The Great Australian Deep-sea Coral and Canyon Adventure

30-day Post Cruise Report

Ship name: Falkor
Cruise Dates - Day Departed: 01/26/2020 **Day Returned**: 2/25/2020
Cruise Number: FK200126
Departure Port: Albany, Australia **Arrival Port**: Fremantle, Australia
Mid-Cruise Port Call (if any): Albany, Australia
Participating Organizations, Institutions, Foundations, Government Agencies, etc.
University of Western Australia; Instituto di Scienze Polari (ISP); Istituto di Scienze Marine (ISMAR); Western Australian Museum
Funding Sources
In addition to in-kind contributions from each institution, the following external funds have been used for cruise expenses and are available for post-cruise research:

- Australian Research Council funding for ARC Future Fellowship to J. Trotter (FT160100259): Decoding deep-sea coral ocean-climate records of the Last Glacial Maximum and Anthropocene.
- University of Western Australia (UWA) Fellowship Support Grant to J. Trotter: Constraining ventilation ages, hydrodynamics, and CO2 flux in the ocean interior through time.
- Italian Programme for Antarctic Research (PNRA) funding to P Montagna (PNRA16_00069.): Geochemical signals in Antarctic biogenic carbonates for paleoceanographic reconstructions (GRACEFUL).
- ARC Centre of Excellence for Coral Reef Studies, co-director M McCulloch (CE140100020).

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Cruise Objectives:
The first objective of the cruise was to undertake the first remotely operated vehicle (ROV) expedition to Southwest Australia's Southern Ocean, facing Bremer (Location 1) and Leeuwin (Location 2) canyons, and to revisit the Perth Canyon (Location 3) during a 32 day cruise aboard the R/V *Falkor*. Using high resolution video imaging from the ROV SuBastian, deep sea faunas and their habitats were documented, as well as the biodiversity and distribution patterns of these unexplored ecosystems to depths of 4000 m. An aerial drone was used to collect images of on-board operations (e.g. ROV and Rosette deployment).

Secondly, the ROV was used to conduct strategic in situ sampling of deep-sea corals and some associated fauna as well as sediment pushcores along depth transects. Plankton was also sampled from *Falkor's* seawater intake system. The ROV strategically sampled the benthos, specifically collecting dead/fossil coral skeletons. These collections will establish a unique reference collection for the Western Australian Museum and underpin post-cruise geochemical analyses.

Following the cruise, the skeletons of the collected corals and foraminifera (collected from the water samples and sediment cores) will be analysed at University of Western Australia's (UWA) state-of-the-art analytical facilities using geochemical proxy methods, i.e. boron isotopes and trace element ratios. The analysis will yield an understanding of the controlling factors enabling these faunas to exist at their extreme limits, quantification of deep-ocean warming and acidification over recent and potentially geological timescales (centennial to millennial), and an understanding of how deep-sea calcifiers will likely be impacted in a high CO2 world. By extending sampling into the deeper reaches of the Perth Canyon (4000 m) and re-sampling the fossil coral graveyards (~30-18 kyr) discovered in 2015, our collections and palaeorecords will be expanded within and beyond the Last Glacial Maximum period.

The cruise also aimed to complete comprehensive physical and chemical measurements of canyon waters in order to characterise the ambient conditions in which the faunas grow. Using CTD and Niskin samplers, seawater parameters (temperature, salinity, O2, nutrients, and carbonate system) were collected to define the physico–chemical dynamics controlling the regional ecology, food sources, skeletal growth rates, and to provide essential calibrations for our geochemical proxy records. On-board measurements of carbonate parameters (alkalinity, DIC, pH etc) were analyzed onboard *Falkor*, utilising existing mobile instrumentation

(spectrophotometry, DIC analyser) proivded by UWA. Drifters were also deployed during the cruise to track surface currents. Collectively, these data will provide a present-day 'baseline' of environmental conditions and enable comparison with past records of environmental change extracted from the coral skeletons.

Finally, high-resolution multi-beam bathymetry was collected when the ROV was not diving and maps will be created for the currently unmapped areas where data is poor and requires greater resolution. The maps also identified prospective dive sites and re-inforced decision-making on where to deploy the ROV.

Impact of the Research:
All of the data gathered during the cruise is new and reveals for the first time what occurs below the surface waters in these canyon systems. The outcomes of the research will alert the general public, authorities, and researchers to the existence of these unique and never before seen ecosystems, and will provide otherwise unattainable information about changing environmental conditions in the Southern Ocean, which plays a major role in regulating global climate. Via media and outreach programs, the public has for the first time seen some of its inhabitants, and together with the ship-to-shore program has had a great impression on young pupils now keen to learn more about the deep-sea and perhaps pursue careers in ocean research.

Relevance to managers and the local communities
The immediate data collected during the cruise can be accessed and used by the Commonwealth Marine Park Authority (MPA). The MPA provides immediate information of what is inhabiting the deep waters of the area and the current conditions, which was previously unknown. When the dive survey data, taxonomy, and canyon environmental conditions and geology are fully determined and integrated as habitat maps, these details will be provided to the MPA which the public will be able to access via the MPA website of the respective canyons.

Summary of Operations and Data Collection
The project conducted some of the first ROV-based investigations of the Southern Ocean facing Bremer and Leeuwin submarine canyons of southwestern Australia and revisited Perth Canyon, first studied in 2015. For logistical reasons the cruise was split into two legs, with the port of Albany serving both as the port of embarkation (January 26th) and mid-cruise port call (February 14th). End of cruise disembarkation was at the port of Fremantle, Perth, on 26th February.

Bremer Canyon, which is located ~120 km east of Albany, was the first target site. Here, an intensive program of multibeam mapping occurred during the evening and/or on transits to the various sites. In this region of southwestern Australia, weather is often problematic and for

about three days (February 6th, 7th and 9th) it was not possible to conduct ROV dives or CTD casts. Also, during this leg, three ROV dives were aborted with no sampling undertaken due to either technical issues (January 27th (dive 311) and February 2nd (dive 316)) or a combination of both weather and technical issues (February 9th (dive 319)). Two dives were aborted (January 30th (dive 313) and February 8th (dive 318)) after approximately three hours of bottom time due to manipulator arm malfunction. On February 2nd (dive 316), the ingression of seawater was detected in a critical component of ROV SuBastian. The solution required that a replacement part be 'hand-carried' from Seattle USA to Bremer Bay, a task that was amazingly completed within 48 hours.

The ROV was fully operational again by February 5th with another five dives being completed. This demonstrated the superlative capabilities and dedication of the ROV crew, onboard workshops, and of SOI operations generally. A total of ten ROV dives were thus undertaken, eight being highly successful. We sampled seawater from five CTD-Rosette casts around Bremer Canyon, the deepest site being 4830m deep, located at the south of the mouth of the canyon. However operation of the CTD-Rosette was curtailed towards the end of this leg due to winch issues. Despite these various challenges of both weather and technical problems, the Bremer Canyon leg of the expedition was highly successfully, with thorough characterisation of Australia's deepest Commonwealth Marine Park now possible for the first time utilising the comprehensive science package of ROV videos, the marine fauna collected especially deep sea corals, CTD seawater characterization of oxygen, temperature and salinity, together with excellent high-resolution multibeam mapping of the canyon morphology and substrate.

The second leg of the cruise departed from Albany with the Leeuwin and Perth Canyons being the target sites. Unfortunately, deteriorating weather conditions severely limited operations to two days of ROV dives at Leeuwin Canyon on February 15th and 16th. Nevertheless, the ROV dives revealed remarkable diversity along the shelf walls, with another site being characterised as a massive fossil graveyard pointing to the sensitivity of deep-sea corals to changing ocean dynamics and climate change. Prior damage to the CTD-Rosette winch precluded seawater sampling in the Leeuwin Canyon area.

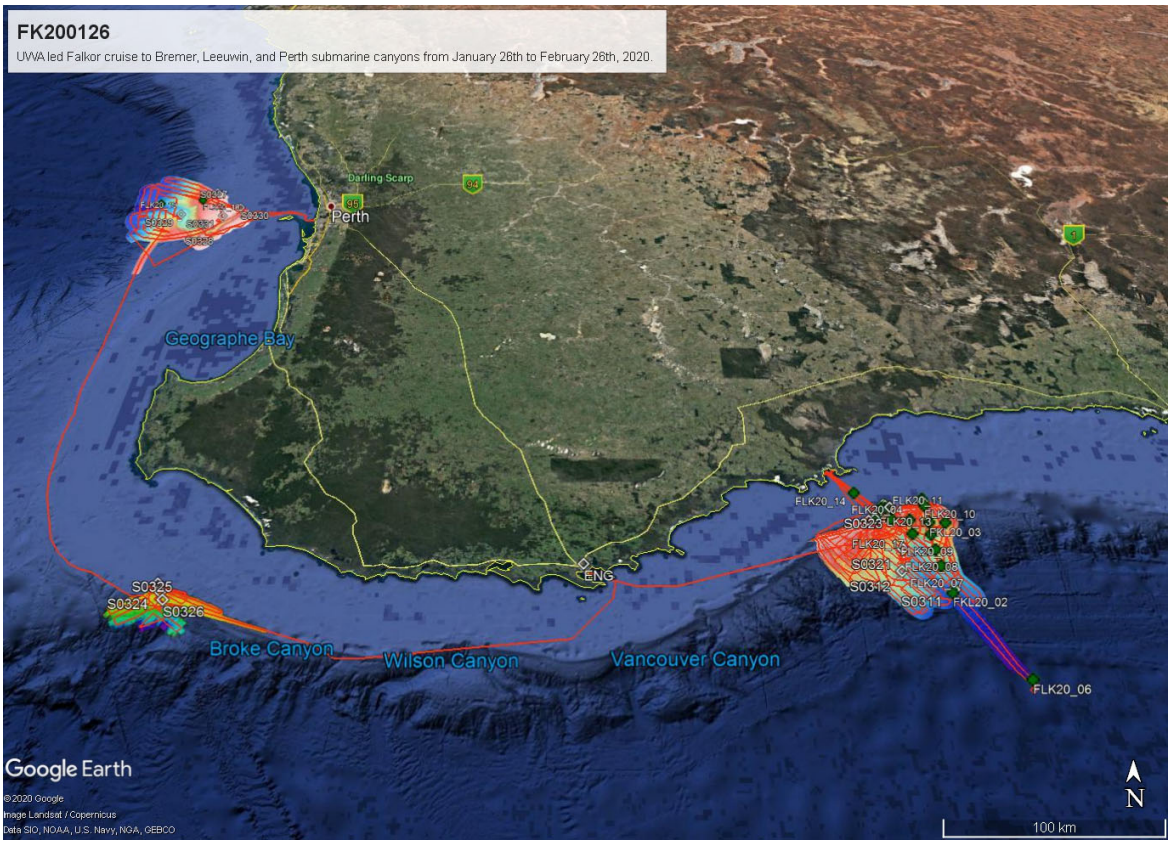
Given the poor weather, we ceased operations in the Leeuwin Canyon and steamed northwards to the Perth Canyon, which is located approximately 50 km offshore Perth, the capital city of WA. ROV dive operations commenced in the Perth Canyon on February 19th, initially targeting sites of coral graveyards discovered in 2015, then moving to deeper unexplored areas to search for new and more productive sites. A total of five ROV dives were conducted over the next five days, the last being on February 23rd (dive 331), when deteriorating conditions again curtailed ROV operations. A temporary repair to the CTD-Rosette system permitted a deep cast to be undertaken to 3830 m depth, which crucially enabled sampling of the deeper waters within the canyon. These data will make for interesting comparisons with waters from the southern

canyons sampled during leg 1, as well as those collected in this canyon during the 2015 expedition aboard *Falkor*.

In addition to the main marine operations described above, other sampling activities were also conducted, including ROV collections of geological samples, both rocks and substrate sediments (~upper 20 cm) using push cores from which interstitial pore waters were also extracted, Manta net tows for collecting surface plastics, as well as planktonic foraminifera collections from *Falkor's* seawater intake system.

The multibeam mapping and data reduction together with geomorphic/substrate analysis occurred in near-real-time as much as practical. First pass Squidle/Sealog data were entered by operators in real-time, which await post-cruise verification and further analysis together with ROV videos. The ROV collected high resolution videos during each dive, with bottom times of approximately three to nine hours, excerpts of which were taken to produce public outreach and media outputs including the ship-to-shore sessions involving schools in Western Australia, Italy, and the United States.

Did you collect Measurements or Samples, including biological specimens? Yes
Is there any suspected or confirmed new species discovered during the cruise? Yes. Various invertebrates which will need to be identified by specialist taxonomists.
Did you deploy and/or recover any Moorings, Bottom Mounted Gear, or Drifting Systems? Yes
Equipment Used: Two instruments were used aboard the Falkor for analyzing total alkalinity (TA) and dissolved inorganic carbon (DIC).
Total number of CTD casts completed during the cruise: 18
Total number of AUV dives completed during the cruise: 0
Total number of ROV dives completed during the cruise: 17
Total number of ROV samples collected during the cruise: Approximately 400
Total number of Unmanned Aerial Vehicle (UAV) or other vehicle deployments during the cruise: Drone used by SOI media officer for aerial photography
Total amount (TBs) of data collected during the cruise: 10


FK200126
UWA led Falkor cruise to Bremer, Leeuwin, and Perth submarine canyons from January 26th to February 26th, 2020.
Darling Scarp
Perth
Geographe Bay
ENG
S0325
S0324
S0326
Broke Canyon
Wilson Canyon
Vancouver Canyon
FLK20_14
FLK20_11
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