RV *Investigator* Voyage Plan

Voyage #:	**IN2018_V08**		
Voyage title:	The Balleny mantle plume: key role in Tasmania-Antarctic breakup?		
Mobilisation:	Thursday 20th December, 2018		
Depart:	0900 Thursday 27th December, 2018		
Return:	0900 Thursday 10th January, 2019		
Demobilisation:	Friday 10th January, 2019		
Voyage Manager:	Matt Kimber	Contact details:	Matt.Kimber@csiro.au
Chief Scientist:	Joanne Whittaker		
Affiliation:	University of Tasmania	Contact details:	0404 143 394
Principal Investigators:	Rebecca Carey		
Project name:	As above		
Affiliation:	UTas	Contact details:	0487 403 164

Scientific objectives

For the past few million years, the Balleny plume has resided beneath the Antarctic tectonic plate, forming the Balleny seamount chain located offshore Cape Adare, Antarctica. Mantle plumes can exist for tens of millions of years, and the Balleny plume has been implicated in causing/aiding the continental breakup between Tasmania and Cape Adare 30-50 million years ago. However, an alternative hypothesis proposes that a dramatic plate tectonic reorganisation was the driving mechanism.

We will test the hypothesis that the Balleny Plume played a significant role in the plate tectonic breakup between Tasmania and Cape Adare, Antarctica, and also investigate the plume's influence on the bathymetric evolution of the Tasman Gateway and related onset of the Antarctic Circumpolar Current.

1. Are the Tasmanian Seamounts an age progressive chain formed by the Balleny Plume? When did the seamounts form?
2. Can the seamount chain be used to decipher plate motions during the dramatic global plate tectonic reorganisation at ~50 Ma?
3. Did this Balleny plume activity cause/aid tectonic breakup between Tasmania and Cape Adare, Antarctica?
4. Were there periods when the location of the plume relative to the Australian plate stalled? Did motion of the Balleny plume stall?

Voyage objectives

The key to answering these questions lies in the rocks of the Tasmanian Seamount chain stretching across the Tasman Sea, to the east and south of Tasmania.

Objective 1. Collect seafloor and subseafloor geophysical data. This data will be used:

a. To identify seafloor fabric, which will help refine plate reconstructions of the Tasman Seas in areas difficult to constrain from magnetic anomaly lineations alone;
b. To obtain comprehensive multibeam and backscatter coverage of the seamounts and their morphology to understand tectonic setting, eruptive style, palaeo-water-depth and sedimentation patterns;
c. To assist in dredge site targeting by identifying sediment-free scarps and slopes;
d. Sub-bottom profile data will be collected to provide additional context for the nature of the near-surface sediment and geological structure.

Objective 2. Dredge volcanic samples from seamounts along the proposed Balleny Seamount chain. Ashore, samples will be:

a. Ar/Ar Dated to determine the age and duration of seamount formation;
b. Volcanic coherent rocks will be described macroscopically, petrographically and mineralogically to classify and characterise the type volcanism on the seamounts. Comparing the nature and origin of volcanism at different sites may reveal multiple episodes of volcanism or variations in volcanic activity in time and space.

c. Volcaniclastic rocks will be described macroscopically, petrographically, mineralogically and include ash morphology descriptions. This work will constrain submarine/subaerial eruption/emplacement and style of transport
d. Sedimentary rocks will be described macroscopically, microscopically and petrographically. Additional U-Pb geochronology will be undertaken as will micro- and macro-fossil palaeontology. These analyses can constrain depth, environment, and time of deposition, important for constraining the timing and rate of subsidence.

The objectives are linked and so have equal priority. If time is lost to weather etc we will dredge fewer locations.

Operational Risk Management

Main Voyage specific operations which have potential risk exposures are dredging and use of a bench rock saw for cutting and cleaning of obtained rock samples.

The planned operations with rock dredging have been identified as potentially high risk work and will therefore trigger MNF procedures for potentially high risk operations.

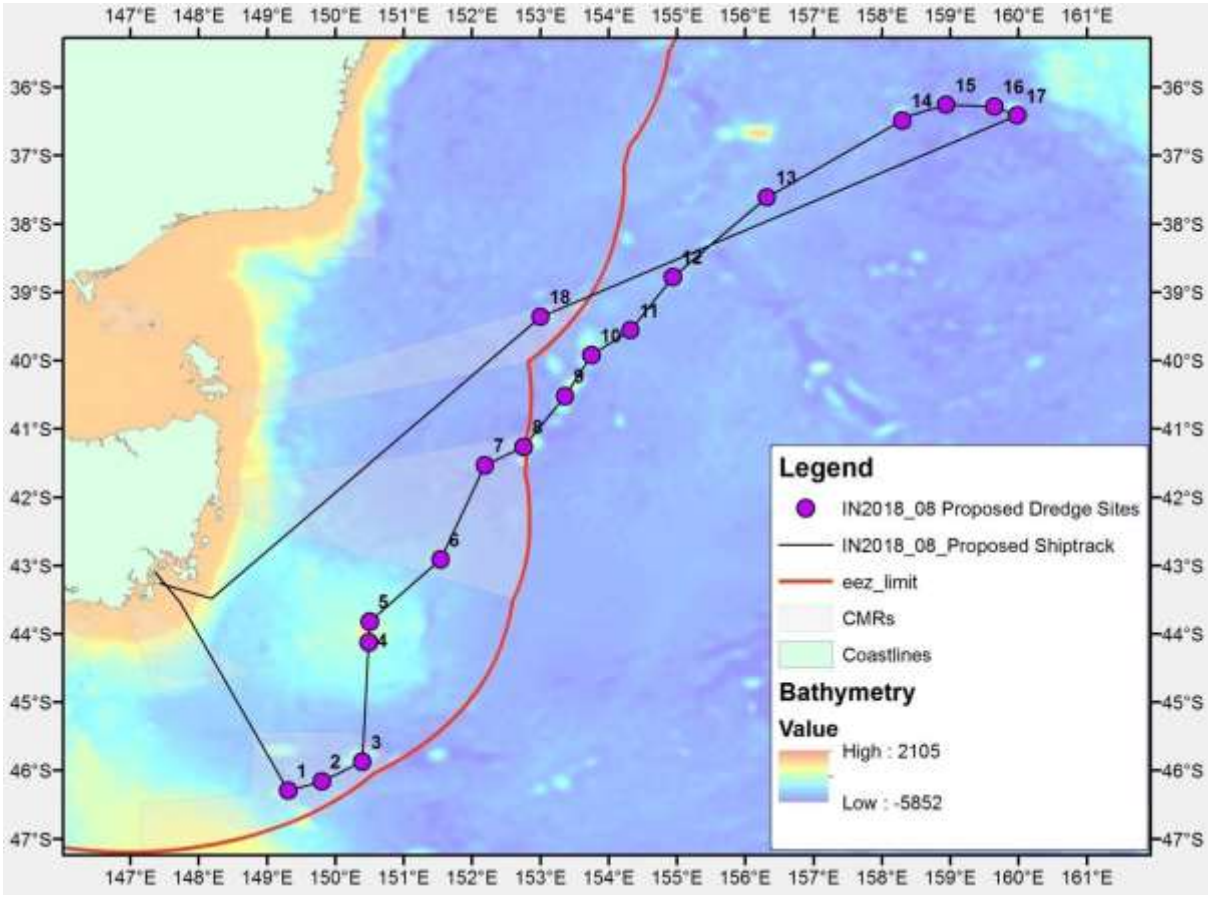
Risk	Activities impacted	Risk management
Using the rock dredge – rock dredge caught on bottom, loss of rock dredge(s)	-Dredging -Deck Activities -Voyage objective	-Safe Work Instructions. -Pre deployment Toolboxes and Job Safety Analysis. -Undertaking dredging slowly. Being prepared to move ship back to over the dredge to release dredge. Set dredge break-pin appropriately (~10 tonnes).
Rock saw use	-Lab activities -Voyage Objective	-new fully enclosed, automatic rock saw has been purchased. -Testing -Safe Work Instruction -Training -Spare saw mobilised (old saw).

Overall activity plan including details for first 24 hours of voyage

Depart Hobart
~20 hours transit to Dredge Station 1 (~215 nM @ 11 knots) Arrive
Station 1.
~4 hours swath map seamount flank to locate suitable dredge target (likely ~1500 m water depth). During this time prepare for first dredge in this area.

In case of poor weather, our voyage track can be undertaken in reverse. In this case we could head to site 18 (~375 nM) or 17 (~750 nM) instead of site 1. Once on site procedure will be the same as for Site 1.

Voyage track example



Waypoints and stations

	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming time (hrs)	Total Steam (hrs)
Hobart	42° 52.2	147° 21.0	0	0	0	0
Storm Bay	43° 19.8	147° 21.54	27.62	27.62	2.51	2.51
Site 1	46° 17.49 S	149° 18.48 E	196.51	224.13	17.86	20.37
Site 2	46° 09.23 S	149° 47.94 E	22.04	246.17	2.00	22.38
Site 3	45° 52.08 S	150° 23.82 E	30.29	276.46	2.75	25.13
Site 4	44° 07.33 S	150° 29.10 E	104.76	381.22	9.52	34.66

Site 5	43° 48.94 S	150° 30.06 E	18.39	399.61	1.67	36.33
Site 6	42° 54.39 S	151° 32.40 E	70.97	470.58	6.45	42.78
Site 7	41° 31.78 S	152° 11.34 E	87.45	558.03	7.95	50.73
Site 8	41° 15.34 S	152° 45.42 E	30.42	588.45	2.77	53.49
Site 9	40° 30.82 S	153° 21.84 E	52.33	640.78	4.76	58.25
Site 10	39° 55.14 S	153° 44.88 E	39.76	680.54	3.61	61.87
Site 11	39° 33.32 S	154° 19.14 E	34.26	714.8	3.11	64.98
Site 12	38° 46.56 S	154° 56.58 E	55.00	769.8	5.00	69.98
Site 13	37° 36.41 S	156° 19.20 E	95.59	865.39	8.69	78.67
Site 14	36° 28.96 S	158° 17.94 E	116.46	981.85	10.59	89.26
Site 15	36° 15.37 S	158° 56.58 E	34.01	1015.86	3.09	92.35
Site 16	36° 16.92 S	159° 38.70 E	34.04	1049.9	3.09	95.44
Site 17	36° 24.71 S	159° 58.98 E	18.11	1068.01	1.65	97.09
Site 18	39° 21.42 S	153° 00.30 E	375.07	1443.08	34.10	131.19
Hobart	42° 52.2	147° 21.0	384.04	1827.12	34.91	166.10

Time estimates

The following time estimates are based on a steaming speed of 11 knots.

Please include estimates of time for periods in between all activities noted below.

Date	**Time**	**Activity**
27/12/2018	9:00	Hobart
27/12/2018	11:30	Storm Bay
28/12/2018	5:22	Site 1 – arrive, swath, dredge
28/12/2018	14:46	Depart site
28/12/2018	16:46	Site 2 – arrive, swath, dredge
29/12/2018	2:10	Depart site
29/12/2018	4:55	Site 3 – arrive, swath, dredge
29/12/2018	14:19	Depart site
29/12/2018	23:51	Site 4 – arrive, swath, dredge
30/12/2018	9:15	Depart site
30/12/2018	10:55	Site 5 – arrive, swath, dredge
30/12/2018	20:19	Depart site
31/12/2018	2:46	Site 6 – arrive, swath, dredge
31/12/2018	12:10	Depart site

31/12/2018	20:07	Site 7 – arrive, swath, dredge
1/01/2019	5:31	Depart site
1/01/2019	8:17	Site 8 – arrive, swath, dredge
1/01/2019	17:41	Depart site
1/01/2019	22:27	Site 9 – arrive, swath, dredge
Date	**Time**	**Activity**
2/01/2019	7:51	Depart site
2/01/2019	11:28	Site 10 – arrive, swath, dredge
2/01/2019	20:52	Depart site
2/01/2019	23:58	Site 11 – arrive, swath, dredge
3/01/2019	9:22	Depart site
3/01/2019	14:22	Site 12 – arrive, swath, dredge
3/01/2019	23:46	Depart site
4/01/2019	8:28	Site 13 – arrive, swath, dredge
4/01/2019	17:52	Depart site
5/01/2019	4:27	Site 14 – arrive, swath, dredge
5/01/2019	13:51	Depart site
5/01/2019	16:57	Site 15 – arrive, swath, dredge
6/01/2019	2:21	Depart site
6/01/2019	5:26	Site 16 – arrive, swath, dredge
6/01/2019	14:50	Depart site
6/01/2019	16:29	Site 17 – arrive, swath, dredge
7/01/2019	1:53	Depart site
8/01/2019	11:59	Site 18 – arrive, swath, dredge
8/01/2019	21:23	Depart site
10/01/2019	8:18	Arrive Hobart

Permits

Permits required for Freycinet, South Tasman Rise, Flinders CMRs.
No foreign clearances required.
No Antarctic waters.
No radioactive materials, lasers or other materials No
UAVs, balloons or buoys or moorings.

Signature

Your name	Joanne Whittaker
Title	Chief Scientist
Signature	
Date:	4th December, 2018

Appendix A

Scientific equipment and facilities provided by the Marine National Facility

Some equipment items on the list may not be available at the time of sailing. Applicants will be notified directly of any changes. Indicate what equipment and facilities you require from the Marine National Facility by placing an **X** in the relevant box.

(i) Standard laboratories and facilities

Name	Essential	Desirable	Notes/Comments
Aerosol Sampling Lab			
Air Chemistry Lab			
Preservation Lab			
Constant Temperature Lab			
Underway Seawater Analysis Laboratory			
GP Wet Lab (Dirty)	X		
GP Wet Lab (Clean)		X	
GP Dry Lab (Clean)		X	
Sheltered Science Area		X	
Observation deck 07 level			
Walk in Freezer			
Blast Freezer			
Ultra-Low Temperature Freezer (-80^{0}C)			
Walk in Cool Room		X	

Salt water ice machine			

(ii) Specialised laboratory and facilities *(May require additional support)*

Name	Essential	Desirable	Notes/Comments
Modular Radiation Laboratory			
Modular Trace Metal Laboratory (TM1-blue)			• For determination of trace metal concentrations • Clean laboratory containing laminar flow cabinets
Modular Trace Metal Laboratory (TM2-white)			• Wet sampling of trace metal clean Niskins • Cannot be overstacked
Modular Hazchem Locker			
Deck incubators			
Stabilised Platform Container			
Clothing container			The use of this container will be identified by MNF

(iii) Standard laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments
CTD - Seabird 911 with 36 Bottle Rosette			
CTD -Seabird 911 with 24 Bottle Rosette			
Total number of Casts:			

Maximum depth:			
Analyses required for each deployment: (indicate which are required and the number of samples per deployment)			
Salinity			
Dissolved oxygen			
Nutrients:			Note: analytical throughput based on 2 hydrochemists/24hours: - Nutrients, dissolved oxygen, salinity. Sampling ration 1:1:1 equates to 48:48:48 - Nutrients, dissolved oxygen, salinity. Sampling ratio 2:1:1 equates to 72:36:36

Name	Essential	Desirable	Notes/Comments
			- Nutrients only collection from every depth 160 maximum analytical output
Nitrate			
Phospate			
Silicate			
Nitrite			
Ammonia (special request after discussion with hydrochemistry			
Lowered ADCP			
MNF Auxiliary Instrumentation for CTD Rosette (please indicate which you require. Note 6 auxiliary sensor channels are generally available:			

Dissolved oxygen sensor			
Altimeter (required if operating anywhere near the sea floor)			
PAR Sensor (Biospherical QCP-2300)			
Transmissometer (Wetlabs C-Star 25cm)			
Fluorometer- Chlorophyll-a (Chelsea Aquatracka 111 – 430/685nm			
Flurometer – CDOM (Wetlabs)			
Nephelometer (Seapoint Turbidity Meter)			
ECO-Triplet (2,000m max depth, chlorophyll, CDOM & backscatter)			
Sonardyne USBL System			
Milli -Q System			
Laboratory Incubators			
Heavy Duty Electronic Balance (80kg)	X		
Name	**Essential**	**Desirable**	**Notes/Comments**
Medium Duty Electronic Balance (15kg/5g resolution)	X		
Light Duty Electronic Balance (3kg/1g resolution)			
Surface Net (mouth area 1m^2) 335 micron, 500 micron, 1,000 micron mesh available – please specify			
Bongo Net (500 micron mesh only, not instrumented) ring diameter 485mm 0.018m^2			

Smith Mac grab	X		
Dissecting Microscopes (x4, please specify number required.			

(iv) Specialised laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
TRIAXUS – Underway Profiling CTD			Notes: Triaxus is a pilotable towed vehicle capable of carrying a variety of instrumentation. Constant depth towing or undulating profiles (e.g. cyclic depth pattern from 10m to 200m) are possible. Towing speed depends on the tow profile, instrumentation payload and prevailing conditions. Typically, undulations from the surface to 200m are possible at 8knt, with slower speeds for deeper profiles and faster for constant-depth towing. Maximum achievable depth typically 300m Usual instrumentation: SBE9plus (pressure sensor and communication hub) and dual pumped temperature/conductivity/dissolved oxygen circuits. Usual auxiliary instrumentation includes an ECO-Triplet (Chl, CDOM, backscatter), transmissometer, PAR sensor, and Laser Optical Plankton Counter.
Desired towing profile:			
Additional instrumentation:			

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
(Please supply, make and model and datasheets. Also a contact person for discussion on integration.			
Continuous Plankton Recorder (CPR)			Note: indicate deployed location and support if required
Deep towed camera			

Piston Coring System			
Gravity Coring System			
Multi Corer			
Kasten Corer			
XBT System	X		
Trace Metal Rosette and Bottles			
Sherman epibenthic sled			
Trace- metal in-situ pumps (x4)			See *"Non-MNF owned equipment"* section below for additional 2 units
Rock Dredges	X		
EZ Net (maximum of 10 nets for depth stratified sampling. Mouth area of 1m^2 Indicate mesh size required:			
335 micron			
500 micron			
1,000 micron			
Rock saw (requires a trained science personnel)	X		
Portable pot hauler			
Beam Trawl			
Trawl doors (pelagic or demersal)			
MIDOC (multiple opening/closing codend system for pelagic trawl			
Name	**Essential**	**Desirable**	**Notes/Comments** ***(These items may require additional MNF support staff)***
Stern Ramp (tick to have the ramp exposed, or leave blank for deck covers installed	X		

Trawl monitoring instrumentation (ITI) (2,000m depth limit)			
Trawl nets: Mid water research trawl Wing end spread usually 21m Average headline height 8.97m Mouth area (on average) 188.37m^2 Mesh size 200mm in mouth area grading to 10mm in cod end.			
Radiosonde Receiver System			

(v) Equipment and sampling gear requiring external support *(May require additional support from applicants)*

Name	Essential	Desirable	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Additional staff may be required for these activities.
Seismic compressors			
Seismic acquisition system			

(vi) Underway systems

Atmospheric Underway Systems

Name	Essential	Desirable	Notes/Comments
75kHz ADCP			
150kHz ADCP			
Name	**Essential**	**Desirable**	**Notes/Comments**

Multibeam echo sounder EM122 12kHz (100m to full ocean depth)	X		
Multibeam echo sounder EM710 70-100kHz (01000m approx.)	X		
Sub-Bottom Profiler SBP120	X		
Scientific Echo Sounders EK60 (6 bands, 18kHz333kHz)		X	
Multibeam Scientific Echo Sounder ME70 (70-100 kHz)		X	
Omnidirectional Echo Sounder SH90			
Gravity Meter	X		

Atmospheric Underway Sensors

Name	Essential	Desirable	Notes/Comments
Nephelometer			
MAAP (multi angle absorption photometer)			
SMPS (scanning mobility particle sizer)			
Radon detector			
Ozone detector			
CPC (Condensation Particle Counter)			
Picarro spectrometer (analysis of CO_2/CH_4/H_2O)			
Aerodyne spectrometer (analysis of N_2O/CO/H_2O)			

CCN (Cloud Condensation Nuclei)			
Polarimetric Weather Radar			

Underway Seawater Instrumentation

Name	Essential	Desirable	Notes/Comments
Thermosalinograph			
Fluorometer			
Optode			
pCO2			

Seawater systems

Name	Essential	Desirable	Notes/Comments
Trace metal			
Scientific clean			
Raw			

Non MNF owned equipment which may be accessed

Name	Essential	Desirable	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required.
D & N Francis winch			
Box Corer			

University of Tasmania (UTAS) in-situ pumps (x2)			
EM2040			

Appendix B

User equipment and facilities to be provided by the Chief Scientist

List the equipment that will be brought on board under the Lead Principal Investigator/Principal Investigator responsible for the item.

The Voyage Operations Manager will advise if a RV *Investigator* Application form will be required for your nominated equipment. A deck layout will be developed from the information provided here and in the RVI Voyage Specific Equipment Installation Form.

Owner	**Item name**	**Supporting information (weight, dimensions, location on board)**	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Do you require any equipment to be fitted to the vessel? What services (e.g. electricity, water) are required to support the equipment? Are there any special procedures to be followed with the new equipment, radiation work, lasers, small boat work or diving? Do you need to test any equipment or procedures before sailing or under controlled conditions? These activities will require separate approvals.	**RV *Investigator* Equipment Application form required?** ***MNF use only (Y/N)***
