 800 m, traversing the upper slope of the reef margin, ascended near vertical wall of reef from 400 m to 200 m, and then steep mesophotic zone to 65 m. Dive highlights included: reef debris ranging from gravel to cobbles and boulders on the upper slope; near vertical rock walls of in situ reef limestone with distinctive karst weathering features (vertical flutes, dissolution hollows); several swimming nautilus between 600 m and 200 m. Also collected push cores at base of slope in muddy sands (pelagic ooze); samples of reef limestone at 120 m; and corals.
 - Successful deployment of small ROV by Antonella Wilby (USYD) within Osprey Reef lagoon using *R/V Falkor* small boat, with support from *R/V Falkor* deck crew.
 - Commenced transit to Noggin Canyon 3 at 14:00 (17 hr transit)
 - Science team well and happy. Weather: 0.5 to 1 m swell, wind 10-12 knots from SE
- Sunday 23rd August – Noggin Canyons to Gloria Knolls

- MBES mapping overnight during transit to Noggin Canyon 3, including mapping along the canyon on approach to planned ROV dive site
- After arriving at Noggin Canyon 3 dive site the currents were assessed to be too strong for safe deployment and recovery of the ROV; operation cancelled at 10:00. ADCP data showed the current was running at 1.5 knots to 200 m depth; interpreted as the edge of the East Australian Current. Any current in excess of 1 knot can create issues with ROV overheating. Increased wind also making back deck operations more challenging.
- Transited to Gloria Knolls submarine slide block to target potential deep water coral habitat, 25 km (14 Nm) southeast of Noggin 3, arriving 13:00. ADCP data again showed currents too strong for safe ROV operations, mapped to 200m at 1.4 -1.6 Knots. Operation cancelled.
- Commenced transit to Tregrosse Reef at 14:30
- Science team well and happy. Weather: 1-1.5m swell, wind 20-25 knots from SE
- Monday 24th August – Tregrosse Reefs (Diamond Islets)
 - MBES mapping overnight during transit to Tregrosse Reefs, including mapping along the northern flank of Malay Reef to extend coverage in deeper water. Arrived at Tregrosse Reef western margin at 11:30.
 - ROV dive 391 completed on northwestern tip of Tregrosse Reefs; on bottom at 12:40, off bottom at 14:40. Dive aborted before completing full 1 km transect due to accelerating ebb tidal flow – reaching 1.5 knots. Depth range completed 350 to 290 m, traversing limestone blocks and pavement with sandy and gravel veneer, and extensive field of linear sand waves. Collected two push core samples of carbonate sand & gravel; plus soft coral and black coral specimens.
 - MBES mapping along western and northern margins of Tregrosse Reefs to extend coverage along the upper reef slope.
 - Science team well and happy. Weather: 1.5m swell, wind 20-25 knots from SE
- Tuesday 25th August – Tregrosse Reefs (Diamond Islets)
 - MBES mapping overnight along the western and northern flanks of Tregrosse Reefs to extend coverage along the upper slope.
 - ROV dive 392 completed on eastern flank of Tregrosse Reefs; commenced with midwater dive to sample jellyfish between 100 and 450 m – among the highest concentration of jellyfish of the midwater dives on the survey.
 - Benthic transect on bottom at 11:00, off bottom at 17:00. Depth range 450 to 65 m, traversing extensive field of rippled sand bed at 450 - 400 m, isolated limestone blocks with soft and hard corals on ascent to 150 m, then mixed gravel and sands with increasing density and diversity of benthic cover into mesophotic zone. Collected two push core samples of carbonate sand & gravel; plus 11 samples of soft coral and black corals.
 - MBES mapping overnight along southern margin of Lihou Reef to extend coverage into deeper water

- Science team well and happy. Weather: 1.5m swell, wind 15-20 knots from SE
- Wednesday 26th August – Lihou Reef to transit
 - MBES mapping overnight along southern margin of Lihou Reef to extend coverage into deeper water
 - CTD completed at planned site for ROV dive, 07:00 to 07:30.
 - ROV dive cancelled due to strong surface currents, 2 knots to 80 m depth and increasingly rough sea conditions (sea state 6)
 - Commenced transit to Brisbane at 08:30 with plan to complete mapping around Marion Reef on route.
 - Commenced packing of samples and lab gear for offloading
 - Science team well and happy. Weather: 1.5 - 2 m swell, wind 20 knots from SE
- Thursday 27th August – Transiting to Brisbane
 - Continued transit to Brisbane
 - Seminar presentation via zoom from Martin Russell, Coral Sea Marine Park manager, Parks Australia
 - Sample packing finalised
 - Science team well and happy. Weather: 1.5 - 2 m swell, wind 20 knots from SE
- Friday 28th August – Transiting to Brisbane
 - Continued transit to Brisbane
 - Seminar on Voyage Summary and Highlights presented to the ship's crew by SN and leg 2 team
 - Data backups continued; lab cleaned and samples packed
 - Science team well and happy. Weather: 1.5 - 2 m swell, wind 20 knots from SE
- Saturday 29th August – Transiting to Brisbane
 - Continued transit to Brisbane, mapping upper slope offshore Fraser Island prior to arriving at pilot station
 - Science team well and happy. Weather: 1.5 - 2 m swell, wind 20 knots from SE
- Sunday 30th August 2020 – Arrival into Brisbane, end of cruise
 - *R/V Falkor* arrived into port of Brisbane at 08:00
 - Science crew disembarked by noon for flights to Canberra/Cairns/Townsville
 - Sediment samples to be collected for freight to Uni Sydney on Monday 31/8
 - Bio samples to be transported by car with Jeremy Horowitz to Queensland Museum