RV *Investigator* Voyage Plan

Voyage #:	IN2016_T01		
Voyage title:	Continuity of Australian terranes into Zealandia: towards a geological map of the east Gondwana margin		
Depart:	Lautoka, 0900, Friday, 30 June 2016		
Return:	Hobart, 1800, Wednesday 13 July 2016		
Voyage Manager:	Lisa Woodward	**Contact details:**	Lisa.woodward@csiro.au 0408 030 224
Chief Scientist:	Simon Williams		
Affiliation:	University of Sydney	**Contact details:**	Simon.williams@sydney.edu.au 0415180182
Principal Investigators:	Maria Seton, Nick Mortimer, Julien Collot (Geoscience) Nick Hardman-Mountford, CSIRO (Bio-optics/Biogeochemistry) Martina Doblin, UTS (Piggyback project c) Bonnie Laverock, UTS (Piggyback project d) Melita Keywood, CSIRO (Piggyback project e) Ann Thresher, CSIRO (Piggyback project f)		

Scientific objectives

There are two scientific streams to this project:

a. Marine geology/geophysics. The main aim is to improve matches in the continental geology of eastern Australia, New Zealand and New Caledonia. Specifically to test competing models for the continuity of east Gondwana Mesozoic igneous belts and terranes between eastern Australia, New Zealand and New Caledonia, contribute to the regional framework of petroleum basins on the Lord Howe Rise and establish the geological origin of the phantom "Sandy Island".

b. ***Bio-optics and biogeochemistry***. Our objective is to characterize bio-optical and associated biogeochemical properties along the transect from optical sensors profiled at CTD stations, and deployed on autonomous profiling floats (biogeochemical Argo). Sensors will measure: fluorometry, absorption, backscattering, attenuation, radiometry, oxygen, pH, temperature, salinity, nutrients. These sensor measurements will be supported by samples taken from water bottles on CTD casts (pigments, CDOM, phytoplankton absorption, suspended particles, nutrients, oxygen, carbon, salinity) to be used for context, validation and/or calibration.

Voyage objectives

We plan 4-6 dredges on the Fairway Ridge and Sandy Island area. The specific locations of potential dredge sites are shown on the voyage plan image and are tied to a confidential seismic reflection profile and/or swath bathymetry data. As we have access to high-resolution swath data from the area from the Geological Survey of New Caledonia, there is no necessity to plan a detailed swath survey for each dredge site. The waypoints for these samples are defined below, with priority listing for the dredge sites:

Waypoint	Longitude	Latitude	Dredge site priority
Dredge 1	161.709506	-20.350414	1
Dredge 2	161.587761	-20.434766	1
Dredge 3	161.422881	-20.538931	1
Dredge 4	161.644005	-20.393789	2
Dredge 5	159.833103	-19.305847	1
Dredge 6	159.833103	-19.305847	2

If the time available for the transit voyage is shortened due to operational or other reasons, we are able to modify our dredging plan by omitting sample locations with priority 2 designation. The feasibility of dredging in this region has been demonstrated on a previous voyage of the *RV Southern Surveyor* led by members of our team (ss2012_v06). Based on this experience and the shallow depth of our target sites (between 500-2200 m depth), we anticipate 4 hours per dredge (no swath survey needed). As we have planned 6 dredging locations, we anticipate 24 hours to complete our dredging program.

Equipment. Dredges, winch, rock saw. This equipment is already installed and the dredges provided.

Swath bathymetry and ocean-bottom profiles (continuous collection)

Operations. We will continuously collect bathymetric data and the North Loyalty Basin will be crossed during the transit voyage, thus requiring no additional time to collect this important swath profile.

Equipment. Sub-bottom profiler and deep-water multibeam. This equipment has already been installed.

Gravity (continuous collection)

Operations. We will continuously collect gravity data. There is no deviation necessary to obtain gravity measurements over the northwestern part of the Fairway Ridge as we will be crossing this area as part of the dredging component of the survey.

Equipment. Gravimeter. This equipment is already installed.

CTD, hydrocast and bio-optical cast

Operations. We will take two daily CTD profiles and hydrocast water samples to 500m to characterise the water at time of deployment for pigment, nutrient, dissolved oxygen, dissolved inorganic carbon and total alkalinity concentrations (up to 25 stations over the whole voyage). For this we will require the 36-bottle CTD rosette. Additional sensors to be included on the CTD frame include chlorophyll and CDOM fluorometers, absorption and backscattering meter, beam transmissometer, dissolved oxygen, deep SUNA and SeaFET pH. A Satlantic radiometer will be deployed separately at each station to a depth of 200m. We will be able to provide sensors that are not available through the MNF equipment pool (i.e. Satlantic SeaFET pH, Satlantic radiometer, Wetlabs acs and bb9, Hobilabs Hydroscat-6). Water samples will be filtered or chemically fixed on board according to standard operating procedures. We anticipate each deployment station taking 1.5 hours, with deployments taking place at the same time each morning and afternoon (nominally 0930 and 1400 hours), when not conflicting with dredge operations.

Table of water requirements from the hydrocast by each group

Measurand	**Group**			
	H-M	Laverock	Doblin	Hydrochem
HPLC/aph	Y		Y	
CDOM	Y			
TSM	Y			
DOC	Y			
POC	Y			
Salts	Y	Y	Y	Y
Nutrients	Y	Y	Y	Y
TA/DIC	Y			Y
Flow cytometer	Y	Y	Y	
Flow Cam	Y			
PP 14C			Y	
GC		Y		
DNA		Y		
RNA		Y		

Robotic Profiling Floats and bio-optics

Operations. CSIRO will provide floats equipped with CTD and bio-optical sensors to measure a range of parameters: T, S, dissolved oxygen, chl and CDOM fluorescence, backscattering (4 wavelengths), beam attenuation, upwelling radiance and downwelling irradiance (4 wavelengths). Floats will be deployed at stations within Australian waters along the ship's route of transit (estimate 155E and 160E). Deployment of the floats can be undertaken from the A-frame off the rear deck or by two people using a rope and manhandling the float over the stern. Once deployed, the floats will descend

to depth and start their pre-programmed cycle of profiling and data collection, with data transmitted via Iridium satellites. During each deployment we will also take a CTD profile and water samples to 1000m to characterise the water at time of deployment for pigment, nutrient, dissolved oxygen, dissolved inorganic carbon and total alkalinity concentrations. Additional sensors to be included on the CTD include chlorophyll and CDOM fluorometers, backscattering meter and/or beam transmissometer, dissolved oxygen, deep SUNA and possibly SeaFET pH. We will seek to provide sensors that are not available through the MNF equipment pool (e.g. pH). Water samples will be filtered or chemically fixed on board according to standard operating procedures. We anticipate each deployment station taking 2-4 hours.

Additional CTD and bio-optical casts will be taken twice per day (morning and afternoon, nominally 9.30am and 2pm) for bio-optical and biogeochemical sampling around the time of satellite overpasses.

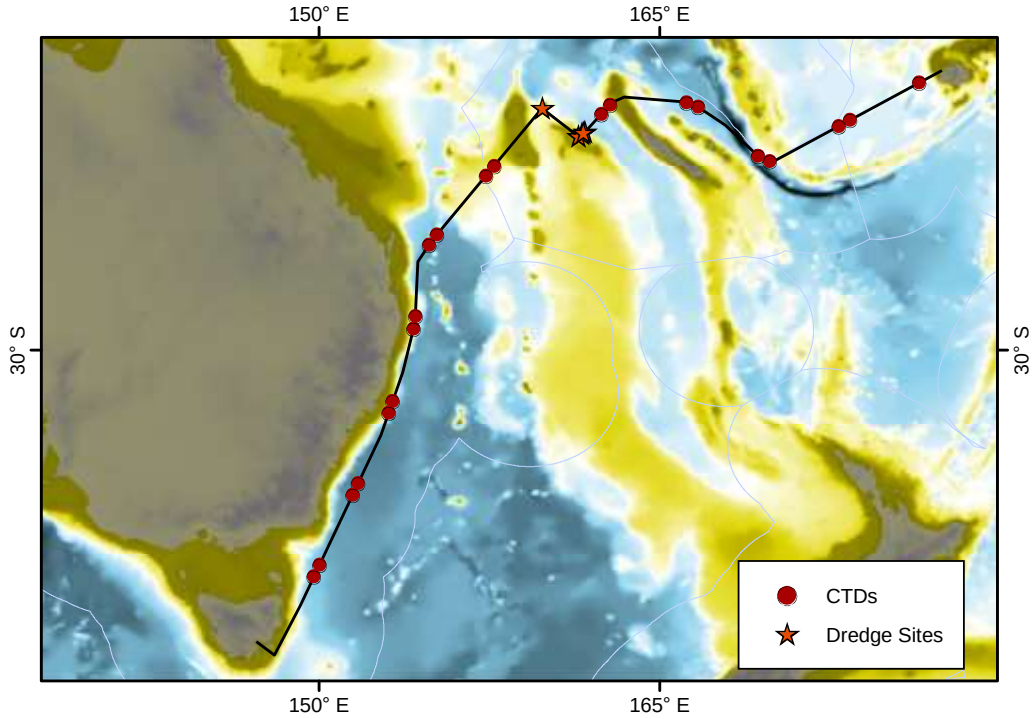
Operational Risk Management

No potentially high risk work has been identified outside standard operations.

Overall activity plan including details for first 24 hours of voyage

Following departure from Lautoka, the first 24 hours of the voyage will involve CTD collection at 2pm

Voyage track



Waypoints and Stations								
	Start	**End**	**Total Elapsed Time (hrs)**	**Total Distance (km)**	**Total Distance (nm)**	**Leg Distance (nm)**	Long	Lat
Depart Lautoka	**30/06/2016 9:00**		0	0.00	0.00			
CTD 1	30/06/2016 14:00	30/06/2016 15:30	5.0	122.2	66.00	66.00	176.442	-18.172
CTD 2	1/07/2016 9:30	1/07/2016 11:00	24.5	488.9	264.00	198.00	173.411	-19.817
CTD 3	1/07/2016 14:00	1/07/2016 15:30	29.0	550.0	297.00	33.00	172.905	-20.091
CTD 4	2/07/2016 9:30	2/07/2016 11:00	48.5	916.7	495.00	198.00	169.864	-21.637
CTD 5	2/07/2016 14:00	2/07/2016 15:30	53.0	977.8	528.00	33.00	169.345	-21.396
CTD 6	3/07/2016 9:30	3/07/2016 11:00	72.5	1344.4	726.00	198.00	166.703	-19.245
CTD 7	3/07/2016 14:00	3/07/2016 15:30	77.0	1405.6	759.00	33.00	166.188	-19.033
CTD 8	4/07/2016 9:30	4/07/2016 11:00	96.5	1772.2	957.00	198.00	162.817	-19.145
CTD 9	4/07/2016 14:00	4/07/2016 15:30	101.0	1833.3	990.00	33.00	162.435	-19.560
Arrive Dredge Site 1	4/07/2016 21:00		108.0	1950.0	1053.00	63.00	161.709	-20.350
Depart Dredge Site 1	5/07/2016 21:00		132.0	1986.0	1072.44	19.44	161.424	-20.537
Arrive Dredge Site 2	6/07/2016 8:00		143.0	2202.0	1189.08	116.64	159.831	-19.304
Depart Dredge Site 2	6/07/2016 16:00		151.0	2202.0	1189.08	0.00	159.831	-19.304
CTD 10	7/07/2016 9:30	7/07/2016 11:00	168.5	2558.3	1381.50	192.50	157.722	-21.842
CTD 11	7/07/2016 14:00	7/07/2016 15:30	173.0	2619.5	1414.50	33.00	157.360	-22.277

Float 1	8/07/2016 4:00	8/07/2016 6:00	187.0	2872.0	1551.50	137.00	155.85	-24.09
CTD 12	8/07/2016 9:30	8/07/2016 11:00	192.5	2945.4	1590.50	176.00	155.432	-24.598
CTD 13	8/07/2016 14:00	8/07/2016 15:30	192.0	3006.5	1623.50	33.00	155.090	-25.043
Float 2	8/07/2016 19:00	8/07/2016 21:00	197.0	3078.0	1662.00	39.00	154.64	-25.54
CTD 14	9/07/2016 9:30	9/07/2016 11:00	216.5	3332.4	1799.50	176.00	154.268	-27.757
CTD 15	9/07/2016 14:00	9/07/2016 15:30	221.0	3393.5	1832.50	33.00	154.245	-28.305
CTD 16	10/07/2016 9:30	10/07/2016 11:00	240.5	3760.2	2030.50	198.00	153.483	-31.525
CTD 17	10/07/2016 14:00	10/07/2016 15:30	245.0	3821.3	2063.50	33.00	153.302	-32.052
CTD 18	11/07/2016 9:30	11/07/2016 11:00	264.5	4188.0	2261.50	198.00	152.039	-35.178
CTD 19	11/07/2016 14:00	11/07/2016 15:30	269.0	4249.1	2294.50	33.00	151.796	-35.692
CTD 20	12/07/2016 9:30	12/07/2016 11:00	288.5	4615.7	2492.50	198.00	150.335	-38.776
CTD 21	12/07/2016 14:00	12/07/2016 15:30	293.0	4676.9	2525.50	33.00	150.091	-39.290
Arrive Hobart		13/07/2016 18:00	321.0	5268.0	2844.0	319.0		

Piggy-back projects (if applicable)

c. ***Marine microbes.*** (CI Martina Doblin, UTS)

The objective of this piggyback project is to examine the temperature tolerance, diversity and activity of upper ocean microbial communities from Lautoka to Hobart. This involves collecting surface seawater along the ship's path, coordinated with morning CTDs, and conducting a series of microbial community characterisation assays using instrumentation contained within the UTS MicroCSI that is normally only available in a land-based laboratory. After water collection, all of our investigations take place in the rad van and the UTS MicroCSI container lab on the ship.

d. ***"Investigation into the microbial contribution to C, N and S cycling in the Coral Sea"*** **and "Spatial scale patterns in photo-physiology and primary productivity"** (CI Bonnie Laverock, UTS)

The aims of this piggyback project fall into four categories:

1. DMS/P production by phytoplankton and bacteria related to Coral Sea light conditions

2. Method development (*DMS measurements in seawater – gas chromatography vs. chemiluminescence detection)*
3. Nitrogen cycling supporting primary production in the Coral Sea
4. Spatial scale patterns in photo-physiology and primary productivity

e. *Atmospheric underway measurements* (CI Melita Keywood, CSIRO)

The scientific objective of this work is to investigate the chemical composition, size distribution, optical properties and cloud nucleating properties of marine aerosol over the southern hemisphere with the aim of quantifying regional contributions of aerosols to radiative forcing. There is currently very large uncertainty associated with the direct, semi-direct and indirect effect of aerosols on radiative forcing. A key feature in this regard is the influence on cloud properties of cloud condensation nuclei (CCN), the very small atmospheric aerosol particles necessary for the nucleation of every single cloud droplet. A recent analysis of the 35-year CCN concentration record at Cape challenges the current accepted wisdom of the role of dimethyl sulfide (DMS) on CCN formation over the Southern Ocean. In particular, it appears that DMS oxidation is only significant during the summer months at Cape Grim, and in fact other sources and processes dominate throughout the rest of the year (Gras pers com). That other sources and processes may be significant in CCN production and modulation has also recently been suggested in a review of the CLAW hypothesis. The identity of these sources remains an open question.

f. Argo float deployments (Ann Thresher, CSIRO)

7 ARGO floats to be deployed during transit as per the table below. The floats can be deployed using longitude as long as the ship is in 2000m of water – and if not, they can easily be moved left or right.

Float #	Latitude	Longitude	Serial number
1	-19.75	175.5	7375
2	-20.5	172.5	7604
3	-24	164	SBE 40
4	-24.75	160.5	SBE 39
5	-26	158	7407
6	-26.5	156.75	7631
7	-27	155	7439

Investigator equipment (MNF)

For Geoscience: Dredge, Swath Bathymetry, Gravity meter, Rock Saw.

For biogeochemistry: Fluorometer, beam transmissometer, acs, bb9 or hydroscat, FRRF, radiometer, oxygen optode, SUNA, SeaFET, CTD.

(i) **Standard Laboratory and Facilities**

Name	Essential	Desirable
Aerosol Sampling Lab	X	
Air Chemistry Lab	X	
Preservation Lab		
Constant Temperature Lab		
Underway Seawater Analysis Laboratory	X	
GP Wet Lab (dirty)	X	
GP Wet Lab (Clean)	X	
GP Dry Lab (Clean)	X	
Sheltered Science Area	X	
Monkey Island		
Walk in Freezer		
Clean Freezer		
Blast Freezer		
Ultra Low Temperature Freezer	X	
Walk in Cool Room		

(ii) **Specialised Laboratory and Facilities**

Name	Essential	Desirable
Modular Radiation Laboratory	X	
Modular Trace Metal Laboratory		
Modular biogeochemistry laboratory [older CSIRO clean van]		
Modular TMR storage container [smaller container]		
Modular HazChem Locker		
Stern Ramp	X	
Modular coring consumables container		

(iii) **Standard Laboratory and Sampling Equipment**

Name	Essential	Desirable
CTD - Seabird 911 with 36 Bottle Rosette	X	
CTD -Seabed 911 with 24 Bottle Rosette	X	
Lowered ADCP	X	
Sonardyne USBL System		
XBT System	X	
Milli-Q System	X	
Laboratory Incubator	x	
Heavy Duty Electronic Balance		

Medium Duty Electronic Balance		
Light Duty Electronic Balance		
Surface Nets		
Bongo Nets		
Portable Capstan		
Beam Trawl		
Smith Mac grab		
Rock Dredges	X	
Dissecting Microscopes		

(iv) **Specialised Laboratory and Sampling Equipment**

Name	**Essential**	**Desirable**
TRIAXUS – Underway Profiling CTD		
Deep Tow Camera		
Deck Incubators	X	
Short Sediment Coring System		
Long Sediment Coring System		
Multi Corer		
Box Corer		
Trace Metal Rosette and Bottles		
Sherman epibenthic sled		
Trace metal *in situ* pumps (x6)		
MIDOC - midwater trawl		
EZ Net		
Rock Saw	X	

(v) **Equipment and Sampling Gear Requiring External Support**

(vi) **Underway Systems**

Name	**Essential**	**Desirable**
75 KHz / 150 KHz ADCP	X	
Multi Beam Acoustics	X	
Sub-Bottom Profiler	X	
Scientific Echo Sounders	X	
Thermosalinograph	X	
Atmospheric Underway Sensors	X	
Biological Oceanography Underway Sensors	X	
Polarimetric Weather Radar		
Gravity Meter	X	
Magnetometer		

User Equipment (responsible PIs are listed in parentheses)

Science aims b (Hardman-Mountford)
Navis BGCi floats
SeaFET pH
Hydroscat-6
IOP package (ac-s/ac-9, bb-9, DH4) and frame
Hyperspectral radiometer
Filter rigs and pumps
Dry shipper for liquid nitrogen (will need filling in Fiji)
1 palette containing bottles, vials, consumables

Science aims c (Doblin)
Isotope laboratory: 20ft Container lab with gear and consumables
2 boxes of gear for the rad lab
2 boxes of scintillation vials, 1 box of scintillation fluid
1 dewar (empty – may be put into the container lab rather than load separately; will need filling in Fiji)

Science aims d (Laverock)
Gas chromatograph with gas cylinders.
Bench-top spectrophotometer for use in one of the dry labs.
Peristaltic pump
Vacuum pump with filter rig
Dry shipper with liquid nitrogen (to be filled in Fiji)

Special Requests

Isotope Laboratory to be situated on Level 02 next to MNF Radioisotope container

Permits

Permits for French and Fiji waters have been applied for.
The voyage plan involves traversing Vanuatu waters, for which permits will not be available.
Permits for 'clean' rocks are not necessary, but the geoscience team have applied for permits for them.
A permit covering all users of the radioisotope lab has been obtained by PI Doblin from NSW EPA.

Personnel List

List all scientific participants, their affiliation and role on the voyage

1.	Lisa Woodward	Voyage Manager	CSIRO MNF
2.	Brett Muir	SIT Support	CSIRO MNF
3.	Ian McRobert	SIT Support	CSIRO MNF

4.	Frances Cooke	GSM Support	CSIRO MNF
5.	Tara Martin	GSM Support	CSIRO MNF
6.	Mark Rayner	Hydrochemistry	CSIRO MNF
7.	Anoosh Sarraf	DAP Support	CSIRO MNF
8.	Simon Williams	Chief Scientist	USyd
9.	Nick Mortimer	Alternate Chief Scientist	GNS
10.	Joanna Tobin	Student	USYD
11.	Martin Patriat	Geophysics/Geology	Ifremer
12.	Samuel Etienne	Stratigraphy	New Cal. Geol.Survey
13.	Joanne Whittaker	Geophysics	UTas
14.	Nick Herold	Climatologist	UNSW
15.	Serena Yeung	Student	USyd
16.	Isabel Sauermilch	Student	UTas
17.	Nick Hardman-Mountford	Lead Investigator, Biooptics	CSIRO
18.	Bozena Wojtasiewicz	Postdoc	CSIRO
19.	James McLaughlin	Experimental Scientist	CSIRO
20.	Charles Kovach	Bio-optical oceanographer	GST
21.	Martina Doblin	Lead Investigator, Piggyback c	UTS
22.	Allison McInnes	Piggy back c	UTS
23.	Bonnie Laverock	Lead Investigator, Piggyback d	UTS
24.	Elisabeth Deschaseaux	Piggy back d	UTS
25.	Charlotte Robinson	Piggy back d	UTS
26.	Reece Brown	Atmospherics (piggy back e)	CSIRO
27.	Doug Thost	DVM	CSIRO
28.	Lena O'Toole	Student	USYD

Signature

Your name	Simon Williams
Title	Chief Scientist
Signature	
Date:	6/4/2016