RV *Investigator* Voyage Scientific Highlights

Voyage #:	IN2019_T02
Voyage title:	Deep seascapes of the Great Barrier Reef: Uncovering submarine canyons and landslides
Mobilisation:	Brisbane, Wednesday 2nd – Thursday 3rd October 2019
Depart:	Brisbane, 0500 Friday, 4th October 2019
Return:	Darwin, 0900 Monday, 14th October 2019
Demobilisation:	Darwin, Monday, 14th October 2019
Voyage Manager:	S. Thomas
Chief Scientist:	R. Beaman
Principal Investigators:	R. Beaman
Project name:	Deep seascapes of the Great Barrier Reef: Uncovering submarine canyons and landslides
Affiliation:	James Cook University
Principal Investigators:	Dr D. Erler
Project name:	First measurements of nitrate isotopic composition in the Coral Sea
Affiliation:	Southern Cross University
Principal Investigators:	Dr E. Woehler
Project name:	Spatial and temporal variability in the distribution and abundance of seabirds
Affiliation:	University of Tasmania
Principal Investigators:	Dr A. Protat
Project name:	ORCA: Using the *Investigator* radar as a moving reference for the Australian operational radar network
Affiliation:	Bureau of Meteorology
Principal Investigators:	Dr R. Przeslawski
Project name:	Environmental baselines for Wessel Marine Park, northern Australia
Affiliation:	Geoscience Australia

Scientific Highlights

The Chief Scientist

Dr Robin Beaman is a marine geologist based at James Cook University in Cairns. His research goal is to understand the geological and physical processes that have influenced the shape of Australia's underwater landscape, and to study the relationships between seabed habitats and their associated marine life. With more than 75% of the Great Barrier Reef (GBR) World Heritage Area lying in depths greater than 30 m, the mapping of the deep GBR and offshore Coral Sea has been a quest led by Dr Beaman over the past decade. These mapping discoveries have led to a variety of projects, including the study of submarine canyons, underwater landslides, submerged reefs, paleo-channels, algal bioherms, cold-water corals, mesophotic (twilight) coral ecosystems, seamounts, tsunami modelling and habitat mapping.

Title

Deep seascapes of the Great Barrier Reef: Uncovering submarine canyons and landslides.

Purpose

This voyage comprised five supplementary projects with the following objectives:

1. Dr Beaman: Better understand the deep (>100 m) underwater landscapes (or seascapes) of the Great Barrier Reef (GBR) by determining the spatial extent, character and timing of the primary erosive features that have sculpted the GBR margin: the submarine canyons and landslides.
2. Erler: Constrain the nitrogen isotope content of deep ocean nitrate in the Coral Sea.
3. Woehler: Quantify variability in the distribution and abundance of seabirds in the marine environment around Australia.
4. Protat: Use the *Investigator*'s weather radar and disdrometer as moving references to evaluate the calibration of selected coastal radars from the BOM operational weather radar network.
5. Przeslawski: Collect and analyse valuable environmental baseline information in the data-poor Wessel Marine Park.

Contribution to the nation

This voyage has improved our knowledge of the spatial distribution, geomorphology and processes influencing the submarine canyons and landslides found on the GBR continental slope. Developing a more complete inventory of these deep GBR features aligns with the criteria under which the GBR was listed as a UNESCO World Heritage Area: Criteria viii) Significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.

The submarine canyons have Outstanding Universal Value and are exceptional because they are representative of mixed siliciclastic-carbonate systems, are of impressive size and extent, and display varied morphology along the slope. The new seabed mapping data from this voyage adds to a greater understanding of their distribution and detail, in particular the canyons adjacent to Stapleton Reef, Cape York, and the large landslide found off the Swain Reefs.

These canyons and landslides are significant features of the deep GBR landscape and geology. The mapping work from this voyage demonstrates to UNESCO that Australia wants to preserve these Outstanding Universal Values and is working to extend knowledge of their properties.

The nitrate project is part of a larger effort to determine if upwelling patterns have changed over the last 100 years in the GBR. The nitrogen isotope signature of the deep ocean is used as a tracer for upwelling. Understanding patterns of upwelling is significant for understanding nitrogen budgets for the continental shelf. The work conducted during this voyage, along with the wider project, will determine if patterns of upwelling in the GBR have changed over the past 100+ years, and how these patterns may have been influenced by climate change.

The Optimising Radar Calibration and Attenuation corrections (ORCA) project will produce a better understanding of the quality of the calibration of our operational weather radars, which are used for several downstream applications (flood forecasting, wind alerts etc.) to inform the nation of weather-related threats.

The Wessel Marine Park survey contributes to an understanding of the values of a northern marine park, including an inventory of communities and habitats as well as potential relationships to geomorphic data. This has national significance for the implementation of the northern marine park management plan, as well as informing future monitoring programs in northern Australia.

As a result of this voyage

1. We have mapped an underwater landslide off the Swain reefs, here called the Swain slide. Debris blocks comprising rafts of intact seafloor, together with disaggregated smaller debris blocks, extend over 20 km away from the scarp face caused by a collapse of the GBR slope.
2. We have a better understanding of the seaward extent of the debris field from the Bowl slide on the central GBR slope. The field extends to over 30 km from the scarp face, with a maximum width of 30 km wide in the Townsville Trough.
3. We have found highly complex canyons offshore of Stapleton Reef, here called the Stapleton canyons. They stretch over a depth range of ~300 to 2400 m into the Queensland Trough. Canyons have knife-edge like interfluves and highly gullied walls.

4. We have commenced a program of data analysis that will generate compiled 3D depth models and sub-surface horizon data for these canyons and landslides. The 3D models will be used for updating the inventory details of these features and understanding debris volume.
5. We have a better understanding of the frequency and magnitude of upwelling onto the continental shelf.
6. We have conducted seabird and marine mammal surveys of areas rarely/if ever surveyed in the Coral Sea, Gulf of Carpentaria and Arafura Sea, and observed a relatively high diversity (40 seabird taxa).
7. We have collected collocated observations of ground clutter (but unfortunately no storm systems) between the operational weather radars along the coast and the RV *Investigator*'s OceanPOL radar. Storm observations are expected to be collected during the second phase of our project (during IN2019_T03) according to the current seasonal forecast.
8. We have linked marine researchers, managers and Traditional Owners together around new data about the seafloor habitats of the Wessel Marine Park in northern Australia.