MNF Voyage Highlights

Voyage #:	IN2022_V07
Voyage title:	HALO - Halimeda bioherm Origins, function and fate in the northern Great Barrier Reef
Mobilisation:	Brisbane, Monday, 8 August 2022 – Thursday, 11 August 2022
Pre-medical clearance period:	Brisbane, Friday, 5 August 2022 – Friday, 12 August 2022
Depart:	Brisbane, Sunday, 14 August 2022
Return:	Cairns, Wednesday, 7 September 2022
Demobilisation:	Cairns, Wednesday, 7 September 2022
Voyage Manager:	David Flynn
Chief Scientist:	Professor Jody Webster
Affiliation:	University of Sydney
Principal Investigators:	Dr Robin Beaman[1], Professor Maria Byrne[2], Dr Luke Nothdurft[3] Dr Mardi McNeil (Alternative Chief Scientist)[4], Geoscience Australia, Associate Professor Helen Bostock[5], Dr Trevor Graham[3], Professor Dirk Erler[6], Dr Angel Puga-Bernabeu[7], Professor Juan Carlos Braga[7] Dr Willem Renema[8], Professor Yusuke Yokoyama[9]
Affiliation:	[1]James Cook University, [2]University of Sydney, [2]Queensland University of Technology, [4]Geoscience Australia, [5]University of Queensland, [6]Southern Cross University, [7]Universidad de Granada, [8]Naturalis, Biodiversity Center, [9]University of Tokyo

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The Chief Scientist

Marine geoscientist Jody Webster is part of the Geocoastal Research Group (GRG) at the University of Sydney. An expert in carbonate sedimentology and stratigraphy and interpretation of marine geology and geophysical data, he investigates coral reef evolution and associated environmental changes. Educated at the University of Sydney (Bsc Hons, PhD) he has worked at University of Papua New Guinea (UPNG) (2001-2), University of California (Santa Cruz) (2002-3), the Monterey Bay Aquarium Research Institute (MBARI) (2003-5), James Cook University (JCU) (2005-8) and now the University of Sydney where he was appointed Professor of Marine Geoscience (2021). He has served on many national and international committees associated with the International Ocean Discovery Program (IODP) (2009-present). Jody has led or participated in numerous blue-water research voyages, including as Co-chief Scientist on IODP Expedition 325 Great Barrier Reef Environmental Changes and the upcoming IODP Expedition 389 Hawaiian Drowned Reefs in 2023. For more information, go to https://www.sydney.edu.au/science/about/our-people/academic-staff/jody-webster.html

Title

HALO - Halimeda bioherm Origins, function and fate in the northern Great Barrier Reef

Purpose

The voyage addressed five scientific objectives to investigate the:

- Bioherm surface and subsurface geomorphology.
- Bioherm internal structure and composition.
- Bioherm modern habitats and biota.
- The role of Halimeda algal habitat in tropical marine carbon and nitrogen biogeochemical cycling.
- Deeper undersea landscape (slope, submarine canyons and basin) and key associated oceanographic processes.

Contribution to the nation

The Great Barrier Reef (GBR) *Halimeda* bioherms have Outstanding Universal Value as the largest modern *Halimeda* bioherm province in the world. The vast meadows of *Halimeda* algae represent active calcium carbonate calcification and accretion over thousands of years. Previous GBR Outlook

Reports (2009, 2014) produced by the Great Barrier Reef Marine Park Authority (GBRMPA) propose that "There remains limited information on the condition and trend of this habitat. The future condition is likely to be affected by declining rates of calcification from changes in ocean chemistry and nutrient upwelling."

The new geophysical, sample and oceanographic data from the bioherms (e.g. live algae distribution and mesophotic coral species) will feed into various management actions (i.e. Reef 2050 Long-Term Sustainability Plan) and will assist managers by contributing to a greater understanding of these significant, but poorly studied inter-reef shelf habitats, to help inform their management and long-term protection.

Additionally, one-half of the GBR Marine Park lies beyond the seaward edge of the shallower reefs on the continental shelf; this area on the northern GBR comprises the continental slope incised cut by extensive submarine canyons, and the abyssal plains. The new detailed submarine canyon mapping on the northern GBR slope will increase the operational area to allow defence and border protection greater access to the remote GBR.

As a result of this voyage

1. We have acquired the highest spatial resolution multibeam bathymetry dataset available for the study area (sub-metre horizontal resolution), complemented by co-located systematic sub-bottom profiling to visualise subsurface sediment layers. These will be ground truthed with new sediment cores to provide a better understanding of the surface and subsurface geomorphological characteristics and evolution of the *Halimeda* bioherms from three different regions across 2.5 degrees of latitude of the northern GBR margin.
2. The voyage provided the first systematically targeted seafloor images, surface sediment samples, rock dredges, sediment cores of the bioherms to provide new information about the composition and biodiversity of the bioherms.
3. CTD data providing the first oceanography and nutrient data for the bioherms. While a series of incubation experiments were undertaken with multicore samples from the bioherms and non-bioherm sites to understand the nutrient cycling between the sediments and the bottom waters in these shallow water systems.
4. We have new maps, CTD and sediment cores from two deep water slope and submarine canyon sites offshore the northern GBR.
5. The voyage has provided critical information for a multidisciplinary program of geomorphology, sedimentology, geochronology, geochemistry, oceanography and biology to understand the 4D growth structure, composition and development of the bioherms, their biodiversity and role as modern benthic habitats, nutrient cycling and paleoceanographic significance. These datasets will support several postgraduate student projects.

Next steps

This voyage represents a key component of Project HALO that is focused on understanding how the bioherms formed over the past 12,000 years (i.e., the Holocene), their importance in biogeochemical nutrient cycling and as modern habitats in one of the GBR's biodiversity hot spots. Samples have

been disseminated to PI institutions for curation, preliminary logging, processing, and further detailed analyses. Two postgraduate student projects have commenced, and several more are planned to work on the sedimentological, geochemical, and biological components of the project.

A follow-up cruise using a smaller vessel is planned for late 2023/24 to deploy in situ oceanographic sensors and an AUV/ROV to systematically map the bioherm benthic habitats using video and still imagery.

Initial communication of results will be through presentations at upcoming major international and national conferences e.g. International Association of Sedimentologists (IAS), GEOHAB, International Coral Reef Symposium, and the annual Australian Marine Science Association conference. Major findings will be submitted to international peer-reviewed journals and magazines such as *EOS*, *Marine Geology, Geomorphology, Continental Shelf Research, Marine Biology,* and *Coral Reefs*. Particularly significant or novel findings will be published in higher-impact journals (*Nature, Nature Geosciences, Nature Communications*). Finally, USYD Geocoastal Research Group (Webster) maintains a comprehensive website (https://grgusyd.org/), including a dedicated Project Halo page for project updates, in addition to active Facebook and Twitter pages. Beaman also maintains a website dedicated to marine geological research (https://www.deepreef.org/). These websites will be used to provide updates of post-cruise research and publication activities. These updates and activities will be shared more broadly via other social media, such as Facebook, Twitter, and LinkedIn. Marine geophysical and sedimentary data will be deposited and stored in publicly accessible databases, including AusSeabed and MARS (Geoscience Australia).