RV *Investigator* Voyage Scientific Highlights

Voyage #:	**IN2017_V01**		
Voyage title:	Interactions of the Totten Glacier with the Southern Ocean through multiple glacial cycles		
Mobilisation:	Hobart, Friday, 13 January 2017		
Depart:	Hobart, 1800 Saturday, 14 January 2017		
Return:	Hobart, 0900 Sunday, 5 March 2017		
Demobilisation:	Hobart, Monday, 6 March 2017		
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Project name:	Interactions of the Totten Glacier with the Southern Ocean through multiple glacial cycles.		
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SCIENTIFIC HIGHLIGHTS

The RV Investigator's first geoscience-focused, Antarctic research mission, *Interactions of the Totten Glacier with the Southern Ocean through multiple glacial cycles*, has re-established Australia's scientific and cooperative international commitment to understanding future climate change from the geological record. The mission achieved all aims in producing: the first detailed seafloor map of the Sabrina coast slope north of the Totten Glacier; identifying major canyons and regionalised sediment deposits from the Totten Glacier and Aurora Basin; recovered both long and short cores that will enable biological, geological and geochemical analyses that can provide insights to past environmental and climatological states continuously over the last ~350 thousand years and other Epochs of time; video of seafloor environments, oceanographic characterisation of the warm water masses going onto, and cool water masses coming off of, the continental shelf and, through a piggy back project, the second ever analysis of Antarctic atmospheric aerosols.

The piggyback project, *Polar Cell Aerosol Nucleation (PCAN)*, has been successful in doubling the available atmospheric measurement data in the East Antarctic sea ice region. The instrumentation deployed on this mission represent the first of their kind in this region, including size distribution and chemical composition of atmospheric aerosols, cloud measurements and atmospheric mercury concentrations and speciation. These measurements will enable insight into aerosol sources and chemistry and help understand seasonal changes and weather and climate drivers for a region of the world plagued by a dearth of atmospheric data and thus poorly represented in climate models. Aerosol data also will contribute directly to major projects with collaborators at NOAA (USA) and PSI (Switzerland). Measurements of aerosol optical depth contribute directly to the Marine Aerosol Network component of NASA's global AERONET program.

Scientific Highlights

The Chief Scientist

Photo D. Thost/MNF

A/Prof. Leanne Armand is an expert in Southern Ocean diatoms (microscopic marine phytoplankton). She uses fossil diatoms in deep sea cores to estimate past Antarctic sea-ice cover. In 2007, whilst a recipient of the prestigious EU's Marie Curie Fellowship, A/Prof. Armand was awarded the Australian Academy of Science's Dorothy Hill award for her excellence in palaeoceanographic research. Leanne joined the Department of Biological Sciences at Macquarie University in 2009. Across her career she has attracted over $3 million in research funding and $8.7 million ship time. She participates in CSIRO's Scientists in Schools program and speaks publicly of her experiences as a female Antarctic research scientist. As a council member of the International Society of Diatom Research and as a representative for the Australian and New Zealand International Ocean Discovery Program Consortium (ANZIC), she represents Australian research interests at the international level. She is the Director of the national Collaborative Australian Postgraduate Sea Training Alliance Network (CAPSTAN) having mobilised and collaboratively designed a national Master-level at sea training program with the Marine National Facility on the RV *Investigator* starting in 2017.

Title

Interactions of the Totten Glacier with the Southern Ocean through multiple glacial cycles.

Purpose

The Totten Glacier is a large outlet glacier in East Antarctica, which is thinning rapidly. It drains a very deep subglacial basin, which has the thickest ice in Antarctica. This rapid thinning could cause accelerated melting of the Ice Sheet. This survey will study how the Totten Glacier behaved during past times of warming climate by examining the sediment it delivered to the continental slope. These deposits will help understand the role of ocean warming in melting the ice sheet. The survey will also be the first sea floor habitat mapping campaign in an area that has been proposed as a new Marine Protected Area by Australia in the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

The piggyback voyage, PCAN, aimed to characterise the atmosphere in the East Antarctic sea ice region. The representation in climate and earth system models of clouds, radiation and

aerosols in this region is currently quite poor, largely due to the dearth of observations. Additionally, the one previous measurements campaign in this region discovered interesting chemistry and atmospheric transport in this region not previously described. Objectives of this project can be summarised as:

- Increase the number and quality of atmospheric observations in the East Antarctic sea ice region.
- Characterise atmospheric aerosol populations and processes.
- Compare data to previous measurements to understand seasonal changes.
- Deploy cloud instrumentation alongside the aerosol suite to enable insights into cloud changes in this unique region.

Contribution to the nation

The Totten Glacier drains a basin containing a large fraction of the ice in East Antarctica. If the Totten undergoes rapid melting, the rate of sea level rise will increase significantly, posing increased problems for low-lying coastal communities. Understanding the processes that affect the Totten Glacier is an important step in reducing uncertainty in future sea level predictions and thus improving the information available to authorities with responsibility for coastal communities and infrastructure. Studies of marine biota and water mass chemistry undertaken on this voyage will enhance the future interpretation of the sedimentary record and will also assist in Australia's role in protecting the Antarctic environment.

PCAN contributions.
The weather and climate of Australia is heavily influenced by the Antarctic and Southern Ocean regions. Unfortunately, our understanding of the processes occurring in this region is hindered by a lack of observations. Aerosols are vital to cloud properties and precipitation, and small changes in this pristine environment can have significant effects. Understanding the properties and processes of aerosols and clouds in this region will feed directly into improving weather and climate models which in turn assist the Australian community and economy in planning for the future. Additionally, atmospheric processes masked in polluted areas can be observed in this pristine environment and can provide insight into pollution events in urban areas and how best to tackle them.

As a result of this voyage

1. We have a better understanding of the distribution of sediments that contain useful records of ice sheet and oceanic changes on the Antarctic continental slope.

2. We have recovered four long piston cores that likely contain records covering the last four glacial-interglacial cycles representing fluctuations of the ice sheet and ocean over the last 374,000 years. We have also recovered two long cores that probably sample older periods.

3. We have mapped an area of 48,000 km^2 of the East Antarctic continental margin using multibeam sonar, sub-bottom profiler and seismic reflection methods. We have acquired five piston cores, 11 kasten cores and four multicores in the region.

4. We have commenced a program of analysis of the cores using palaeontological, geochemical and sedimentological methods which are being enhanced by the results from water column sampling for biota and DNA.
5. Seismic reflection data are being processed to better understand the origins of the sediments sampled and their mode of formation.

PCAN results.

1. We have a better understanding of the size distribution and composition of atmospheric aerosols and how they interact with clouds in a region uncommonly measured, and distinct from surrounding regions.
2. We have doubled the available atmospheric data for a region of the globe that has been found to be distinct from the more commonly (but yet still poorly) measured regions of the Antarctic continent and the Southern Ocean.