RV *Investigator* Voyage Plan

Voyage #:	**IN2017_C01**		
Voyage title:	GAB deep water geological and benthic ecology program		
Mobilisation:	Hobart 0800 10 April 2017 – 0800 11 April 2017		
Depart:	Hobart 0800 11 April 2017		
Return:	Hobart 0800 28 April 2017		
Demobilisation:	Hobart 2359 28 April 2017		
Voyage Manager:	Tegan Sime	**Contact details:**	Tegan.Sime@csiro.au
Chief Scientist:	Dr Asrar Talukder		
Affiliation:	CSIRO Energy	**Contact details:**	Asrar.Talukder@csiro.au
Principal Investigators:	Charlotte Stalvies, Alan Williams, Andrew Ross		
Project name:	Great Australian Bight Deepwater Marine Program		
Affiliation:	CSIRO	**Contact details:**	Andrew.Ross@csiro.au

Scientific objectives

The Great Australian Bight (GAB) represents a unique cold water carbonate margin with a large sedimentary depositional sequence. Whilst recent voyages have begun to reveal the nature and complexity of both the deep water geology and biology the basin, especially along the abyssal slope.

The Ceduna sub-basin is the product of rifting followed by the subsequent Southern Ocean seafloor spreading between Australia and Antarctica. The rifting created a narrow seaway between Australia and Antarctica, which was initially filled by two large deltaic super sequences (represented by the Tiger and Hammerhead super sequences respectively). Decreased sediment supply followed this period, during which commencement of fast seafloor spreading led to the initiation of widespread igneous activity and the development of a large number of volcanoes across the basin. Subsequent low sedimentation rates combined with continued subsidence have created the current modern deep water Ceduna sub-basin geomorphology. Key knowledge gaps in the understanding of the fundamental geology of the Ceduna sub-basin include:

1. Sedimentary facies and paleo environment

The deltaic sedimentary super sequences of the Great Australian Bight were deposited at high latitudes at critical periods within the Cretaceous hothouse period. They thus record information about plaeoenvrionmental conditions which can be used to inform our understanding of global paleo-environmental records. Rock dredging during prior voyages in the GAB (IN2015_C01, SS01/2007) successfully recovered samples from both the Tiger and Hammerhead super sequences, however, large gaps remain in our understanding about the formation of these sedimentary sequences and the paleo-environment of deposition. Spatially precise sampling of outcropping rocks from these intervals, from the abyssal slope and within canyons, will permit the paleo-environments of deposition to be characterised, and placed in context with global paleo-environmental records.

Whilst the Great Australian Bight has been regarded as a passive continental margin environment with low sedimentation rates, data from recent voyages and historical 3D seismic surveys reveal a complex seafloor shaped by active sedimentary processes that have occurred throughout the Tertiary sedimentary sequence and recent geological history. These processes include mass transport deposits (turbidite and debrite flows) on the continental slope. We aim to improve understanding of the nature of these processes and the timing of their occurrence; this is important in determining the dynamic factors influencing the geomorphology and ecology of the deep water margin of southern Australia.

2. Identification and sampling of potential seeps

Many of areas of potential seepage (hydrocarbon and other fluids) visited during the IN2015_C01 voyage in the GAB were determined not to be areas of seepage, however a large number of potential sites of seepage remain to be characterised. Further study of these areas will be used to describe subsurface fluid processes and chemical and biological coupling between the geosphere, seafloor and overlying hydrosphere in the GAB.

3. Basin and benthic biodiversity and distribution

The GAB is a region of high endemism and whilst the majority of seabed terrains across the deep continental slope are thought to be predominantly calcareous oozes, the geological targets described above represent areas of hard substrates with localised current regimes or chemosynthetic energy source in the case of seeps. The objective of this aspect of the study is to describe the composition, abundance and distributions of benthic fauna in these areas to define aspects of diversity community structure, endemism and functional ecology.

Voyage objectives

The voyage objectives are built around three main scientific objectives:

- The benthic characterisation and sampling outcropping sedimentary rocks to aid understanding of modern seabed erosional mechanisms, sedimentary processes and paleoenvironmental reconstruction.
- Benthic characterisation and sampling in areas of potential seepage to determine if fluid escape is occurring and the nature of the fluids and their relationship to the benthic fauna in these areas.
- Sampling of benthic fauna over a large geographic area to establish deep water community structure and function and augment understandings gained from recent IN2015_C01 and IN2015_C02 voyages.

Benthic characterisation of outcrop rocks and sampling of benthic fauna carry higher weight than that of the seep characterisation. The voyage plan includes more planned operations in each target area than can be achieved within the time allocations for the survey. Each of these target areas are ranked based on their importance in delivering on the scientific objectives.

The survey will use a hierarchical design comprising seafloor mapping prior to seafloor sampling and limited water column characterisation.

Seafloor mapping and water column characterisation

1. Hull mounted acoustic characterisation of the water column and seafloor over the target areas of interest. This activity will comprise the use of MBES, water column acoustic backscatter, single beam echo sounder, sub-bottom profiler and ADCP to determine processes occurring in the water column and map the seafloor and shallow subsurface geology.
2. Seafloor characterisation from the surface will be complemented with a limited number of tow camera to obtain video transects across the target area seafloor and overlying near bottom waters.

Seafloor and water column sampling

A number of sampling operations will be undertaken to describe the seafloor geology and benthic biota. Each sampling operation will differ dependant on sampling target, primarily based on substrate composition. For the soft substrate targets there will be a focus on grab samples whilst for the harder substrate types the focus will be on dredging. Sampling will be by:

1. Deployment of grab sampler to sample the surface sediment infauna, microbiology, hydrocarbon chemistry and physical properties.
2. Use of a beam trawl or Sherman sled to collect samples of benthic macro fauna over target areas.
3. Use of rock dredges to collects lithified sediments for description and detailed chemical analysis.
4. Limited collections of water column profile data including CTD, chemical sensor readings and associated water samples

Operational Risk Management

- There are some minor operational risks associated with the voyage due to operational water depths and the navigational accuracy required. The voyage requires high precision water column and seafloor USBL positioning of towed equipment in water depths of up to 5500 m.
- These risks will be mitigated through early technical discussions between the MNF team and science team.
- All types of operation have been on prior voyages of the R/V Investigator and so the risks due to lack of experience/capability on board has been minimised.

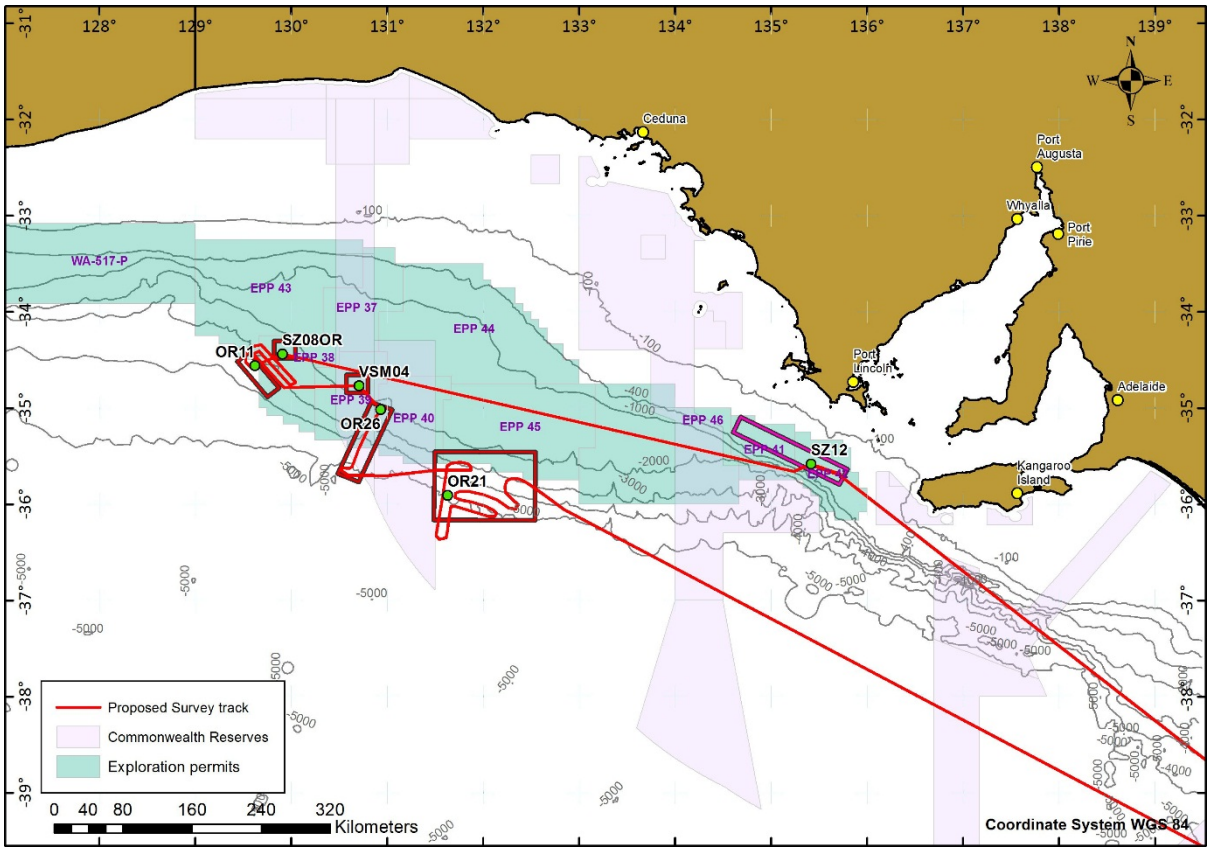
Overall activity plan including details for first 24 hours of voyage

Transit to the Great Australian Bight from Hobart.

Activity	Region	Distance	Time (days)	Date
Mobilisation	Hobart	N/A	1 day	0800 10th April – 02359 10th April 2017
Transit to sampling	Hobart to Southern most sampling station	~1670 km	3.5 days	0000 11th April – 14th April 2017
Sampling time on station, and contingencies	Area of interest	~810 km	9 days	14th April – 23rd April 2017
Transit between sites	Area of interest	~730 km	1.5 days	23rd April 2017 – 24th April 2017
Transit	Eastern most sampling station to Hobart	~1465 kms	3 days	25th April 2017 - 27th April 2017
Demobilisation	Hobart	N/A	1 day	0800 28th April – 2359 - 28th April 2017
	TOTAL		19 days	

Voyage track example

Figure 1 shows the proposed track line between 126-137° East. The transit route to the survey area from Hobart is shown entering from the eastern edge of the map. Canyon and rock outcrop (OR), volcanic seamounts (VSM) and potential hydrocarbon seep targets (SZ) are shown as red/pink boxes. Lease block areas are shaded green, and Commonwealth Marine Reserves shaded pink. The number of operations to be undertaken in each of the target areas exceeds of the time available for the survey so these targets will be rationalised and are subject to further review. The actual track may vary depending on the weather and the sequence and number of target areas.



Waypoints and stations

Site	Decimal Latitude	Decimal Longitude	Distance (km)	Total Distance (km)	Steaming time (hrs)	Total Steam (hrs)
Hobart	42° 54.775' S	147° 22.679' E		0		0
OR21	35° 49.988' S	132° 32.478' E	1670	1670	83.50	83.50
OR26	35° 55.001' S	131° 34.771' E	687	2357	45.80	129.30
VSM04	35° 0.959' S	130° 56.032' E	35	2392	2.33	131.63
OR11	34° 46.049' S	130° 42.438' E	278	2670	18.53	150.17
SZ08OR	34° 33.600' S	129° 37.245' E	30	2700	2.00	152.17
SZ12	34° 26.380' S	129° 54.581' E	614	3314	40.93	193.10
Hobart	42° 54.775' S	147° 22.679' E	1465	4779	73.25	266.35

Time estimates

Currently within the planning phase, current route map timings established but subject to update and change. To review in draft 2.

Date	Time	Activity
14/04/2017	5:30:00 AM	Port to OR21
17/04/2017	10:51:34 AM	OR21 swathing and sampling
17/04/2017	3:23:34 PM	OR21 to OR26
19/04/2017	5:33:13 AM	OR26 swathing and sampling
19/04/2017	7:51:08 AM	OR26 to VSM04
19/04/2017	11:26:08 PM	VSM04 sampling
20/04/2017	4:14:08 AM	VSM04 to OR11
22/04/2017	12:58:34 AM	OR11 swathing and sampling
22/04/2017	2:57:21 AM	OR11 to SZ08
22/04/2017	8:20:41 AM	SZ08 sampling
23/04/2017	10:32:41 AM	SZ08 to SZ12
23/04/2017	10:43:45 PM	SZ12 swathing and sampling
26/04/2017	11:55:45 PM	SZ12 to Port

Piggy-back projects (if applicable)

Bio Argo float deployment in the Great Australian Bight
Dr Nick Hardman-Mountford

Scientific and voyage objectives

Our objective is to deploy two (2) Bio-Argo profiling floats and two (2) Argo floats to provide autonomous measurements of bio-optical and biogeochemical properties of the GAB for improving satellite remote sensing estimates of productivity and characterising the biogeochemistry of the region.

CSIRO will provide the four (4) floats, two (2) of these floats will be equipped with CTD and bio-optical sensors to measure a range of parameters: T, S, dissolved oxygen, chl fluorescence, backscattering (4 wavelengths), nitrate, upwelling radiance and downwelling irradiance (4 wavelengths). Floats will be deployed at stations within Australian waters along the ship's route of transit (estimate stations OR21 and OR11). 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 a CTD profile and water samples to 1000m are also required to characterise the water at time of deployment for salts, pigment, nutrient and dissolved oxygen concentrations. Additional sensors to be included on the CTD include chlorophyll fluorometer, backscattering meter, beam transmissometer, dissolved oxygen sensor and deep SUNA/ISIS nitrate sensor. We will provide the backscattering meter as this is not available through the MNF equipment pool. Water samples will be analysed on board where possible or filtered and chemically fixed otherwise (e.g. pigments) according to standard operating procedures. We anticipate each deployment station taking 3 hours.

Time implications are limited to the time required to deploy the Argo floats and an associated CTD deployment. Deployments will take place within the area of operations with limited or no deviation from the planned route.

Investigator equipment (MNF)

1. All water column acoustic systems and drop keel
    a. MBES - EM122, EM710, ME70 with water column backscatter and seafloor bathymetry and backscatter
    b. Single beam split beam sonar - EK60 (38KHz, 18Khz)
    c. ADCP – 75/150KHz
2. Sub-bottom profiler - SBP120 12KHz
3. Sound velocity probe (x 2)
4. XBT's for sound speed corrections
5. CTD
    a. 36 bottles rosette CTD with lowered ADCP, PAR, fluorometers (Chlorophyll fluorescence), eco-bb backscatter, transmissometer, dissolved oxygen sensors mounted on CTD frame.
    b. Spare 24 bottle CTD
    c. CTD deployment boom
6. Thermosalinograph and Underway water analysis instruments
7. DGPS and Sonardyne ranger 2 USBL system (calibrated over 100-5000m depth range)
8. USBL beacons compatible with ranger 2 system (x 2)
    a. 1 x 6000 m rated
    b. 1 x 3000 m rated
    c. QUINCY or similar USBL logging navigation software
9. 5000 m rated deep water tow camera with HD video camera (operating to 2500m water depth)
10. Rock dredges (x 4)
11. Sherman benthic sled (x 2)
12. Beam trawl (x 2)
13. Smith-McIntyre grab (x 2)
14. Milli-Q water system
15. Stereo microscopes with lighting (x2)
16. -80^{o} C Freezers (x2) and walk-in freezer
17. Hydrochemistry laboratory
18. Constant temperature laboratory for cores and rock sample storage (@ 4^{o}C for sample storage)
19. Wet/dirty lab for biological and sediment sampling
20. Wet lab for biological and sediment processing
21. Dry lab for analytical instrumentation
22. Photographic space/biological preservation laboratory
23. Lab/operations room space and data analysis

24. Fume cabinets and chemical storage cabinets (flammables/acids), gas storage for (CH_3, H_2, N_2 + TBA), Gas alarms (if possible), O2 and flammables
25. Rear deck facilities, sea rated crane for equipment deployment
26. Communication/control systems (e.g. Operations Room, Bridge, rear deck)
27. Continuous plankton recorder

User Equipment

1. CSIRO Beam trawl (x 2)
2. Sherman benthic sled (x2) (back up)
3. Photographic equipment including U/V black light
4. Survey logging system (computer terminals)
5. Stereo microscope (x1)
6. Balances (for sample weighing)
7. CSIRO Energy hydrocarbon sensor array and battery for integration on to MNF CTD (as per IN2015_C01 voyage).
8. Four Argo floats (2 normal, 2 bioArgos)

Special Requests

1. The user-supplied beam trawl, Sherman sled (if used) and Argo floats will require assistance from the Investigator crew to deploy.

Permits

EPBC self-assessment – Completed
Animal Ethics permit – Approved and sent to MNF
Commonwealth marine parks permit – Approved and sent to MNF
Commonwealth waters permit – Approved and sent to MNF
AFMA permit – Approved and sent to MNF

Personnel List

List all scientific participants, their affiliation and role on the voyage (up to 40 berths).
Please list Students as Student/role.

1.	Tegan Sime	Voyage Manager	CSIRO MNF
2.	Ben Baldwinson	SIT Support	CSIRO MNF
3.	Will Ponsonby	SIT Support	CSIRO MNF
4.	Bernadette Heaney	GSM Support	CSIRO MNF
5.	Frances Cooke	GSM support	CSIRO MNF
6.	Karl Malakoff	DAP Support	CSIRO MNF
7.	Peter Shanks	DAP Support	CSIRO MNF
8.	Cassie Schwanger	Hydrochemistry Support	CSIRO MNF
9.	Asrar Talukder	Chief Investigator (CI)	CSIRO Energy
10.	Alan Williams	Shift lead	CSIRO O&A
11.	Christine Trefry	Data Manager	CSIRO Energy
12.	Stacey Maslin	Data Manager	CSIRO Energy
13.	Charlotte Stalvies	Geology - Sampling lead	CSIRO Energy
14.	Emanuelle Frery	Geology - Sampling	CSIRO Energy
15.	Richard Kempton	Geology - Sampling	CSIRO Energy
16.	Lionel Esteban	Geology - Sampling	CSIRO Energy
17.	Lousie Russell-Cargill	Geology - Sampling	Volunteer student
18.	Thomas Tam	Geology – Sub-bottom profiler/sampling	CSIRO Energy - Student
19.	Mark Green	Logistics (bio + geo)	CSIRO O&A
20.	Candice Untied	Sample lead + data	CSIRO O&A – Student
21.	Maylene Loo	Sample lead + data	Contractor
22.	Karen Gowlett-Holmes	Taxonomy + photography	CSIRO O&A
23.	Deborah Osterhage	Photography (microbiology)	Contractor
24.	Emily Armstrong	Tissues	CSIRO O&A – Student
25.	Kate Naughton	Microbiology	Museum Victoria
26.	Ken Graham	Taxonomy- fishes	Aust Museum (AMRI)
27.	David Staples	Taxonomy - invertebrates	Mus Victoria
28.	Lisa Goudie	Taxonomy - invertebrates	Contractor
29.	Kelly Merrin	Taxonomy - invertebrates	Mus Victoria
30.	Francesco Criscione	Taxonomy - invertebrates	Aust Museum (AMRI)
31.	Anna Murray	Taxonomy - invertebrates	Aust Museum (AMRI)
32.	Nick Mortimer	Electronics (sensors and Argo float deployment)	CSIRO O&A
33.	Scott Foster	Biology team	CSIRO Data61
34.	Kirsten Lea (tentative)	Communicator	CSIRO Comms

Please note: The MNF support staff numbers in this table are the absolute minimum and the numbers will increase depending on the activities being undertaken on the voyage. It may include Hydrochemists in addition to the other groups.

Signature

Your name	Asrar Talukder
Title	Chief Scientist
Signature	Asrar Talukder
Date:	22 March 2017

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
Aerosol Sampling Lab		
Air Chemistry Lab		
Preservation Lab	X	
Constant Temperature Lab	X	
Underway Seawater Analysis Laboratory		X
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	X	
Clean Freezer	X	
Blast Freezer	X	
Ultra-Low Temperature Freezer	X	
Walk in Cool Room	X	

(ii) Specialised laboratory and facilities

May require additional support

Name	Essential	Desirable
Modular Radiation Laboratory		
Modular Trace Metal Laboratories		
Modular Hazchem Locker	X	
Deck incubators		
Stabilised Platform 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
LADCP		
Sonardyne USBL System	X	
Milli -Q System	X	
Laboratory Incubators		
Heavy Duty Electronic Balance		
Medium Duty Electronic Balance		
Light Duty Electronic Balance		
Surface Net		
Bongo Net		
Smith Mac grab	X	
Dissecting Microscopes	X	

(iv) Specialised laboratory and sampling equipment

May require additional support

Name	Essential	Desirable
TRIAXUS – Underway Profiling CTD		
Continuous Plankton Recorder (CPR)		X
Deep tow camera	X	
Piston Coring System		
Gravity Coring System		
Multi Corer		
XBT System	X	
Trace Metal Rosette and Bottles		
Sherman epibenthic sled	X	
Trace- metal in-situ pumps		
LADCP		
Rock Dredges	X	
EZ Net		
Rock saw		X
Portable pot hauler		
Beam Trawl	X	
Trawl doors (pelagic or demersal)		
Stern Ramp	X	
Trawl monitoring instrumentation (ITI)		
Radiosonde		

(v) Equipment and sampling gear requiring external support

May require additional support from applicants

Name	Essential	Desirable
Seismic compressors		
Seismic acquisition system		

(vi) Underway systems

Acoustic Underway Systems

Name	Essential	Desirable
75kHz ADCP		X
150kHz ADCP		X
Multi Beam echo sounder EM122 12kHz (100m to full ocean depth)	X	
Multi Beam echo sounder EM710 70-100kHz (0-1000m approx.)	X	
Sub-Bottom Profiler SBP120	X	
Scientific Echo Sounders EK60 (6 bands, 18kHz-333kHz)	X	
Gravity Meter		X
Trace metal clean seawater supply		

Atmospheric Underway Sensors

Name	Essential	Desirable
Nephelometer		
MAAP (multi angle absorption photometer)		
SMPS (scanning mobility particle sizer)		
Radon detector		
Ozone detector		
Manifold instrumentation (intake temperature and humidity)		
Picarro spectrometer (analysis of CO_2/CH_4/H_2O)		
Aerodyne spectrometer (analysis of N_2O/CO/H_2O)		
O2 analyser		
Manifold instrumentation (intake temperature and humidity)		
CCN (Cloud Condensation Nuclei)		
MOUDI (Micro-Orifice Uniform Deposit Impactors)		
NOx monitor		
Polarimetric Weather Radar		

Underway Seawater Instrumentation

Name	**Essential**	**Desirable**
Thermosalinograph		X
Fluorometer		X
Optode		X
PCO2		X