MNF Voyage Highlights

Voyage #:	IN2020_V06		
Voyage title:	Probing the Australian-Pacific Plate Boundary: Macquarie Ridge in 3-D		
Mobilisation:	Hobart, Saturday 3 October – Thursday 8 October 2020		
Depart:	Hobart, 1308 Thursday, 8 October 2020		
Return:	Hobart, 0810 Tuesday, 3 November 2020		
Demobilisation:	Hobart, Tuesday, 3 November 2020		
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Voyage Highlights

The Chief Scientist

Marine geophysicist Mike Coffin investigates the Earth beneath the sea. Educated at Dartmouth College (AB) and Columbia University (MA, MPhil, PhD), he has worked at Geoscience Australia (1985-1989), University of Texas at Austin (1990-2001), University of Tokyo (2001-2007), Japan Agency for Marine-Earth Science & Technology (2002-2003), UK's University of Southampton and National Oceanography Centre (2007-2010), and University of Tasmania (2011-). He has also held visiting positions at Dartmouth College (1982), Norway's Universitetet i Oslo (1992, 1996), Geoscience Australia (2000), France's Université de Strasbourg (2001), University of Hawai'i at Mānoa (2002), Woods Hole Oceanographic Institution (2016-), and University of Maine (2017-). From 2003-2005, Mike served as the inaugural chair of the Science Planning Committee of the International Ocean Discovery Program. He served as inaugural Director of Research at the UK's National Oceanography Centre from 2007-2009. From 2011-2015, Mike served as inaugural Executive Director of the Institute for Marine & Antarctic Studies at the University of Tasmania. Mike has led or participated in 36 blue-water research voyages.

Title

Probing the Australian-Pacific Plate Boundary: Macquarie Ridge in 3-D

Purpose

The voyage encompassed two main projects with the following objectives:

1. Acquire passive ocean bottom seismometer (OBS) data to:
    a. Characterise the 3-D structure of the oceanic crust and sub-crustal lithosphere along the central Macquarie Ridge Complex (MRC) with novel lithospheric seismic imaging.
    b. Describe the structural, thermal, and compositional nature of the central MRC by applying a range of seismic imaging techniques to identify velocity anomalies in the crust and mantle.
    c. Probe deep Earth structure and investigate other recorded natural phenomena (e.g., trajectories of low-pressure weather systems, whale migrations) via array seismology techniques.

2. Acquire marine geophysical data to:
    a. Define sites for OBS deployments in the vicinity of Macquarie Island along the central MRC using multibeam sonar and sub-bottom profiling data.
    b. Characterise the neotectonics, structure, and stratigraphy of the active Australian-Pacific plate boundary in the vicinity of Macquarie Island using multibeam sonar, sub-bottom profiling, gravity, and magnetics data.

Contribution to the nation

Passive seismological and marine geophysical 3-D imaging of the central MRC and Macquarie Island will be of immediate benefit for understanding the tectonic evolution of the Australian-Pacific plate boundary and the mechanisms responsible for earthquake generation in the region. Passive seismology studies will advance understanding of the initiation of tectonic plate subduction, a first-order problem in global geoscience, enhance monitoring of this earthquake belt, and provide more accurate estimates of tsunami potential. Therefore results will be relevant not only to the seismological research community, but also to national earthquake monitoring programs, such as those operated by Geoscience Australia and New Zealand's Earthquake Commission and GNS Science. Marine geophysical imaging will provide the first data to enable baseline benthic habitat mapping around the World-Heritage Listed Macquarie Island, including the Commonwealth Macquarie Island Marine Park and Tasmanian Macquarie Island Nature Reserve – Marine area. These data will thus contribute to Commonwealth and State of Tasmania management of the marine realm surrounding UNESCO World Heritage-listed Macquarie Island.

As a result of this voyage

1. We have a better understanding of the tectonic setting of Macquarie Island, the tectonic framework of the central MRC, and the distribution of sedimented vs unsedimented seafloor along the central MRC.
2. We have found that the central MRC is the steepest, narrowest mountain range on Earth, that Macquarie Island's major geological fault can be traced offshore on both sides of the island, and that the central MRC has experienced multiple slope failures with tsunamigenic potential.
3. We have mapped ~25,000 km^2 of central MRC seafloor, in water depths ranging from ~36.5 to 5,530 m, imaged the shallow sub-seafloor, acquired gravity and magnetics data, and deployed 27 OBSs around Macquarie Island in water depths ranging from 520 to 5,517 m.
4. We have commenced a program of tectonic interpretation of the multibeam sonar, sub-bottom profile, gravity, and magnetic data, and of recording approximately one year of global earthquake data on the 27 OBSs planned to be retrieved in late 2021.
5. We have re-estimated the theoretical array response functions due to relocating OBSs to new positions from their original indicative sites.

Next steps

This voyage is the first of two associated with the "Probing the Australian-Pacific Plate Boundary: Macquarie Ridge in 3-D" research project, with the second planned for late 2021 to retrieve the 27 OBSs that will contain the global earthquake data, and to complete seafloor mapping of the central MRC. Multibeam bathymetry and backscatter data from this voyage have already been provided to Parks Australia and the Tasmania Parks & Wildlife Service, and those from the second voyage will be provided in late 2021 or early 2022. Unprocessed seismological data will be accessible through the ANSIR/AuScope data management system AusPass (http://auspass.edu.au/) two years after the planned late 2021 completion of the experimental component, i.e., in late 2023. Marine acoustics, gravity, and magnetics data, both raw and processed, will be deposited and stored in publicly accessible databases, including CSIRO MNF, the IMAS data portal, Geoscience Australia, and the NOAA National Centers for Environmental Information.

Initial communication of results will be through presentations at the Australian Earth Science Convention, seminar talks around Australian universities, and at major international meetings such as the annual American Geophysical Union meeting, the annual European Geosciences Union

meeting, and the quadrennial International Union of Geodesy and Geophysics General Assembly. As the results reach fruition we will work with the National Computational Infrastructure Vizlab team, and the Australian National University, University of Cambridge, University of Tasmania, and California Institute of Technology media teams to reach out to broader audiences. New results will be published in high profile peer-reviewed international journals such as *Journal of Geophysical Research, Geophysical Journal International, Earth and Planetary Science Letters, Geophysical Research Letters, Tectonophysics and Geology,* and the results will be communicated to the local community through the *Australian Journal of Earth Science*. Major discoveries will be submitted to high-impact journals such as *Nature, Nature Geoscience*, *Science*, and *Proceedings of the National Academy of Sciences*.