RV *Investigator* Voyage Plan

Voyage #:	**IN2015_C01**		
Voyage title:	GAB deep water geological and benthic ecology program		
Mobilisation:	Hobart, 0900 Thursday, 22–25 October 2015		
Depart:	Hobart, 1800 Sunday, 25 October 2015		
Return:	Port Lincoln, 0800 Saturday, 28 November 2015		
Demobilisation:	Port Lincoln, 0900-2359 Saturday, 28 November 2015		
Voyage Manager:	Stephen McCullum	**Contact details:**	Stephen.McCullum@csiro.au
Chief Scientist:	Dr Andrew Ross		
Affiliation:	CSIRO Energy	**Contact details:**	Andrew.Ross@csiro.au
Principal Investigators:	Drs Alan Williams, Joanna Parr, Asrar Talukder		
Project name:	Great Australian Bight Deepwater Marine Program		
Affiliation:	CSIRO	**Contact details:**	08 6436 8790

Scientific objectives

The Great Australian Bight (GAB) represents one of Australia's most prospective frontier hydrocarbon exploration regions. However, the primary Ceduna sedimentary sub-basin – the focus of our work - is characterised by a paucity of data on its deep water geology and almost no knowledge of its benthic biological communities.

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 source rocks

Whilst rock dredging has recovered samples from both the Tiger and Hammerhead super sequences, large gaps remain (particularly in the Hammerhead) in our understanding of the facies that describe how these sequences were formed and about the existence or otherwise of organic rich potential source rocks for petroleum systems in the basin. Therefore a scientific research objective of the survey is to sample lithified outcropping rocks from the Hammerhead sequence on the deep water slope and within canyons, to better understand the formation of the deltaic super sequence and identify any potential source rocks for hydrocarbon reserves.

2. Hydrocarbon seeps

Geological investigations of the intervals from the few wells drilled in the basin show evidence for hydrocarbon migration, however further evidence is required to define whether active petroleum systems exist or not and to understand their character. To test this, a scientific research objective of the survey is to sample potential areas of hydrocarbon seepage in order to determine if active petroleum systems are present and the nature of their hydrocarbons.

3. Mid-Eocene Volcanic activity

Igneous activity that occurred in the middle Eocene is currently defined using seismic data and little is known of the provenance, mechanisms of formation, precise timing and impact on the host sedimentary rocks of this magmatic activity. These attributes are not only important in terms of hydrocarbon potential for the basin, but are also fundamental to the understanding of the breakup between Australia and Antarctica. Therefore, to understand the tectonic history of the basin and the role that igneous activity played in this breakup, a research objective of the survey is to collect samples from volcanic seamounts that will allow us to understand timing, chemistry and mechanisms for emplacement.

4. 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 survey targets:

- Outcrops of sedimentary rocks – to collect samples for sedimentary facies and source rock analysis
- Potential areas of seepage – to determine if hydrocarbon seepage can be identified
- Deepwater seamounts – to identify, sample and investigate the nature of the mid-Eocene volcanics

The voyage objectives linked to each type of target carry equal weight and the proposed voyage plan includes more targets than can be visited within the time allocations for the survey. Each of these target areas will be ranked based on their importance of each target in delivering on the scientific objectives.

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

Seafloor mapping and water column characterisation of target areas will be by:

1. Collection of water column profile data including CTD, chemical sensor readings, LADCP and associated water samples
2. 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, SBP, gravity, magnetics and ADCP to determine processes occurring in the water column and map the seafloor and shallow subsurface geology.
3. Seafloor characterisation from the surface will be complemented with a tow camera to obtain video transects across the target area seafloor and overlying near bottom waters.

Seafloor 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 coring whilst for the harder substrate types the focus will be on dredging. Sampling will be by:

1. Deployment of an integrated coring platform (ICP) with a multicorer to sample the surface sediment infauna, microbiology, hydrocarbon chemistry, redox chemistry and physical properties. In addition ancillary sensor data will also be collected, such as hydrocarbon sensors and turbidity.

2. Use of a beam trawl or Sherman sled to collect samples of benthic megafauna over target areas.
3. Use of 12 m piston cores (or gravity cores where appropriate) to characterise and describe the chemistry and properties of recent sediments.
4. Use of rock dredges to collects lithified sediments and volcanic rocks for description and detailed chemical analysis.

Of the 17 target areas identified, 64% occur in water depths of between 876 –and 3000 m, 24% occur in water depths of 3000-4500 m with the remaining targets (24%) occurring in water depths between 4500 – 5200 m.

Operational Risk Management

There are some 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 5200 m.

These risks will be mitigated through early technical discussions between the supplier teams, the MNF team and science team. In addition there is an extended mobilisation period in Hobart specifically to test the integration of systems and equipment before transit to the Great Australian Bight.

All other types of operation have been undertaken on the shakedown surveys of the R/V Investigator and so the risks due to lack of experience/capability on board has been minimised.

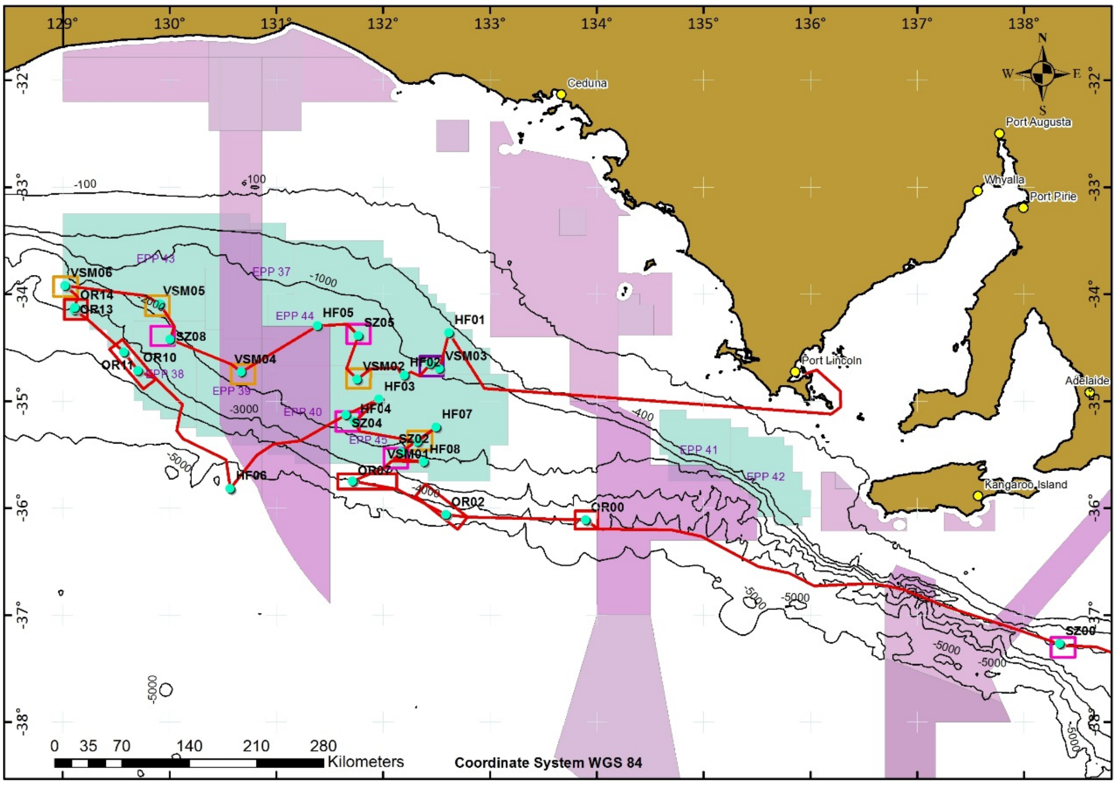
Overall activity plan including details for first 24 hours of voyage

Activity	**Region**	**Distance**	**Time (days)**	**Date**
Mobilisation	Hobart	TBA	4 days	0900 22 October – 1800 25 October
Transit to sampling	Hobart to western most sampling station	2185 kms	5.23 days	1800 25 October - 31 October 2015
Sampling time on station, and contingencies	Area of interest			31 October – 27 November 2015
Transit between sites	Area of interest	932 kms	2.62	31 October – 27 November 2015
Transit	GAB to Port Lincoln	400 kms	0.82	27 November - 28 November 2015
Demobilisation	Port Lincoln	N/A	1 day	28 November 2015
		TOTAL	**39 days**	

For the first 24 hrs the vessel will steam from Hobart towards the GAB following the predetermined track line.

Voyage track example

Figure 1 shows the proposed track line between 128.5-139° east. The transit route to the survey area from Hobart is shown entering from the eastern edge of the map. Canyon and rock outcrop target areas are shown as red boxes, volcanic seamounts target areas are shown as pink boxes and potential hydrocarbon seep targets are shown as orange boxes. Lease block areas are shaded green, and Commonwealth Marine Reserves shaded pink. The number of target areas are in excess 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

Include a table of latitudes and longitudes in degrees and decimal minutes representing waypoints and stations. Time estimates are based on 11 knot steaming speeds during transit.

Name	Decimal Latitude	Decimal Longitude	Distance (km)	Total Distance (km)	Steaming time (hrs)	Total Steam (hrs)
Hobart	-42.8900	147.3400	0	0		0.00
SZ00	-37.2697	138.3344	1188	1188	58.32	58.32
OR00	-36.1117	133.8938	427	1615	28.81	87.13
OR02	-36.0633	132.5882	118	1733	7.96	95.10
OR07	-35.7499	131.7129	87	1820	5.87	100.97
HF08	-35.5686	132.3811	67	1887	4.52	105.49
SZ02	-35.4740	132.1695	34	1921	2.29	107.78
VSM01	-35.3776	132.3212	17	1938	1.15	108.93
HF07	-35.2430	132.4957	38	1976	2.56	111.49
HF04	-35.1920	131.7337	83	2059	5.60	117.09
HF03	-34.9838	131.9587	31	2090	2.09	119.18
SZ04	-35.1285	131.6508	32	2122	2.16	121.34
HF06	-35.8175	130.5702	131	2253	8.84	130.18
OR10	-34.7143	129.7041	136	2389	9.18	139.36
OR11	-34.5434	129.5725	22	2411	1.48	140.84
OR13	-34.1500	129.1094	61	2472	4.12	144.96
OR14	-34.1276	129.1154	3	2475	0.20	145.16
VSM06	-33.9216	129.0208	28	2503	1.89	147.05
VSM05	-34.0910	129.9099	85	2588	5.74	152.79
SZ08	-34.4219	130.0074	40	2628	2.70	155.49
VSM04	-34.7279	130.6721	73	2701	4.93	160.41
HF05	-34.2942	131.3843	81	2782	5.47	165.88
SZ05	-34.3872	131.7690	41	2823	2.77	168.64
VSM02	-34.7968	131.7558	50	2873	3.37	172.02
HF02	-34.7567	132.1981	50	2923	3.37	175.39
SZ03	-34.6523	132.4406	31	2954	2.09	177.48
VSM03	-34.6979	132.5263	9	2963	0.61	178.09
HF01	-34.3597	132.6158	39	3002	2.63	180.72
Port Lincoln	-34.7200	135.8700	440	3442	21.60	202.32

Piggy-back projects (if applicable)

Not applicable.

Investigator equipment (MNF)

1. All water column acoustic systems and drop keel
   a. MBES - EM122, EM710 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, oxygen,
   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
9. 5000 m rated deep water tow camera with HD video camera
10. Piston corer in 12 m coring configuration, corer boom and coring equipment storage container
11. Rock dredges (x 2)
12. Sherman benthic sled (x 2)
13. Beam trawl (x 2)
14. Smith-McIntyre grab (x 2)
15. K-C multicorer (x 1)
16. Gravity meter – away for repairs
17. Milli-Q water system
18. Stereo microscopes with lighting (x2)
19. -80° C Freezers (x2) and walk-in freezer
20. Hydrochemistry laboratory
21. Constant temperature laboratory for cores and rock sample storage
22. Wet/dirty lab for biological and sediment sampling
23. Wet lab for biological and sediment processing
24. Dry lab for analytical instrumentation
25. Photographic space/biological preservation laboratory
26. Lab/operations room space and data analysis
27. 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
28. Rear deck facilities, sea rated crane facilities for equipment deployment
29. Communication/control systems (e.g. Operations Room, Bridge, rear deck)
30. Continuous plankton recorder

User Equipment

1. 3000 m rated Instrumented Corer Platform with 6-barrel KC Multi-corer
2. D&N Francis electric hydraulic winch
3. CSIRO Beam trawl (x 2)
4. Hydrocarbon and chemical sensors for ICP/ CTD (plus spare sensors)
5. Core splitter
6. Core logging tools (hand held)
7. Magnetometer*
8. Sherman benthic sled (1) (back up)
9. Geochemical analytical equipment†
    a. Rockeval instrument*
    b. Headspace Gas analyser
    c. Piccaro Cavity ring down spectrometer
    d. Omni Star Mass spectrometer
    e. GC-FID
10. Photographic equipment including U/V black light
11. Survey logging system (computer terminals)
12. Pore water squeezer
13. Deep water temperature probe‡
14. Stereo microscope (x1)

* Geoscience Australia supplied
† Third party supplied

Special Requests

1. The user-supplied D&N Francis winch will be operated by the science team on board. Crew will assist with deployment and operating the A-frame.
2. Higher VSAT data provision required (minimum 1 Mb/s up/down) to receive and transmit data to second survey vessel.
3. Temperature probe to be deployed from the side of the vessel using the coring boom and requires MNF assistance with integration and testing.
4. Analytical equipment and glove box utilise gasses and will require relevant gas safety assessments by science and MNF team.
5. Relatively long mobilisation period has been included for testing and integration before sailing. This may also comprise a short calibration and testing voyage requiring return to Hobart port or personnel transport to the vessel via small craft.

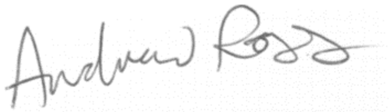
Permits

- Animal Ethics permit – Approved
- Commonwealth marine parks permit – Approved
- Commonwealth waters permit – Approved
- AFMA permit - Approved

Personnel List

1.	Stephen McCullum	Voyage Manager	CSIRO MNF
2.	Aaron Tyndall	SIT Support	CSIRO MNF
3.	Rod Palmer	SIT Support	CSIRO MNF
4.	Mark Lewis	SIT Support	CSIRO MNF
5.	Bernadette Heaney	GSM Support	CSIRO MNF
6.	Matt Boyd	GSM Support	CSIRO MNF
7.	Peter Hughes	Hydrochemistry	CSIRO MNF
8.	Pamela Brodie	DAP	CSIRO MNF
9.	TBA	Electronics	CSIRO O&A
10.	Karl Forcey	Electronics	CSIRO O&A
11.	Andrew Ross	Voyage leader	CSIRO, Energy
12.	Alan Williams	Shift leader, Co-PI	CSIRO, O&A
13.	Joanna Parr	Volcanics/Co-PI	CSIRO, Mineral Resources
14.	Asrar Talukder	Shallow geophysics/Co-PI	CSIRO, Energy
15.	Franzis Althaus	Data management/ Ecologist	CSIRO, O&A
16.	Christine Trefry	Data management/Reporting	CSIRO, Energy
17.	Amy Nau	Data visualisation	CSIRO, O&A
18.	Stuart Edwards	USBL Navigation	CSIRO, O&A
19.	Emanuelle Frery	Geophysics	CSIRO, Energy
20.	Nick Mortimer	ADCP and LADCP processing	CSIRO, O&A
21.	Charlotte Stalvies	Water and sediment sampling	CSIRO, Energy
22.	April Picard	Core & rock description/logging	CSIRO, Energy
23.	David Mole	Core & rock description/logging	CSIRO, Mineral Resources
24.	David Fuentes	Water and sediment sampling	University of Sydney
25.	Martijn Woltering	Analytical instrumentation	CSIRO, Energy
26.	Mederic Mainson	Sensor tech/sampling	CSIRO, Energy
27.	Mark Green	Benthic sampling	CSIRO, O&A
28.	Karen Gowlett-Holmes	Biological sampling - imagery	CSIRO, O&A
29.	Hugh Macintosh	Invertebrate processing and curation	Museum Victoria
30.	Andrea Crowther	Invertebrate processing and curation	South Australia Museum
31.	Steve Keable	Invertebrate processing and curation	Australian Museum, Sydney
32.	Dan Gledhill	Fish processing and curation	CSIRO,O&A
33.	Ken Graham	Fish processing and curation	Australian Museum, Sydney
34.	Christian Müller	Temperature probe technician	Fielax
35.	Matt Lansdell	Biological and geological sampling	CSIRO, O&A
36.	Sureyya Kose	Geochemical sampling	Curtin University
37.	Wade Farley	Communications/videographer	Wade Farley

Signature

Your name	Andrew Ross
Title	Chief Scientist
Signature	
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List of additional figures and documents

None