

RV Investigator Scientific Highlights

Voyage #:	IN2016_V01		
Voyage title:	HEOBI – Heard Earth-Ocean-Biosphere Interactions		
Mobilisation:	Fremantle, Wednesday-Friday, 6-8 January 2016		
Depart:	Fremantle, 1330 Friday 8 January 2016		
Return:	Hobart, 0815 Saturday, 27 February 2016		
Demobilisation:	Hobart, Saturday, 27 February 2016		
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Title: Heard Earth-Ocean-Biosphere Interactions

Introduction

Phytoplankton in the ocean supply about half of the oxygen in Earth's atmosphere. Iron supply limits the growth of phytoplankton in the anaemic Southern Ocean as well as elsewhere in the global ocean. Situated entirely within the Indian Ocean sector of the Southern Ocean, Australia's only active subaerial volcanoes, Heard and McDonald islands on the central Kerguelen Plateau, are among the world's most active hotspot volcanoes. Widespread fields of submarine volcanoes, some of which may be active, extend for distances of up to several hundred kilometres from the islands. The predominantly eastward-flowing Antarctic Circumpolar Current sweeps across the central Kerguelen Plateau, and extensive blooms of phytoplankton are observed on the Plateau down-current of Heard and McDonald islands. We are testing the hypothesis that hydrothermal fluids, which cool active submarine volcanoes in the Heard and McDonald islands region, ascend from the seafloor and fertilise surface waters with iron, thereby enhancing biological productivity beginning with phytoplankton.

Contribution to the nation

Our planet sustains life as we know it because Earth has liquid water, oxygen, and sunlight at its surface. Advancing understanding of how the Earth-ocean system functions – especially its carbon and oxygen cycles – is critically important as human population continues to grow and thereby increasingly stresses local, regional, and global ecosystems. At present, the sources, mechanisms, and processes that supply iron to the Southern Ocean and thus promote the growth of phytoplankton – both a crucial source of oxygen to Earth's atmosphere and the base of the oceanic food chain – remain mysteries. Our investigations address what role heat generated in the Earth's interior, manifested on the seafloor and on land by active volcanoes, might play in supplying iron to the Southern Ocean. This is a first-order question that has major implications for Earth's oxygen, carbon, and trace metal budgets, fluxes, and cycles. Moreover, our work has the potential to inform investigations of geoengineering in the form of ocean iron fertilisation.

As a result of this voyage

1. We documented, for the first time, the role of active Heard, McDonald, and nearby submarine volcanoes in supplying iron to the Southern Ocean. Nearshore waters had elevated dissolved iron levels. Although biomass was not correspondingly elevated, fluorescence induction data indicated highly productive resident phytoplankton.
2. We discovered >300 acoustic plumes emanating from the seafloor and ascending up to tens of metres into the water column near Heard and McDonald islands. Deep tow camera footage shows bubbles rising from the seafloor in an acoustic plume field north of Heard Island.

3. We mapped ~1,000 km² of uncharted seafloor around Heard and McDonald islands. Submarine volcanoes punctuate the adjacent seafloor, and yielded iron-rich rocks similar to those found on Heard and McDonald islands, respectively. Acoustic plumes emanating from some submarine volcanoes suggest active seafloor hydrothermal systems.
4. We have commenced a multidisciplinary research effort to identify the sources, mechanisms, and processes in the Heard and McDonald islands area that supply iron to the Southern Ocean, and thereby to advance geoscientific, biogeochemical, and physical understanding of the region and Southern Ocean beyond.

CSR/ROSCOP Parameter Codes

	METEOROLOGY
M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

	PHYSICAL OCEANOGRAPHY
H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current metres
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys
D06	Neutrally buoyant floats

	MARINE BIOLOGY/FISHERIES
B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans
B28	Acoustic reflection on marine organisms

D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

	CHEMICAL OCEANOGRAPHY
H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

	MARINE GEOLOGY/GEOPHYSICS
G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements

	MARINE CONTAMINANTS/POLLUTION
P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements