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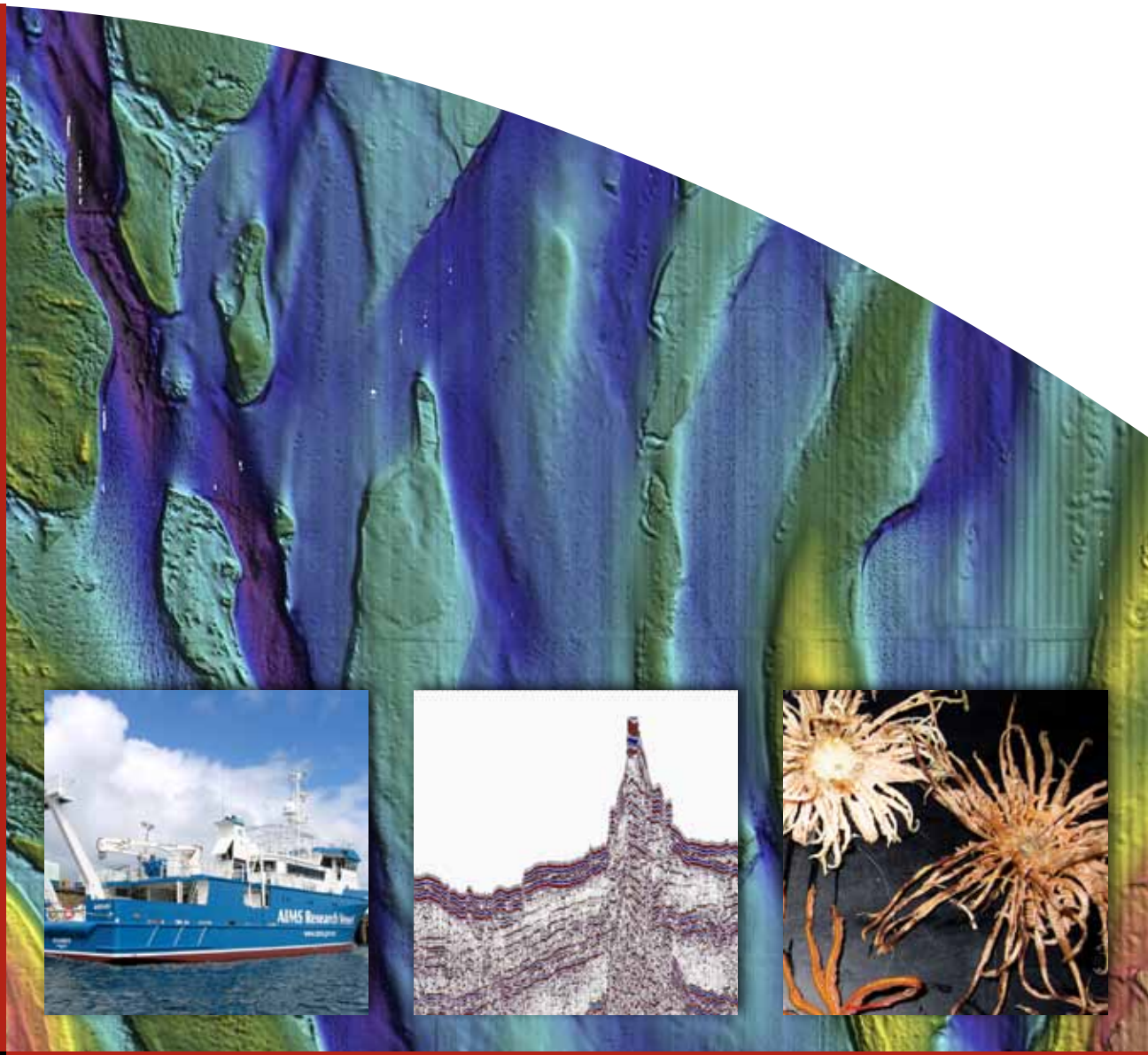

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Contents

List of Figures

List of Tables

Executive Summary

A seabed mapping survey over a series of carbonate banks, intervening channels and surrounding sediment plains on the Van Diemen Rise in the eastern Joseph Bonaparte Gulf was completed under a Memorandum of Understanding between Geoscience Australia and the Australian Institute of Marine Sciences. The survey obtained detailed geological (sedimentological, geochemical, geophysical) and biological data (macro-benthic and infaunal diversity, community structure) for the banks, channels and plains to establish the late-Quaternary evolution of the region and investigate relationships between the physical environment and associated biota for biodiversity prediction. The survey also permits the biodiversity of benthos of the Van Diemen Rise to be put into a biogeographic context of the Arafura-Timor Sea and wider northern Australian marine region.

Four study areas were investigated across the outer to inner shelf. Multibeam sonar data provide 100% coverage of the seabed for each study area and are supplemented with geological and biological samples collected from 63 stations. In a novel approach, geochemical data collected at the stations provide an assessment of sediment and water quality for surrogacy research. Oceanographic data collected at four stations on the Van Diemen Rise will provide an understanding of the wave, tide and ocean currents as well as insights into sediment transport. A total of 1,154 km^2 of multibeam sonar data and 340 line-km of shallow (<100 mbsf) sub-bottom profiles were collected.

The data show that the seabed of the outer to middle shelf is relatively complex, with numerous banks, terraces, channels, ridges and deep/hole/valleys present. This includes an over-deepened channel (>200 m) on the middle shelf, which is the second deepest known channel on the northern Australian shelf. Backscatter data show patterns that are likely related to the texture and composition of the seabed sediments. Sub-bottom profiles reveal a relatively complex sub-surface geology dominated by multiple northward-dipping strata that can be linked to prominent surface environments, namely terraces, banks and ridges and pockmarks. Acoustic scattering occurs in the water column above pockmarks on the inner shelf sediment plains although the cause is unknown. The banks, terraces and ridges are generally characterised by species-rich sponge and octocoral gardens comprising assemblages distinct from the Kimberly shelf region. Lithistid or stony sponges and other species known to consolidate otherwise unstable sedimentary seafloor topography are common. Sediment plains are dominated by infauna comprising mostly polychaetes and amphipods. This is in contrast to the *Halimeda* and scleractinian coral dominated banks elsewhere on the northern Australian shelf.

Information and data collected on the survey can be used to support the work programs of the Department of Resources, Energy and Tourism and Department of the Environment, Water, Heritage and the Arts. Specifically, data collected on the present survey will be combined with existing data for the whole Joseph Bonaparte Gulf to provide a regional picture of seabed environments that can potentially be used to support resource development by industry and to characterise proposed marine protected areas.

Acknowledgements

We thank the crew of the RV *Solander* and shore-based science staff at the Australian Institute of Marine Sciences for their support in conducting the survey. We also thank the Field and Engineering Support staff at Geoscience Australia and staff at Pearl Marine Engineering Pty Ltd in Darwin for their logistical support in conducting the survey. Drs Scott Nichol, Ralf Haese and Tara Anderson (all of Geoscience Australia) assisted with geomorphology interpretations, water quality method development and planning the biological component, respectively. Preliminary assessments of the sponge fauna were completed by Drs Belinda Alvarez (Northern Territory Museum), Rachel Przeslawski (Geoscience Australia) and Chris Battershill (AIMS). Drs John Kennard (Geoscience Australia) and Peter Doherty (AIMS) are thanked for their reviews of the original draft. This record is published with permission of the Chief Executive Officers of Geoscience Australia and the Australian Institute of Marine Science.

1. Introduction

This report provides details of the activities undertaken during the conjoint Geoscience Australia and Australian Institute of Marine Science seabed mapping survey SOL4934, including a list of the samples and data that were collected. The survey was completed between 27 August and 24 September, 2009. Detailed scientific results of the survey will be reported in a later complementary report that incorporates data and information from the wider Joseph Bonaparte Gulf, beyond the areas occupied during the present survey.

1.1. BACKGROUND

Survey SOL4934 was conducted under a Memorandum of Understanding (MOU) between Geoscience Australia (GA) and the Australian Institute of Marine Science (AIMS). A major component of the MOU is to conduct collaborative seabed mapping surveys using the AIMS research vessel *Solander* (Fig. 1.1) to provide regional biophysical information for Australia's shelf (<200 m) environments (see Appendix A for ship's complement). Entering into this MOU resulted in a program that has produced integrated outputs that could not have been possible without the collaboration. The agreement brings together the considerable resources of the two research agencies that when combined offered the best opportunity to achieve outcomes that deliver to current government priorities and Australia's offshore oil and industry needs.

Under the MOU, GA makes available its shallow water 300 kHz multibeam sonar system in exchange for time on the RV *Solander*. The arrangement permits two days of multibeam sonar support by GA for one day of vessel time by the AIMS. The present four-week survey was preceded by eight weeks of multibeam support by GA on several AIMS-led surveys. This report pertains only to the GA-led survey associated with its vessel time.

The purpose of survey SOL4934 is to provide data and information on the shallow seabed environments of the eastern Joseph Bonaparte Gulf, northern Australia (Fig. 1.1). This region was chosen because existing regional data reveal that the seabed environments (banks, channels, sediment plains) are typical and representative of the wider Joseph Bonaparte Gulf (Heap & Harris, 2008). Studying these environments in detail, and incorporating these detailed data with regional datasets collected over a wider area, provides a relatively accurate picture of the dominant (and distinct) seabed environments of the gulf.

The Joseph Bonaparte Gulf is a location of petroleum and fishing activity. The region is also a major trade corridor between southeast Asia and northern Australia. Planned future infrastructure development by Australia's offshore petroleum industry in the form of pipelines and anchored processing plants is expected to exploit the gas resources in the region. The Van Diemen Rise itself is an area proposed for protection as part of a national representative system of marine protected areas due to its important conservation values. Data and information collected on the present survey will assist in preparation of maps and reports that characterise the seabed environment. These products will support industry activity and help inform management of the marine resources in the region.

1.2. SCIENTIFIC RATIONALE

Linking the abundance and distribution of benthic marine organisms with their physical habitats is not new. There have been numerous studies that have established or inferred a direct link between textural and compositional seabed properties and the distribution and abundance of benthic marine biota (see review by McArthur *et al*. 2009 and the references therein). The increasing prominence of these studies has come about from recent

Figure 1.1. Photo of the Australian Institute of Marine Science's 35 m-long research vessel *Solander*.

international efforts to map and predict benthic marine biodiversity principally for sustainable resource management but also for Law of the Sea (sovereignty) claims, security assessments, and safe navigation. Research into 'physical surrogates' through investigations of the links between physical (abiotic) and biological (biotic) seabed attributes has increased in prominence over the past two decades due in part to the increasing wide-spread use of off-the-shelf, commercially-available multibeam sonar systems which, when combined with sampling programs, can provide an unprecedented level of detail for characterising and mapping distributions of seabed habitats, particularly for deep water (>1,500 m) ecosystems.

The present survey builds on this body of work by implementing a 'seabed mapping' strategy to investigate benthic marine habitats on Australia's northern tropical shelf. This information adds to the (growing) inventory of seabed habitats for the Australian marine jurisdiction but also, when incorporated with other geological and biological data, has the potential to inform assessments of the likely effects to the tropical shelf ecosystem of proposed activities. A regional sedimentological study of the gulf by Van Andel and Veevers (1967) shows significant variation in seabed texture and composition from the inner to outer shelf environments, including the Van Diemen Rise. Data from this regional study will be used to provide regional context for the more targeted sedimentological and biological data collected on the present survey.

In an extension to the traditional seabed mapping surveys for biodiversity prediction, shallow (<100 m) sub-surface sediments that make up the banks, intervening channels and surrounding sediment plains were investigated to provide information on the geotechnical properties of the seabed for these different environments. These data will help establish the Late Quaternary history of northern Australian shelf—a topic that has received comparatively limited attention—and the potential for such seabed habitats to support the proposed infrastructure development.

In a relatively novel approach to seabed mapping, data were collected to trial geochemical indices that may help predict benthic marine biodiversity: including sediment oxygen demand (SOD; Ferguson *et al*., 2007) and different forms of phosphorus (e.g., adsorbed and oxide-associated P, authigenic-P, detrital-P and organic-P; Coston *et al*., 2000). These variables will be used together with the metals, pigments, dissolved inorganic carbon (DIC) fluxes and organic constituents in the environmental characterisation to infer patterns in sediment redox status (selected trace elements), P-availability (P-forms) and carbon

quality (SOD). We will also refine our understanding of surrogates already in use. For example, we intend to compare/contrast the biological-prediction utility of chlorin indices (measured in intervals from 0-0.02 mbsf) and sediment chlorophyll-a (measured in intervals from 0-0.01 mbsf) of shallow sub-surface sediments. These data will contribute to developing a comprehensive regional dataset of seabed geochemical properties for northern Australia. Initial research indicates that geochemical variables related to carbon freshness or quality (especially the chlorin index; Schubert *et al*., 2005) are better descriptors of the diversity of deep-sea *Lebensspuren* than many traditional indices such as sediment texture and composition (e.g., particle size and carbonate content), and thus show promise as surrogates for predicting benthic biodiversity (e.g., Dundas & Przeslawski, 2009; Radke *et al*., in press), hence their focus in the present study.

Knowledge of the benthic marine biota for northern Australia stems mainly from opportunistic collections of epifauna or scattered fisheries data. Aside from the detailed but spatially-constrained biological studies commissioned by petroleum companies for environmental assessments associated with specific activities across the northern and northwest Australian shelf (e.g., Sinclair, Knight, Merz Pty Ltd, 2001), there is no comprehensive regional inventory of benthic biota for the environments of Joseph Bonaparte Gulf. Video from the Big Bank Shoals, a series of coral reefs on the outer shelf to the northwest, and surrounding area has revealed four distinct biological communities based on dominant taxa: *Halimeda* and encrusting sponges, corals, continental shelf communities, and filter feeding communities (Heyward *et al*. 1997). To help fill the gap in regional benthic biota (epifauna and infauna) information, benthic organisms were observed and sampled to characterise the biological communities of the representative seabed environments in the Joseph Bonaparte Gulf. This work will largely be driven by researchers at AIMS with significant contributions by GA scientists. This component of the project forms part of both organisations work programs to establish a comprehensive inventory of shallow tropical seabed habitats and biota for northern Australia.

1.3. SURVEY AIM AND OBJECTIVES

The principal aim of the survey was to collect geophysical and geological data for shallow (<200 m) seabed environments for the eastern Joseph Bonaparte Gulf, and associated intervening channels to assist in understanding the regional geological setting and their environmental significance. Specific objectives of the survey were to:

1. obtain high resolution geophysical (bathymetry, sub-bottom profiler) data for the banks and channels for the eastern Joseph Bonaparte Gulf,
2. characterise the oceanography of the banks and channels of the eastern Joseph Bonaparte Gulf using oceanographic moorings and CTD casts,
3. characterise the physical properties and benthic biota of representative seabed environments from samples and underwater video, and
4. characterise the abiotic and biotic relationships associated with the banks and channels of the eastern Joseph Bonaparte Gulf.

1.4. STUDY AREAS

Four study areas (A-D) were identified along a N-S transect (Fig. 1.2). This transect contains seabed environments that are representative of the eastern gulf and the broader north Australian shelf region. The banks and channels covered by the four study areas are common environments in the gulf. Area A, located on the outboard section of the shelf, represents deeper-water channel seabed environments. Area B, located on the outboard flank of the Van

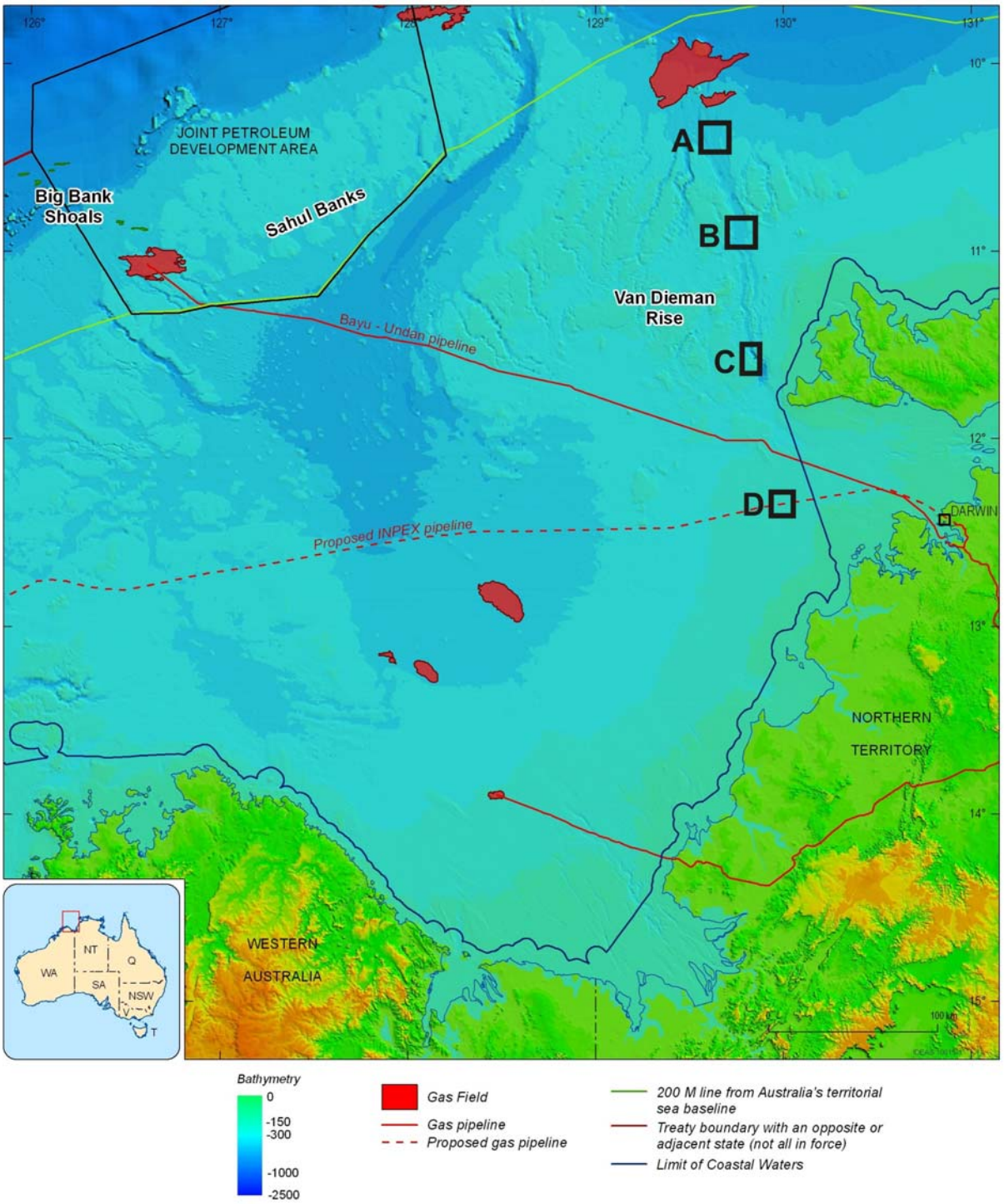

Figure 1.2. Map showing bathymetry of Joseph Bonaparte Gulf and the study areas (A-D) of the survey. Also shown, gas and oil fields, maritime boundaries, existing and planned pipelines, and features referred to in the text.

Diemen Rise, represents bank environments that are interspersed by relatively shallow channels. Area C, located on the top of the Van Diemen Rise, represents an area of bank environments interspersed with a steep-sided and relatively deep channel. Area D, located on the inboard section of the shelf, represents the shallow, relatively flat environments of the inner Joseph Bonaparte Gulf. Area D also coincides with the proposed Inpex gas pipeline route from the Ichthys Field (Browse Basin) to Darwin.

2. Methods

2.1. GENERAL SURVEY METHODOLOGY

The survey comprised a series of geophysical mapping and associated sampling programs in each of the four study areas. Each study area was first surveyed using the multibeam sonar for 100% spatial coverage. Shallow (<70 m) sub-surface data was then collected across each of the study areas with the sub-bottom profiler. The sub-bottom profiler lines were designed to broadly characterise the sub-surface geology and included tie lines. Priority areas were then selected in each of the study areas for physical sampling so as to cover all of the seabed environments mapped and salient sub-surface features. The number and location of sampling stations depended on the number and nature of the seabed environments and local weather conditions. Typically, a suite of operations were conducted at each station, including: CTD, camera tow, vibrocore, boxcore, surface grab, benthic sled, rock dredge, and rotary core (Fig. 2.1a-i). The combination of operations undertaken at each station was determined on a station-by-station basis. Rotary cores were only collected on the bank environments in study area "C". Detailed day-to-day descriptions of the survey activities are contained in the voyage leader's logs in Appendices B and C.

2.2. GEOPHYSICAL DATA ACQUISITION AND PROCESSING

High-resolution bathymetry data were collected over all four study areas using Geoscience Australia's SIMRAD EM3002D (300 kHz) multibeam sonar system (Fig. 2.2). The system was used in dual head mode for all mapping, except for the central parts of Area C where water depths were beyond the limit of the system to resolve in dual head mode. The multi-beam sonar data were processed using Caris HIPS/SIPS V6.0 software. The data were initially processed to compensate for tide and vessel pitch, roll and heave. Variations in the speed of sound through water were corrected using data collected from underway sound velocity profiles and CTD casts collected across the four study areas. These data were then further cleaned by applying software filters that removed any remaining spikes. Finally, a visual inspection of each line was undertaken to manually remove any remaining artefacts and noisy data. A surface (grid) of 4 m horizontal resolution of the processed data was then created for display and analysis.

Seabed reflectance (backscatter) data were processed using CMST-GA MB Process v8.11.02.1 software, a multibeam backscatter processing toolbox co-developed by Geoscience Australia and the Centre for Marine Science and Technology (CMST) at Curtin University of Technology. The fully processed backscatter strengths were corrected for transmission loss and isonification area. The process within the toolbox also involved removal of the system transmission loss, removal of the system model, calculation of the incidence angle and removal of the angular dependence. The angularly equalised backscatter strengths were normalised to the backscatter strength at an angle of 25°.

Shallow (<70 mbsf) sub-surface sediment data were collected using an Applied Acoustics CSP-1200 "Sparker" sub-bottom profiler towed at speed of 5-7 knots (9-13 km hr^{-1}) in calm to slight seas. A total of four channels were recorded with an oil-filled hydrophone eel. The data were processed by applying a band-pass filter (60-600 Hz), removal of false triggers, followed by application of normal move-out corrections. Data from all four hydrophone channels were then stacked, the amplitudes scaled, and a correction applied. Finally, the processed data were then imported into the computer software package GEOFrame for interpretation and analysis. Depths were converted from two-way travel time

Figure 2.1. Sampling gear used on the survey, including: A) CTD, B) niskin bottles in series, C) video camera and characterisation equipment, D) vibrocorer, E) boxcorer, F) Smith-McIntyre grab (shipek grab not shown), G) benthic sled, H) rock dredge, and I) rotary corer.

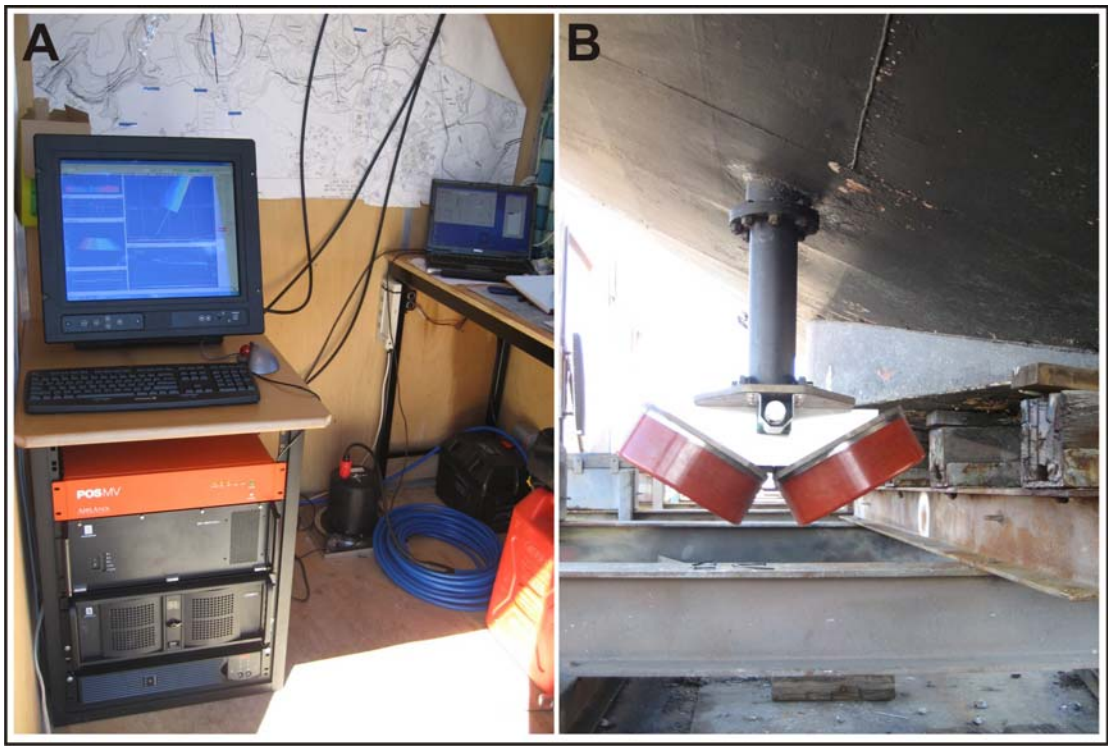

Figure 2.2. Geoscience Australia's SIMRAD EM3002D multibeam sonar system showing: A) motion reference unit, data acquisition and processing units, and B) sonar heads mounted on the ship's hull.

Table 2.1. Summary details of oceanographic moorings deployed during survey SOL4934.

Instrument	Latitude	Longitude	Depth (m)	Time of deployment (UTC)	Time of recovery (UTC)
ADV	-11° 38.679	129° 50.556	22	27/08/09 23:20	21/09/09 12:40
PC-ADP	-11° 35.468	129° 49.563	33	28/08/09 00:35	22/09/09 05:57
BRUCE	-11° 34.235	129° 50.241	50	28/08/09 01:50	22/09/09 06:47
ADCP	-11° 32.783	129° 51.157	100	28/08/09 04:10	22/09/09 09:22

(TWT) using a speed of sound in the water column and shallow sub-surface sediments of 1,500 m s^{-1}. At the time of writing, only preliminary interpretations of the data had been completed. These interpretations will be reported fully in a separate publication.

2.3. OCEANOGRPAHIC DATA ACQUISITION

Wave, tide and ocean currents were recorded using four oceanographic moorings deployed in Area C (Table 2.1). The moorings consisted of a Sontek Acoustic Doppler Velocimeter (ADV), a Sontek Phase-coherent Acoustic Doppler Profiler (PC-ADP), Nortek acoustic doppler velocimeter, two optical backscatter sensors and Seabird SBE-37 Microcat CTD (BRUCE), and an RD Instruments Acoustic Doppler Current Profiler (ADCP). The moorings were deployed at stations 1-4 in a roughly N-S transect that spanned bank (stations 1, 2) and terrace (stations 3, 4) geomorphic features (see Figure 3.9 for locations). The position of the moorings was designed to be representative of sediment transport processes across the complex shallow banks of the Van Diemen Rise.

The ADCP was deployed upward-looking, and measured the mean current velocity at 1 m bin intervals through the entire water column. Measurements were made at 15 second intervals and the vector-averaged stored every 10 minutes. The PC-ADP was deployed downward-looking, and measured the current velocity at 0.05 m bin intervals in the first 1 m above the bed. Measurements were made of waves and time-averaged current velocity at 1 Hz for a burst period of 17 minutes every 6 hours. The ADV was deployed to measure the current velocity at a single point located 1 m above the bed. Measurements were made at three different sampling rates, burst durations and burst intervals to capture turbulence, waves and tides. Turbulence sampling was at 10 Hz, for 10 minutes every 2 hours. Wave sampling was at 2 Hz for 17 minutes every hour. Tide sampling was at 0.2 Hz for 120 seconds every 30 minutes. Each of the moorings was deployed for a period of 26 days. A preliminary visual inspection of the data indicates that each instrument recorded data of good quality that is suitable for standard analysis for extraction of wave-, tide- and ocean-induced currents. At the time of writing, the oceanographic data had not been processed.

2.4. SAMPLES – SEDIMENTOLOGY

The principal aim of the sedimentological component of the survey was to determine the texture and composition of the surface (seabed) and shallow (<3 mbsf) sub-surface sediments for seabed characterisation and shallow geotechnical properties. Unconsolidated surface (seabed) sediments were collected at each station using a Smith-McIntyre grab (Fig. 2.1f). Sub-surface sediments were recovered at select stations using an electric vibrocorer and hydraulic-driven rotary drill corer (Fig. 2.1d, i).

Up to 100 g of bulk sediment was sub-sampled from the grab and the top 0-2 cm from each vibrocore for texture and compositional analysis. For each grab and core sub-sample, the major sediment fractions of gravel, sand and mud were determined (wt%) by washing of a sub-sample though 2,000 μm and 63 μm stainless steel meshes. Bulk particle size

distributions, as well as mean, median, standard deviation, skewness and kurtosis indices (all vol%), were also determined by laser diffraction using a Malvern Mastersizer 2000 particle size analyser. Carbonate concentrations were determined on the bulk sub-sample and the mud and gravel fractions using the carbonate digestion method. Calcium carbonate contents for the gravel fraction were estimated through visual inspection. In all cases, one out of every ten samples was analysed in duplicate for quality assurance purposes.

Vibrocores were cut into 1 m-long sub-sections and rotary drill cores were extracted from the liner and packed into PVC liners. Physical properties wet bulk density (WBD), fractional porosity (FP), and the sediment colour spectrum (RGB) were determined at 0.01 m intervals for all of the vibrocores using a GEOTEK™ MS2 multi-sensor core logger. Split cores were then logged visually to identify major facies and intervals that denote describe characteristic features. At the time of writing the cores had not been fully processed for physical properties for sedimentology.

Rock samples from Area C were recovered with the rock dredge (Fig. 2.1h). Different lithologies were identified and described, then separated out for packing and transport back to the laboratory in Canberra. At the time of writing only preliminary descriptions of the rock samples had been completed.

2.5. SAMPLES – GEOCHEMISTRY

The first aim of the geochemical component of the survey was to characterise the seabed sediments from a geochemical perspective, and thus value-add to the assessments based on sedimentology. The second aim of the geochemistry work was to explore the potential of geochemical surrogates of biodiversity.

Surface sediment samples from the shipek grab were processed for inorganic geochemistry on board the vessel. Where samples were of sufficient size, the sediment was divided into 13 sub-samples for analysis, as follows: sediment texture and composition (particle size distributions & carbonate content), Mg-carbonate (by x-ray diffraction), acid-extractable metals, bulk sediment chemistry (by x-ray fluorescence/x-ray diffraction), pore-water dissolved inorganic carbon (DIC) fluxes (via vial incubation experiments), sediment oxygen demand (SOD), chlorophyll-a, porosity, sediment nutrients (C, N, and their isotopes), and an archive (Table 2.2). SOD (Fig. 2.3) was measured at two different sub-surface depths at each station in order to compare the biological-prediction utility of this parameter at 0-2 cm (the depth of sediment typically used to define surface sediment) and 0-0.5 cm (as per the method described in Ferguson *et al.*, 2007). Porosity and bulk sediment density were also measured at these same two depth intervals because this information was needed to convert the SOD output from mg O_2 consumed L^{-1} to mg O_2 consumed g^{-1} dry sediment.

Surface and shallow (<0.2 m) sub-surface sediments were also recovered in two boxcores (Fig. 2.1e) at stations 008 and 009. A sediment core was collected from each of these box cores by hand-pushing an 84 mm diameter PVC tube into the top of the sample (Table 2.2). Once in the sediment, the core liners were sealed at the bottom with plastic plugs fitted with o-rings and removed through the base of the corer. The cores were then sectioned at 0.02 m intervals on the day of collection. Each section was divided in half. One half was kept as an archive and the other half was analysed for sediment nutrients (TOC, TN and their isotopes) and grain surface area. Core lengths of 0.08 m (station 008) and 0.16 m (station 009) were recovered. Details of the laboratory processing of all sub-samples collected for geochemistry are provided in Table 2.3.

Figure 2.3. Incubator and samples for SOD and vial incubations. Seawater flowed continuously through the incubator maintaining temperatures within 0.1° C of sea surface temperature (SST).

2.6. SAMPLES – WATER QUALITY

The primary aim for conducting water quality analyses was to derive baseline data and to identify key variables that control water quality on the northern Australian shelf. Specifically, the analyses were designed to answer the following questions:

1. Do surface water properties (temperature, salinity, fluorescence, total suspended solids) vary from the outer to inner shelf and, if so, can this variability be explained by different surface water currents?
2. What controls the level of total suspended solids and light penetration through the water column (sediment re-suspended from the seabed or land-derived sediment)?
3. What carbonate minerals are present in the water and seabed sediments and will these minerals likely dissolve due to increases in ocean acidification predicted over the next 50 to 100 years?

Temperature, conductivity (≈salinity) and fluorescence of the surface water (<5 m below the sea surface) was recorded every 10 seconds using the ship's Seabird Electronics SBE-21 thermosalinograph, which was operative at most times throughout the survey. Additionally, conductivity, temperature and depth casts were also collected at select stations using a Seabird Electronics SBE-19 plus CTD deployed using the hydrographic wire (Fig. 2.1a). At stations where the CTD casts were taken, surface water and bottom water (within 5 m of seabed) samples were also collected using 5 litre niskin bottles attached in series to the hydrographic wire (Fig 2.1b). Four niskin bottles were used for surface water samples and three bottles used for bottom water samples. For the bottom water samples, all of the water collected was combined into a large container before sub-sampling. For the surface water samples, water from three niskin bottles was combined in a large container while the water

Table 2.2. Summary of all the geochemical sub-samples acquired during survey SOL4934.

Sample	Archive	Texture/ composition	Mg-Carbonate	Extractable metals	DOP	XRF/ XRD	Vial Incubation	SOD (0-0.5 cm)	SOD (0-2.0 cm)	Porosity (0-0.5 cm)	Chlorophyll-*a*	Porosity/ Chlorins	Sediment nutrients
004/GR004	§	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
005/GR005	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
006/GR008	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
007/GR009	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
008/BC001		Y											
008/GR012	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
009/BC002		Y											
009/GR014	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
010/GR016	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
011/GR018	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
012/GR020	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
013/GR022	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
014/GR024	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
018/GR026	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
019/GR028	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
021/GR030	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
022/GR032	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
023/GR034	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
024/GR036	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
025/GR038	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
026/GR040	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
027/GR042	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
028/GR044	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
029/GR046	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
030/GR048	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
031/GR050					Y	Y	Y*	Y			Y	Y	Y

Sample	Archive	Texture/ composition	Mg-Carbonate	Extractable metals	DOP	XRF/ XRD	Vial Incubation	SOD (0-0.5 cm)	SOD (0-2.0 cm)	Porosity (0-0.5 cm)	Chlorophyll-*a*	Porosity/ Chlorins	Sediment nutrients
002/GR053					Y	Y	Y*	Y			Y	Y	Y
032/GR055			Y		Y	Y	Y*	Y			Y	Y	
001/GR057					Y	Y	Y*	Y			Y	Y	
033/GR059	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
034/GR061		Y								Y	Y		
035/GR063	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
036/GR063		Y	Y		Y	Y	Y*	Y	Y	Y	Y	Y	Y
037/GR067	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
038/GR070	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
039/GR072	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
040/GR076	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
003/GR076	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
041/GR078								Y		Y	Y		
042/GR080		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
043/GR082		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
044/GR084		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
045/GR086		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
046/GR088		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
047/GR090		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
048/GR092		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
049/GR094		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
050/GR096		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
051/GR098		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
052/GR100		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
053/GR102		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
054/GR104		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
055/GR106		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Sample	Archive	Texture/ composition	Mg-Carbonate	Extractable metals	DOP	XRF/ XRD	Vial Incubation	SOD (0-0.5 cm)	SOD (0-2.0 cm)	Porosity (0-0.5 cm)	Chlorophyll-*a*	Porosity/ Chlorins	Sediment nutrients
056/GR108		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
057/GR110		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
042/GR080		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
043/GR082		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
044/GR084		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
045/GR086		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
046/GR088		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
047/GR090		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
048/GR092		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
049/GR094		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
050/GR096		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
051/GR098		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
052/GR100		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
053/GR102		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
054/GR104		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
055/GR106		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
056/GR108		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
057/GR110		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
058/GR112		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
059/GR114		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
060/GR115		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

§ The sample designated for archive was used for grain size and carbonate at this site.

** TCO_2 concentrations and pH were measured at T=0 at these sites in order to estimate TCO_2 pool sizes and pore water pH. There was insufficient sediment to measure TCO_2 concentrations ~24 hours later at T=1. Therefore benthic TCO_2 fluxes could not be calculated at these sites.

Table 2.3. Details of geochemistry sub-sample laboratory processing.

Analysis	Shipboard processing	Pre-processing (GA Lab.)	Analysis method (GA Lab.)
A) Shipek Grab			
Archive (bulk sample)	Bulk sub-sample collected in plastic vial and frozen.	N/A	N/A
Texture/Composition	Bulk sub-sample double-bagged and refrigerated.	H_2O_2 removal; Sieve to remove gravel.	Sieve and laser diffraction; carbonate digestion
(a) Extractable metals (b) Bulk metal analysis (c) XRD (d) P-fractionation	Sub-samples in acid-washed falcon vials. Pore waters removed within 1 hr of collection then frozen.	Drying/grinding; PSZ mill.	(a)1M HCl extraction (4 hrs) (b) XRF/ICP AES (c) XRD with fluorite (d) Sequential extractions
(a) Sediment TOC and TN (& isotopes) (b) Particle surface area	Sub-samples in falcon vials. Pore waters were removed within 1 hr of collection then frozen.	(a) Acid treatment, drying and grinding. (b) Drying and grinding.	(a) Mass spectrometry (b) Surface Area Analyser
Archive (pore waters removed)	Sub-samples in falcon vials. Pore waters were removed after ~24 hrs incubation (dark) at SST than frozen.	N/A	N/A
Vial Incubation (TCO_2 analyses)	Sub-sample 1: pore waters were filtered (0.45 µm) into gas-tight vials within 1 hr (T =0). Sub-sample 2: pore waters were filtered (0.45 µm) into gas-tight vials after ~24 hrs incubation at SST (T =1).	N/A	DIC analysis of extracted pore waters. Final flux determinations will incorporate porosity/bulk density data.
SOD (0-0.5 cm)	Bulk sub-sample (4 ml) incubated for ~24 hrs at SST.	N/A	Final flux determinations will incorporate porosity/bulk density data.
SOD (0-2.0 cm)	Bulk sub-sample (6.5 ml) incubated for ~24 hrs at SST.	N/A	Final flux determinations will incorporate porosity/bulk density data.
Porosity (0-0.5 cm)	Bulk sub-sample frozen.	Freeze-drying and weighing.	Weight difference.
Chlorophyll-a (0-0.5 cm)	Bulk sub-sample bagged and frozen.	Thawing to room temperature.	Acetone extraction. Spectrophotometry
(a) Porosity (0-0.2 cm) (b) Chlorins	Bulk sub-sample collected into plastic vial then frozen.	(a) Freeze-drying and weighing. (b) Freeze-drying, weighing and grinding.	(a) Weight difference. (b) Triple Acetone Extraction/Fluorometric determination (Schubert et al., 2005).
DOP	Bulk sub-sample frozen.	Thawed in oxygen-free atmosphere.	TBD
B) Box core			
(a) Sediment TOC and TN (b) Bulk metal analysis	Pore waters removed then frozen.	(a) Acid treatment, drying and grinding. (b) Drying and grinding (PSZ mill).	(a) Mass spectrometry (b) XRF/ICP AES
DOP	Bulk sub-sample frozen.	Thaw in an oxygen-free atmosphere.	TBD

in the fourth niskin bottle was separated for additional analyses (Table 2.4). Additionally, a depth profile of photoactive radiation (PAR) was recorded to a maximum of 30 m below the sea surface at the CTD stations, where operations allowed. Surface water samples were processed as follows:

1. Total suspended solids (TSS) – GF/C filter,
2. X-ray diffraction (XRD) – filtered through 0.45µm cellulose acetate filter paper,
3. Chlorophyll a (Chl-a) – GF/C filter in low light,
4. Grain size – filtered through 0.45µm cellulose acetate filter paper.

In addition, the surface water from the fourth niskin bottle was sub-sampled into small volume bottles with minimum atmospheric mixing and no headspace for analysis of pH, total alkalinity, Gilvin absorbance and filtration for dissolved inorganic carbon (DIC). The sample for DIC analysis was prepared by filtering using a 0.45µm syringe filter into a 3 mL exetainer pre-dosed with a drop of saturated mercuric chloride. Bottom water samples were processed as follows:

1. Total suspended solids (TSS) – GF/C filter,
2. X-ray diffraction (XRD) – filtered through 0.45µm cellulose acetate filter paper.

All filter papers were frozen on board and transported back to Geoscience Australia's laboratory for final analysis.

2.7. SAMPLES – BIOLOGY

Biological samples were collected to establish a regional-scale inventory of the benthic biota for representative seabed environments of the eastern Joseph Bonaparte Gulf. Secondly, the samples were processed to generate biological data that could be linked with physical seabed properties to identify factors that may be driving patterns in benthic biodiversity.

Epifauna were sampled using the benthic sled (Fig. 2.1g). The sled was towed along the seabed for approximately 100 m to ensure an adequate and representative sample was collected. All material was removed from the cod-end, separated into broad taxonomic groups (i.e., sponges, gorgonians, crinoids, etc.) and each group weighed, as per the methods described in Brooke *et al*. (2009). Large animals (e.g. massive sponges) were grouped according to morphospecies, photographed, weighed, and either frozen for bio-prospecting (Leg 1) or discarded (Leg 2) after a small sub-sample (taxonomic voucher) was preserved in ethanol for later identification and archived with the Northern Territory museum. Smaller specimens were photographed and preserved in formalin (polychaetes, ascidians) or ethanol (all other taxa). Species richness was estimated onboard according to morphospecies. All samples from the sled were sent to the AIMS for storage and preliminary identification, except for a few polychaete samples that had already been identified onboard and lodged with the Northern Territory Museum for archival. Sponges, octacorals, ophiuroids and molluscs will be sorted and sent to the Museum of Victoria and Northern Territory Museum for identification and archival. A taxonomic workshop is planned for 2010 to begin this process for the major faunal groups.

Seabed infauna were collected using the Smith-McIntyre grab (Fig. 2.1f). Each residual sample (after a small amount had been taken for analysis of sediment texture and composition – see above) was weighed and processed. Samples were elutriated for five minutes over a 500 µm sieve to collect animals lighter than the sediments. Animals retained on the sieve were preserved in ethanol, except for visible polychaetes which were removed by hand, fixed in formalin and then sent to the Northern Territory Museum. (Identifications for these animals have already been completed although not reported here). In order to account for heavier animals such as molluscs which may not be collected during elutriation,

Table 2.4. Summary of water quality sample processing undertaken during survey SOL4934, excluding wet sediment samples.

Study Area	Sample Id	Sample type	TSS	XRD	GRAIN	Chl-a	Alk_T	pH	Gilvin	DIC	PAR	Sal/ EC
A												
	005CTD005_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	005CTD005_WS73A	B	Y	Y	N							
	008CTD006_WS0A	S	Y	Y	N	Y	Y	Y	Y	Y	Y	
	008CTD006_WS87A	B	Y	Y	N							
	009CTD007_WS0A	S	Y	Y	N	Y	Y	Y	Y	Y	N	
	009CTD007_WS89A	B	Y	Y	N							
	014CTD008_WS0A	S	Y	Y	N	Y	Y	Y	Y	Y	Y	
	014CTD008_WS77A	B	Y	Y	N							
	Station 018	I	Y	Y	N	Y	Y	Y	Y	Y	N	
	A-B_In_Transit	I	Y	Y	Y	Y	Y	Y	Y	Y	N	
B												
	021CTD009_WS0A	S	Y	Y	N	Y	Y	Y	Y	Y	Y	
	021CTD009_WS19A	B	Y	Y	N							
	024CTD010_WS0A	S	Y	Y	N	Y	Y	Y	Y	Y	N	
	024CTD010_WS100A	B	Y	Y	Y							
	Area_B_algal_bloom	I	Y	Y	N	Y	Y	Y	Y	Y	N	
	027CTD011_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	027CTD011_WS68A	B	Y	Y	Y							Y
	Transit_from_B_#1	I	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Transit_from_B_#2	I	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
C												
	Transit_to_C_#3	I	Y	Y	Y	Y	Y	Y	N	Y	N	Y
	001CTD001_WS0A	I	Y	Y	Y	Y	Y	Y	Y	Y	N	
	030CTD012_WS0A	S	Y	Y	N	Y	Y	Y	Y	Y	N	Y
	030CTD012_WS40A	B	Y	Y	N							Y
	032CTD013_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	032CTD013_WS60A	B	Y	Y	N							N
	036CTD014_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	036CTD014_WS192	B	Y	Y	N							Y
	038CTD015_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	038CTD015_WS62A	B	Y	Y	N							Y
D												
	043CTD018_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	043CTD018_WS44A	B	Y	Y	N							Y
	048CTD019_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	048CTD019_WS38A	B	Y	Y	N							Y
	Station_048	I	Y	Y	Y	Y	Y	Y	Y	Y		Y
	049CTD020_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	049CTD020_WS41A	B	Y	Y	N							Y
	053CTD021_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	053CTD021_WS37A	B	Y	Y	N							Y
	057CTD022_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	057CTD022_WS35A	B	Y	Y	N							Y
	059CTD023_WS0A	S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	059CTD023_WS36A	B	Y	Y	N							Y
Total			**42**	**42**	**19**	**25**	**25**	**25**	**25**	**25**	**13**	**25**

S = Niskin surface; B = Niskin bottom; I = Ship intake (surface).

the coarse fraction was sorted by hand and 25 ml of sieved sediment was preserved in ethanol for laboratory processing for microscopic animals. In the laboratory, infaunal animals were separated into taxonomic groups, identified to lowest possible taxonomic level, and photographed. Polychaetes and molluscs are being sent to the relevant specialist taxonomists at the Northern Territory Museum, and echinoderms to the relevant taxonomist at Museum of Victoria for identification and archival. All other taxa will be sent for identification and archival to appropriate institutions pending agreements. At the time of writing, approximately half of the infaunal samples had been fully processed.

Epifauna and broad-scale sedimentology and topography of the seabed were captured by a series of underwater video tows and still images. The underwater video and still cameras were towed 1-2 m above the seabed for ~500 m (Fig. 2.1c). Live video fed to the surface was monitored and characterised according to the scheme of Anderson *et al*. (2008). In this classification scheme descriptions of substrata, relief and biota were made every 15 seconds using a pre-programmed keyboard. Because they were the dominant taxa at most stations this classification system used definitions of sponge and octocoral coverage in which 'sparse' was defined as 1 or less individual of each group per second of footage (<5% total area), 'moderate' was defined as 2-5 individuals per second of footage (5-49%), and 'high' was defined as >5 individuals per second of footage (50%+). These classifications were not relative to other taxonomic groups observed in the video, but rather to within-taxa differences at other stations. After the survey, the video footage for all stations was re-characterised using a classification system in which the coverage of sponges and octacorals was defined according to total percent cover among all taxonomic groups. This was done in order to standardise methods with previous video characterisations and allow comparisons between other surveys on the Australian shelf (e.g. GA Survey SOL4769 – Carnarvon Shelf, WA). Upon retrieval of the cameras, the still images were downloaded and renamed by station and a sequential image number. Images of interesting or representative habitat and biota were singled out for further analysis and description. At the time of writing, the still images had not been analysed for sponge and octacoral morphology and percent cover.

3. Preliminary Results

Brief descriptions and preliminary interpretations of the results are provided here that mainly reflect observations gathered during the survey. These broad observations represent both the current state of knowledge gathered on the survey and degree to which the data have been processed and analysed. They are included here to provide a general overview of the physical, chemical and biological seabed characteristics of the four study areas. Detailed descriptions of the results from the further specific analyses detailed in this report and further interpretations will be available in subsequent publications. Including in these future publications will be a report that incorporates the data collected on the survey with regional datasets.

The total area mapped over the four study areas (A-D) was 1,154 km^2 (Table 3.1). Greatest coverage was obtained in Area A due to the relatively large area of deep (<100 m) shelf, followed by areas B and D, with moderate water depths (Figs 3.1, 3.5, 3.13). Smallest coverage was obtained in Area C due to the predominance of relatively shallow (<25 m) terraces and banks and a deep channel (>200 m) which attained depths beyond the limit of the multibeam system to resolve (Fig. 3.9). However, shallowest water depths occur over Moss Shoal in Area B which shoals to within 5 m of the water surface.

Area C exhibits the greatest range in backscatter (seabed reflectance) values (Figs 3.2, 3.6, 3.10, 3.14), coinciding with the greatest variation in depth and seabed complexity. Area D exhibits the smallest range in backscatter values. Generally, across all four study areas, higher backscatter values were associated with channels and depressions, and lower backscatter values were associated with terraces and banks. Interestingly, a distinct splayed pattern radiating toward the NE region of study area B and a NW-SE trending pattern of alternating high and low backscatter values was recorded in Area D (Figs. 3.6, 3.14). The cause of both of these patterns is unknown. Certainly, both patterns are not related to water depth as neither is visible in the multibeam data from the two study areas. It is possible that these patterns in the backscatter reflect changes in seabed sediment character, associated with the local acceleration of ocean currents (tides).

Geomorphic features present are: bank, terrace, deep/hole/valley, ridge, shelf and plain (Table 3.2). Geomorphic units super-imposed on these features are: depressions, crests, platforms, flanks, floors, scarps, runnels, sand waves and ridges. Area C comprised the most complex and varied geomorphology of the four study areas with three and nine types of geomorphic feature and units present, respectively. Area D was the only study area to contain geomorphic elements: pockmarks. In all cases, terraces and banks comprised the greatest area of the geomorphic features present. Banks along with deep/hole/valley were the most common feature present. Interestingly, acoustic scattering is observed in the water column above the pockmarks (Fig. 3.15). The cause of the scattering is unknown, although (fluid?) escape features are identified below pockmarks in several of the sub-bottom profiles (Fig. 3.16).

A total of 340 line-kms of sub-bottom profiler data were also collected from the four study areas (Figs. 3.1, 3.5, 3.9, 3.13). The amount of sub-bottom penetration varied significantly in the study areas, and ranged from <1 m to >140 m. Generally, greatest penetration occurred in regions of relatively flat seabed; conversely least sub-bottom penetration occurred over relatively rugged ground. Multiple sub-bottom reflections were recorded at each of the four study areas. Sub-bottom reflections were least distinct in Area C, where the relatively high acoustic impedance of the carbonate banks and terraces weakened the sub-surface signals. Consequently, sub-bottom reflection were more distinct (though not

Table 3.1. Details of multibeam coverage by study area.

Study area	Area (km)	Area (%)
A	426	37
B	378	33
C	160	14
D	190	16
Total	**1154**	**100**

Table 3.2. Geomorphology of study areas A-D.

Study area	Province	Feature	Unit	Element
A	Shelf (outer)	Terrace Deep/hole/valley	Flank Floor Platform Scarp	
B	Shelf (outer)	Bank Deep/hole/valley Ridge Shelf	Flank Floor Plain Platform	
C	Shelf (middle)	Bank Deep/hole/valley Terrace	Crest Depression Flank Floor Platform Ridge Runnel Sand wave Scarp	
D	Shelf (inner)	Deep/hole/valley Plain	Depression Flank Floor Platform	Pockmark

necessarily more numerous) in Areas A, B, and D, which are characterised mostly by relative flat and sedimented seabed environments. Screen-captured images of all the sub-bottom profiles are contained in Appendix D.

Sub-bottom profiles for Area A show several northward-dipping sub-bottom reflections beneath the undulating seabed surface (Fig. 3.3). These reflections bound regions of relatively homogenous seismic character (interpreted as sand banks) and of indistinct but continuous internal reflections (interpreted as channel fill). Similar northward-dipping sub-bottom reflections also occur at similar depths in the Arafura Sea, 500 km further east, which have been inferred to represent a progradational tertiary sequence of siliciclastics (Logan *et al*., 2006). The reflections in Area A are deeper than could be directly sampled, however siliciclastic (mudstone/siltstone) clasts were recovered in grab samples from the floor and flanks of the over-deepened channel in Area C (north-dipping reflectors are also present there—see below), where the morphology and sub-bottom profiles show that these rocks crop out at the seabed surface. A distinct, continuous undulating reflector forms the base of these seismic packages, which is interpreted to be the pre-Holocene surface.

Sub-bottom profiles for Area B show several distinct sub-bottom reflections that are sub-parallel to the undulating seabed surface (Fig. 3.7). Sub-bottom reflections are masked beneath Moss Shoal by the high acoustic impedance of the carbonate shoal. To the east of Moss Shoal, the profiles indicate a package of sediment, which may represent a Holocene

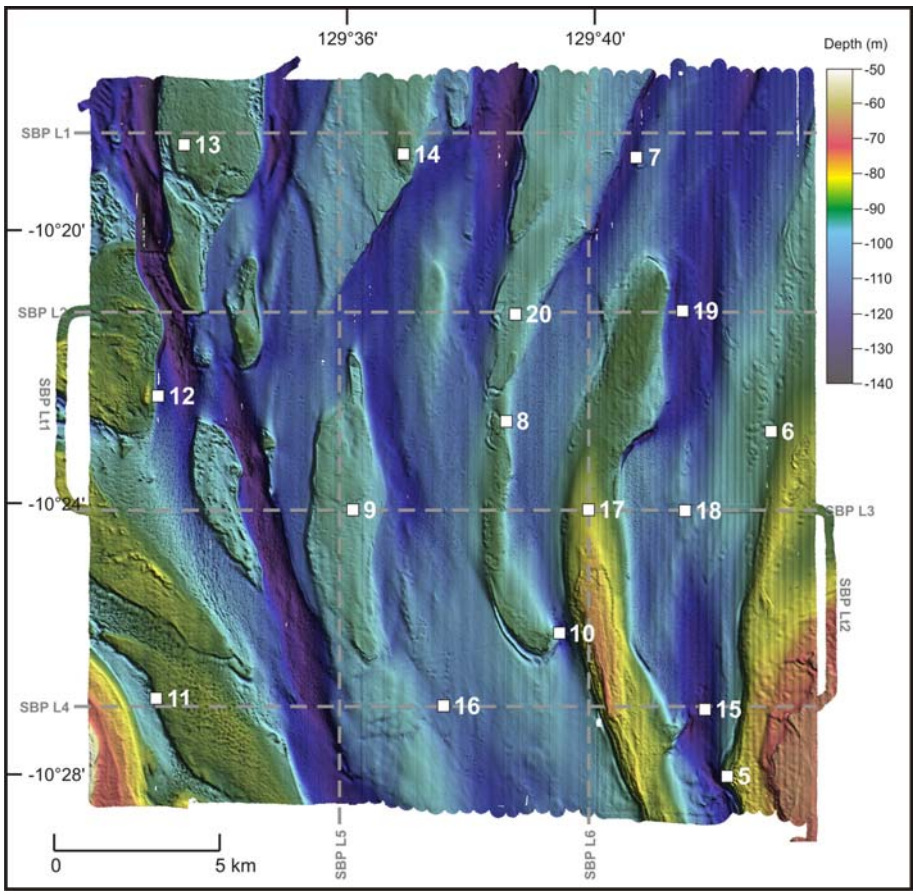

Figure 3.1. False colour bathymetry image of Area A. This area, located on the outer shelf, is characterised by an alternating series of elongate deep/hole/valleys and terraces. Sub-bottom profiler lines and sampling stations are also shown.

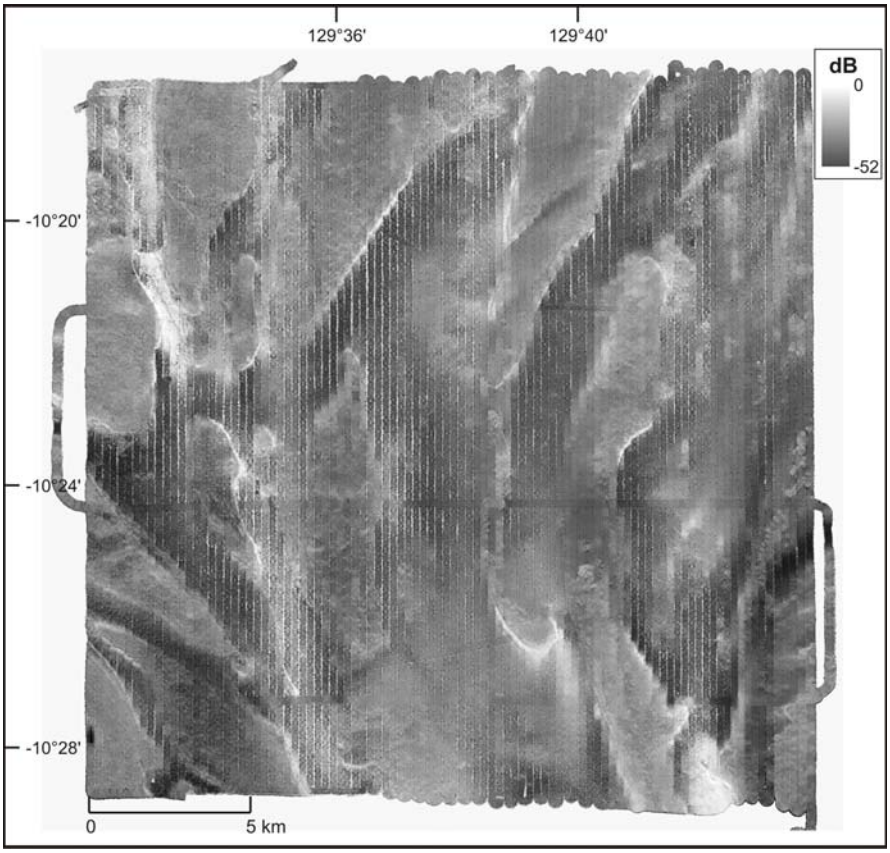

Figure 3.2. Greyscale image of seabed reflectance (backscatter) from Area A. Note that generally the terraces have lowest backscatter values and deep/hole/valleys have relatively higher values.

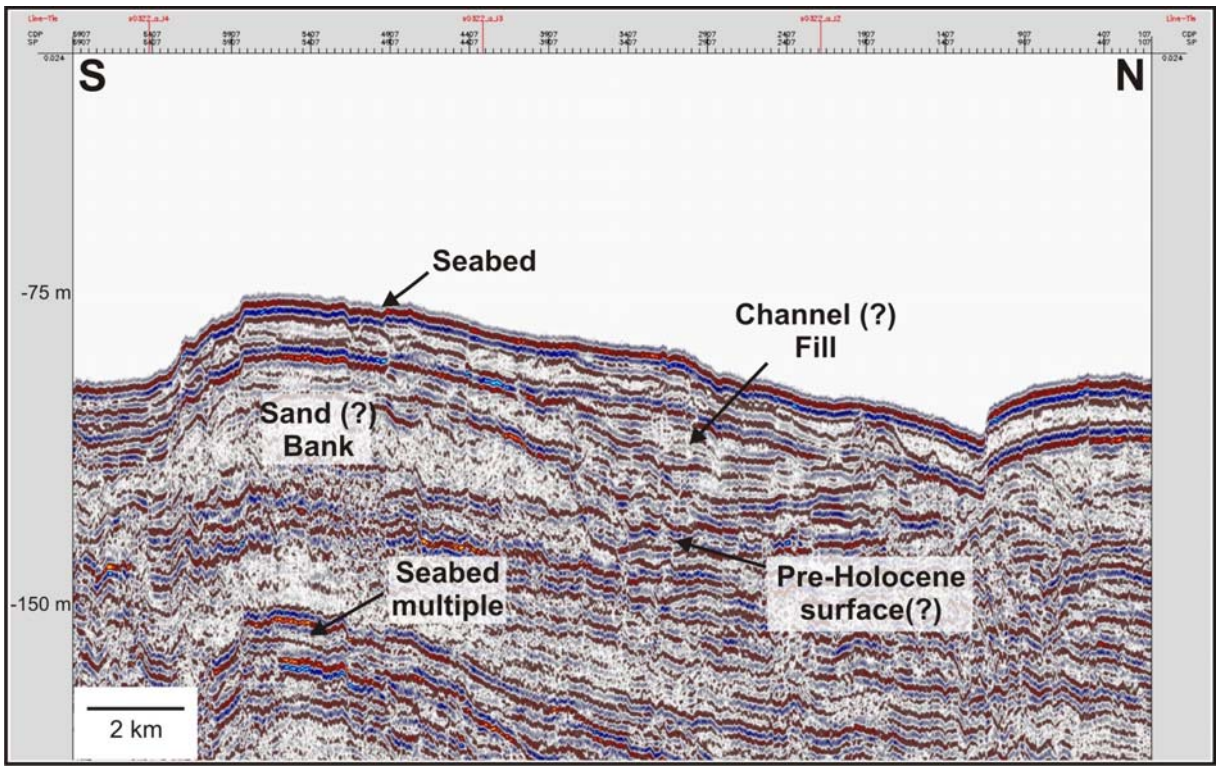

Figure 3.3. Profile of SOL4934_A_SBPL6 showing multiple sub-bottom reflectors that are characteristic of the area, and their preliminary interpretations. Depths are in metres below sea surface assuming a sound velocity in shallow sediments and water column of 1,500 m s^{-1}.

Figure 3.4. Typical sled haul from terraces in Area A comprising predominantly sponges and octacorals. Composition of sled hauls generally reflected biota seen in the video footage.

talus deposit, similar in origin to those seen next to submerged reefal platforms across northern Australia (cf. Heap *et al.*, 2009).

Table 3.3. Operations undertaken at each station in Area A.

Stn	CTD*	Light	CAM	GR**	BS	DR	BC	VC	RD
05	5	1	1	5, 6	2				
06			2	7, 8	3				
07			3	9, 10	4				
08	6	2	4	11, 12	5		1		
09	7		5	13, 14	6		2		
10			6	15, 16	7	1			
11			7	17, 18	8				
12			8	19, 20	9				
13			9	21, 22	10				
14	8	3	10	23, 24	11				
15								1	
16								2	
17								3	
18				25, 26				4	
19				27, 28				5	
20								6	

* CTD includes water (niskin) samples at sea surface and seafloor, and PAR.
** Grabs include Smith-McIntyre and shipek.

In Area C, numerous sub-parallel northward (seaward)-dipping reflections below the carbonate banks and terraces are truncated by the over-deepened shelf channel and can be traced beneath the bank to the north (Fig. 3.11). The sub-bottom profiles also show that the floor of the channel contains a sequence of sediment fill. Given that the channel is over-deepened with respect to the elevation of the last glacial sea level it is likely that this sediment fill represents deposition in a brackish (marginal marine) or lacustrine environment. Vibrocores collected from the floor of the channel terminated in de-watered sticky grey clay, which we infer to be brackish sediments. Further analysis of the core material will help ascertain the age and origin of the channel fill sediments.

Sub-bottom profiles for Area D show that the pockmarks are underlain by depression structures that are bounded by seismic packages of relatively homogenous (transparent) seismic character (Fig. 3.16). Similar sub-bottom reflections have been imaged and sampled on the inner to middle shelf of the Arafura Sea and which represent fluid and gas escape features (Logan *et al.*, 2006). Such an interpretation is entirely consistent with the sub-bottom reflections recorded in Area D, although the origin and existence of any natural seepage is speculative without direct sampling. Below these features, deeper in the section, is a distinct reflector with an undulating surface. This surface also crops out near the seabed along the flanks of the channels and could represent the pre-Holocene land surface that was exposed during the last glacial.

A total of 63 sampling stations were occupied during the survey over the four study areas (Figs. 3.1, 3.5, 3.9, 3.13). Samples were collected from the full spectrum of seabed geomorphic features mapped (see Table 3.2). Different combinations of sampling devices were used at each station depending on the sampling objectives for that feature (Tables 3.3-3.6). Typically, a camera tow was completed at each station to support characterisation of the seabed by the physical properties and biota.

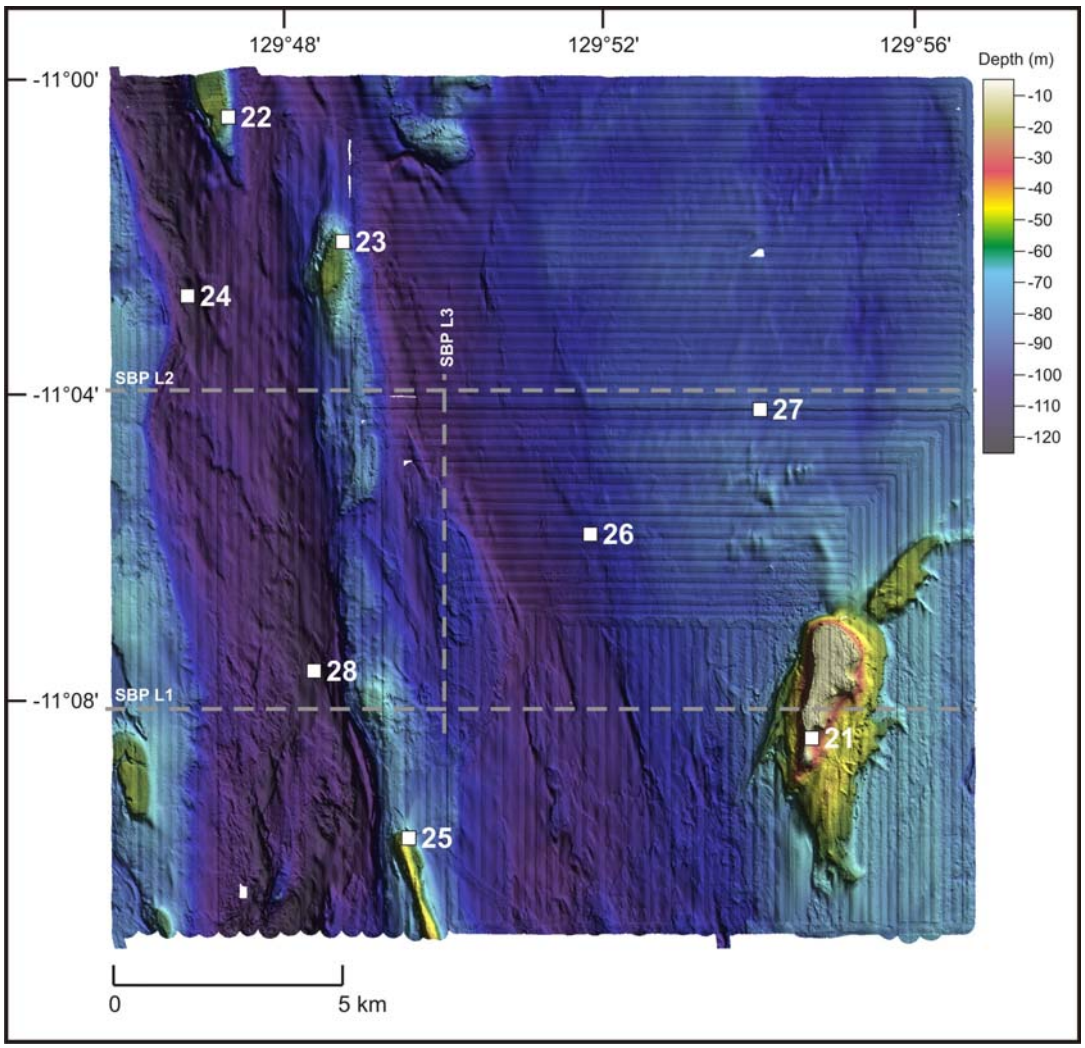

Figure 3.5. False colour bathymetry image of Area B. This area, located on the outer shelf, is characterised by relatively deep elongate deep/hole/valleys and shallower banks and ridges. Moss Shoal, a known feature located in the SE corner of the study area is the shallowest feature mapped during the survey with the summit attaining 5 m below the water surface. Sub-bottom profiler lines and sampling stations are also shown.

Seabed sediment across all four study areas was overwhelmingly composed of carbonate grains. The seabed comprised well sorted coarse to medium sands to very-poorly sorted sandy mud. Generally, coarser sediments were found on the carbonate banks and the finer sediments occurred on the inner shelf (Area D) and deep channel (Area C). Despite the wide variety of sediment types collected, most of the seabed was composed of poorly sorted carbonate muddy sands, characteristic of the relatively energetic oceanographic conditions of this upper meso- to macro-tidal shelf. Gravel clasts (mostly coralline algae) made up a relatively minor component of the bulk sediment. Rounded to sub-rounded lithic grains and clasts were also recovered from the deep channel in Area C.

Study areas A, B, and C were characterised by rich sponge and octacoral gardens on the banks, ridges and some terraces (Figs. 3.4; 3.8, 3.12). These gardens were not continuous across video transects with some transects showing relatively barren patches interspersed with moderate to high densities of sessile epifauna. Higher abundances and richness of octacorals was observed on the ridges and terraces in areas A and B. In contrast, bank, terrace and ridge features in Area C were characterised by a greater proportion of sponges compared to the other dominant taxa. Generally, a high diversity of species, as well as a large biomass of reef-forming species and morphotypes (e.g. lithistids, halichondrids, and *Xestospongia*) were observed in the sponge taxa. Plains and deep/hole/valley features in areas A, B and C were characterised by scattered epifauna and the seabed showed various levels of

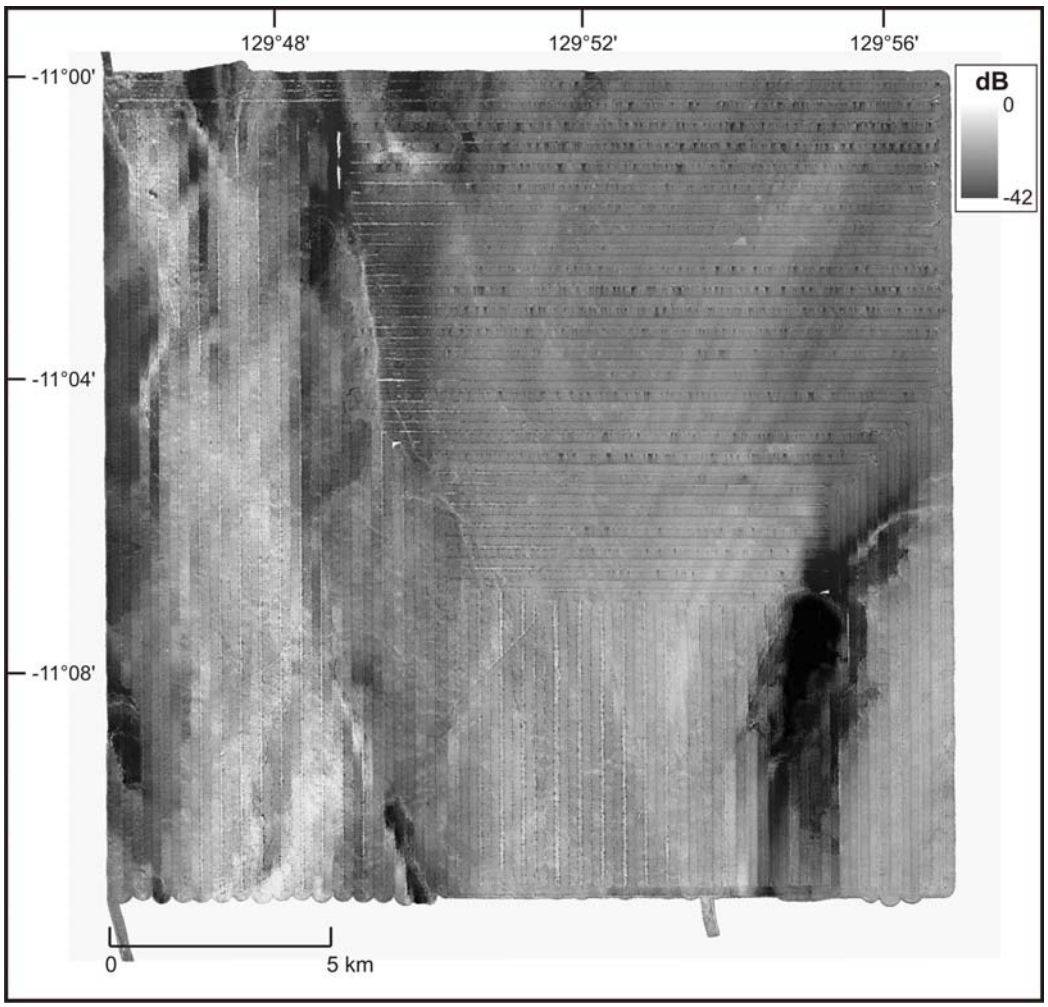

Figure 3.6. Greyscale image of seabed reflectance (backscatter) from Area B. Note that generally banks have lowest backscatter values and deep channels have relatively higher values. Interestingly, a splayed pattern of relatively lower backscatter is present radiating out towards the NE sector of the study area. The cause of this pattern is unknown, but does not appear to be associated with bathymetry. Possibly, it is associated with shelf currents (tides) in this area.

Table 3.4. Operations undertaken at each station in Area B.

Stn	CTD*	Light	CAM	GR**	BS	DR	BC	VC	RD
21	9	4	11	29, 30	12				
22			12	31, 32	13				
23			13	33, 34	14				
24	10		14	35, 36					
25			15	37, 38	15				
26			16	39, 40	16				
27	11			41, 42				7	
28				43, 44				8	

* CTD includes water (niskin) samples at sea surface and seafloor, and PAR.
** Grabs include Smith-McIntyre and shipek.

bioturbation from infauna. Area D was characterised by sparse to moderate abundances of epifauna and a relatively rich infauna, dominated by polychaetes and amphipods (Fig. 3.17). Although water depths over the banks, ridges, terraces and parts of the sediment plains were shallow enough to allow light to penetrate to the seabed and presumably support

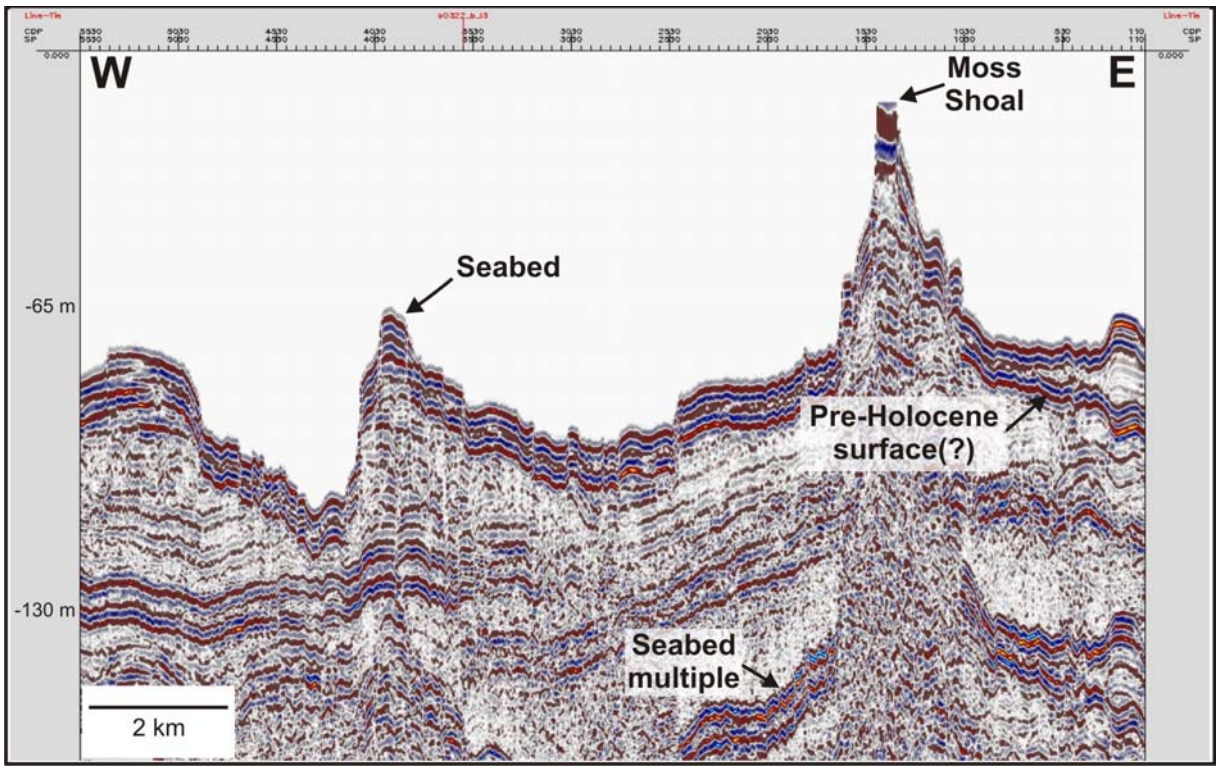

Figure 3.7. Profile of SOL4934_B_SBPL1 showing multiple sub-bottom reflectors that are characteristic of the area, and their preliminary interpretations. Depths are in metres below sea surface assuming a sound velocity in shallow sediments and water column of 1,500 m s^{-1}.

Figure 3.8. Typical sled haul from banks and ridges in Area B comprising predominantly sponges and octacorals. Composition of sled hauls generally reflected biota seen in the video footage.

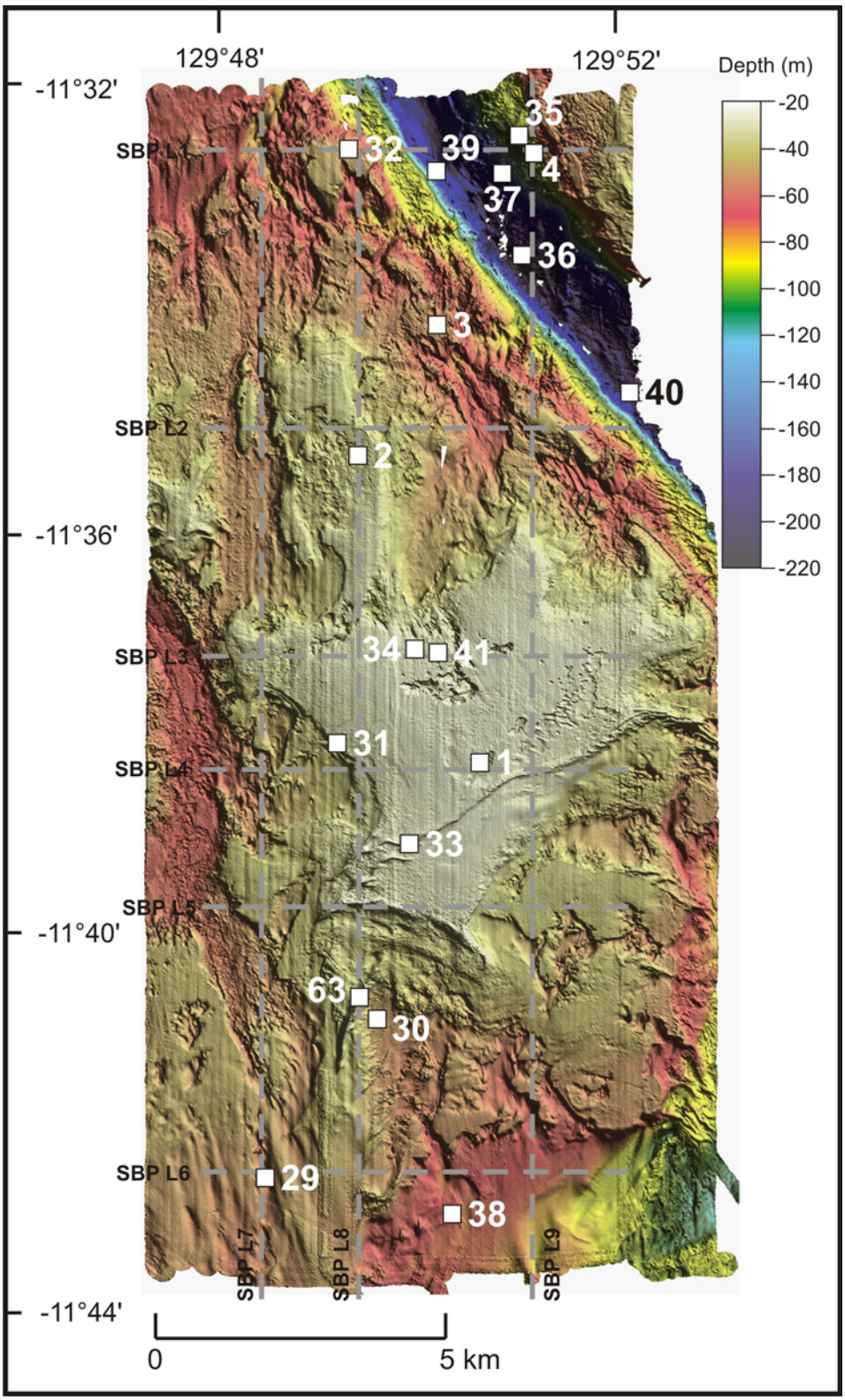

Figure 3.9. False colour bathymetry image of Area C. This area, located on the middle shelf, is characterised by a relatively complex (rugged) seabed geomorphology comprising discontinuous shallow carbonate banks and terraces and a very deep deep/hole/valley. At >200 m, the valley in this study area is the deepest valley mapped in detail on the northern Australian shelf, rivalled in depth only by the Malita Shelf valley which drains the Joseph Bonaparte Gulf and separates the Van Diemen Rise from the Sahul Banks further to the NW. Superimposed on the geomorphic features are several units, namely: sand wave fields (including comet marks), scarps, depressions and partially-consolidated carbonate ridges. The crest of the largest ridge shoals to within 20 m of the water surface. Sub-bottom profiler lines and sampling stations are also shown.

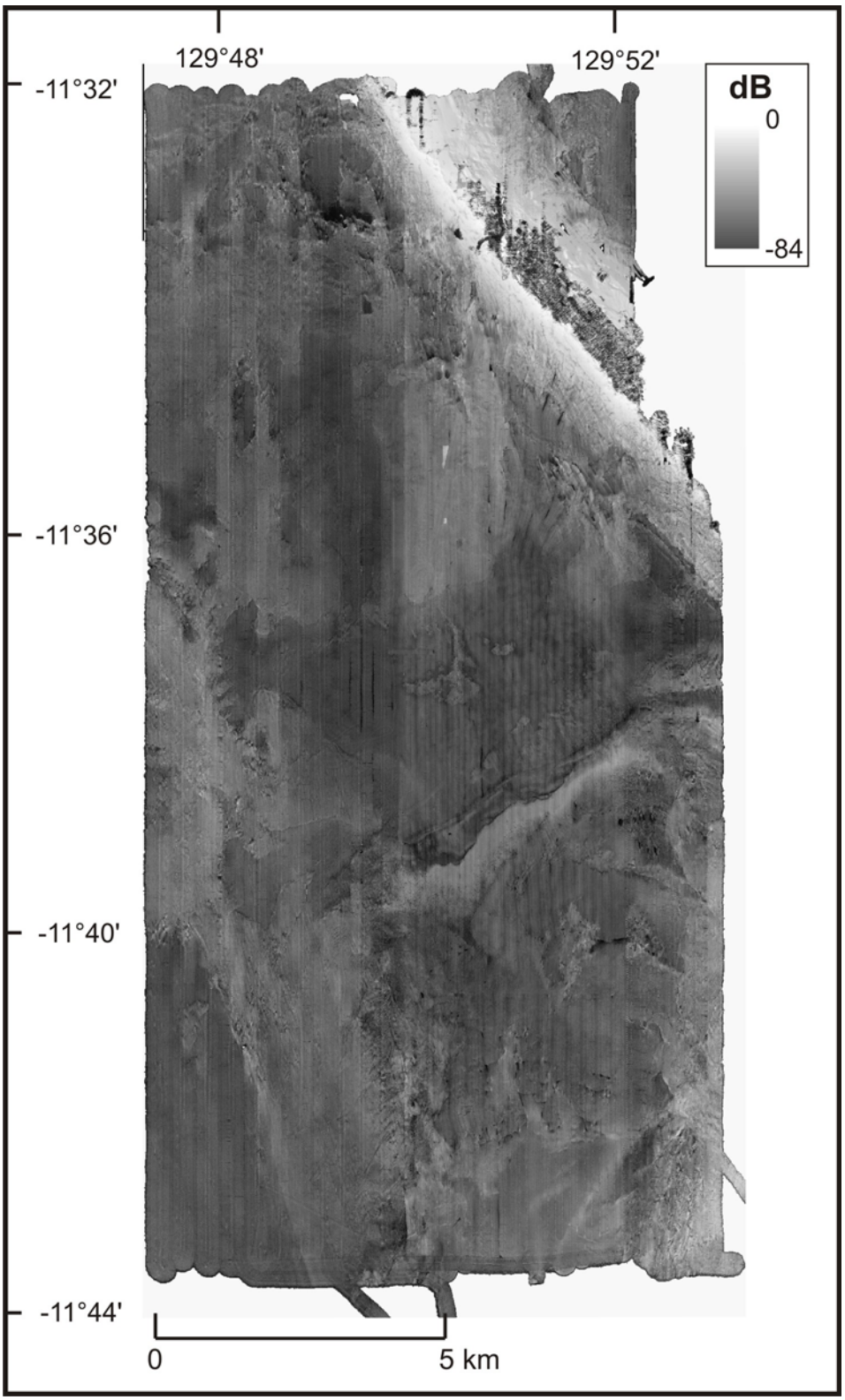

Figure 3.10. Greyscale image of seabed reflectance (backscatter) from Area C. Note that generally the terraces have lowest backscatter values and deep/hole/valleys have relatively higher values, particularly the flanks and terraces in the deep shelf valley.

photosynthesis, very little algae were observed. Only a solitary *Halimeda* specimen was recovered in a benthic sled from Area B (station 21). This is in contrast to the Sahul Banks, which is a similar complex of banks, channels and terraces on the outer shelf to the northwest that is dominated by *Halimeda*. Similarly, scleractinian corals (*Acropora* sp.) were only observed in Area D, an area characterised by sandy mud, strong tidal currents and relatively turbid water.

Table 3.5. Operations undertaken at each station in Area C.

Stn	CTD*	Light	CAM	GR**	BS	DR	BC	VC	RD
01	1		22	56, 57	21				1, 2
02	2		20	1, 52, 53	19				
03	3		27	2, 75, 76	27				
04	4			3, 4					
29			17	45, 46	17				
30	12, 17		18	47, 48					
31			19	49–51	18				
32	13, 16	5	21	54, 55	20		2		
33			23	58, 59	22				
34			24	60, 61	23				
35			25	62, 63	24				
36	14	6		64, 65	25		3	11	
37				66, 67					
38	15	7	26	69, 70	26			9	
39				71, 72				10	3, 4
40				73, 74					
41			28	77, 78	28				
63			45	117, 118	45				

* CTD includes water (niskin) samples at sea surface and seafloor, and PAR.
** Grabs include Smith-McIntyre and shipek.

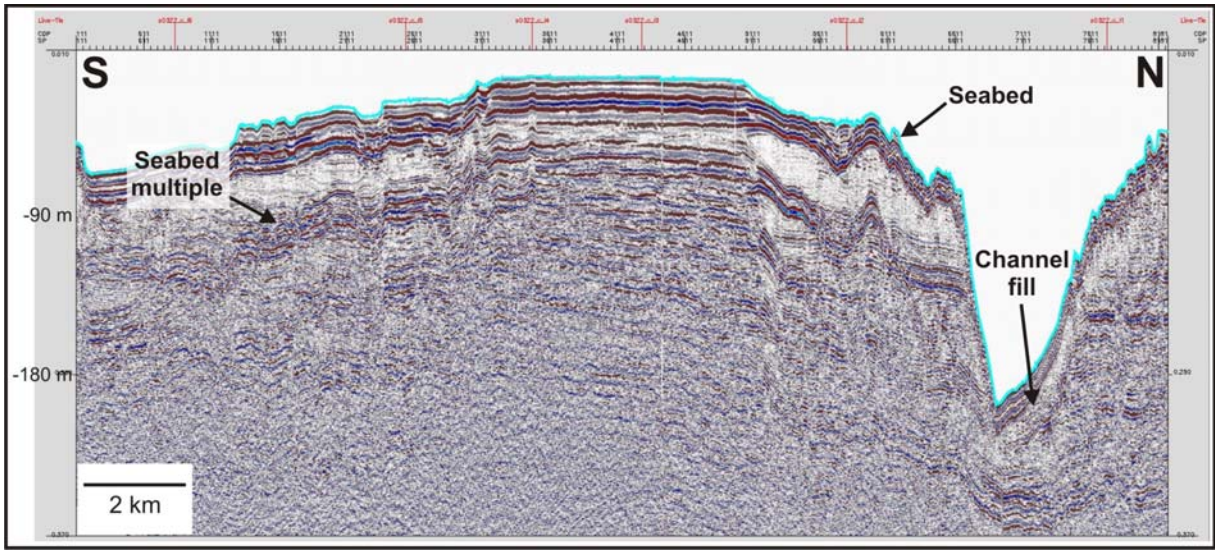

Figure 3.11. Profile of SOL4934_C_SBPL9 showing multiple sub-bottom reflectors that are characteristic of the area, and their preliminary interpretations. Numerous north-dipping sub-bottom reflectors beneath the carbonate banks are truncated by the deep channel which is characterised by sediment fill at its base. Depths are in metres below sea surface assuming a sound velocity in shallow sediments and water column of 1,500 m s^{-1}.

Figure 3.12. Typical sled haul from banks and terraces in Area C comprising predominantly sponges and octacorals. Composition of sled hauls generally reflected biota seen in the video footage.

Table 3.6. Operations undertaken at each station in Area D.

Stn	CTD*	Light	CAM	GR**	BS	DR	BC	VC	RD
42			29	79, 80	29				
43	18	8	30	81, 82	39			11	
44			31	83, 84	31			12[§], 16	
45			32	85, 86	32				
46			33	87, 88	33				
47			34	89, 90	34				
48	19	9	35	91, 92	35				
49	20	10	36	93, 94	36				
50			37	95, 96	37				
51			38	97, 98	38				
52			39	99, 100	39				
53	21	11	40	101, 102	40			14	
54			41	103, 104	41				
55			42	105, 106	42				
56			43	107, 108	43				
57	22	12	44	109, 110	44				
58				111, 112					
59	23	13		113, 114					
60				115, 116					
61								13	
62								15	

* CTD includes water (niskin) water samples at sea surface and seafloor, and PAR.
** Grabs include Smith-McIntyre and shipek.
[§] Recorded but no recovery.

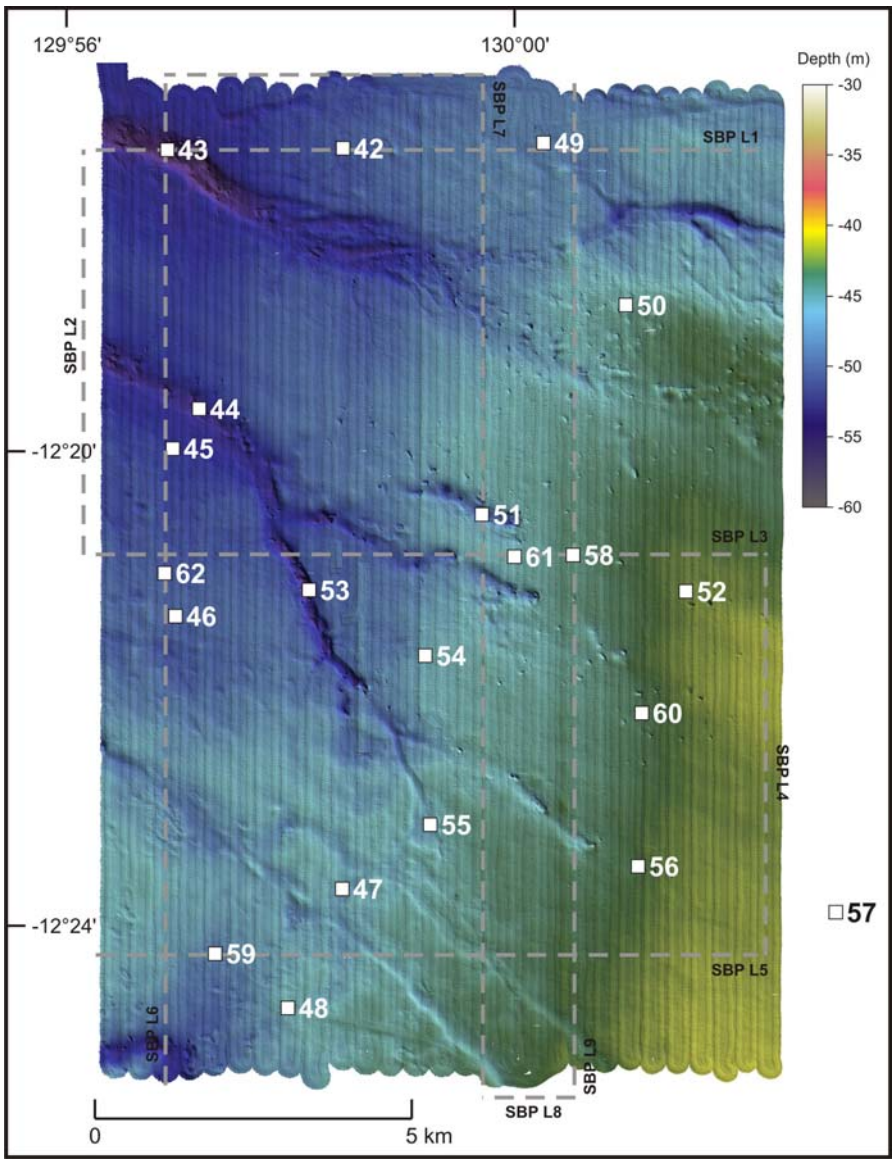

Figure 3.13. False colour bathymetry image of Area D. This area, located on the inner shelf, is characterised by a relatively subdued seabed geomorphology comprising plain and deep/hole/valley features. Drainage channels trend NW in a dendritic pattern, and their thalwegs are periodically punctuated by circular depressions (pock marks) up to 300 m in diameter and 10 m deep. The depressions also occur across the sediment plain. Some of the channel walls coincide with the underlying rocks cropping out at the seabed. Sub-bottom profiler lines and sampling stations are also shown.

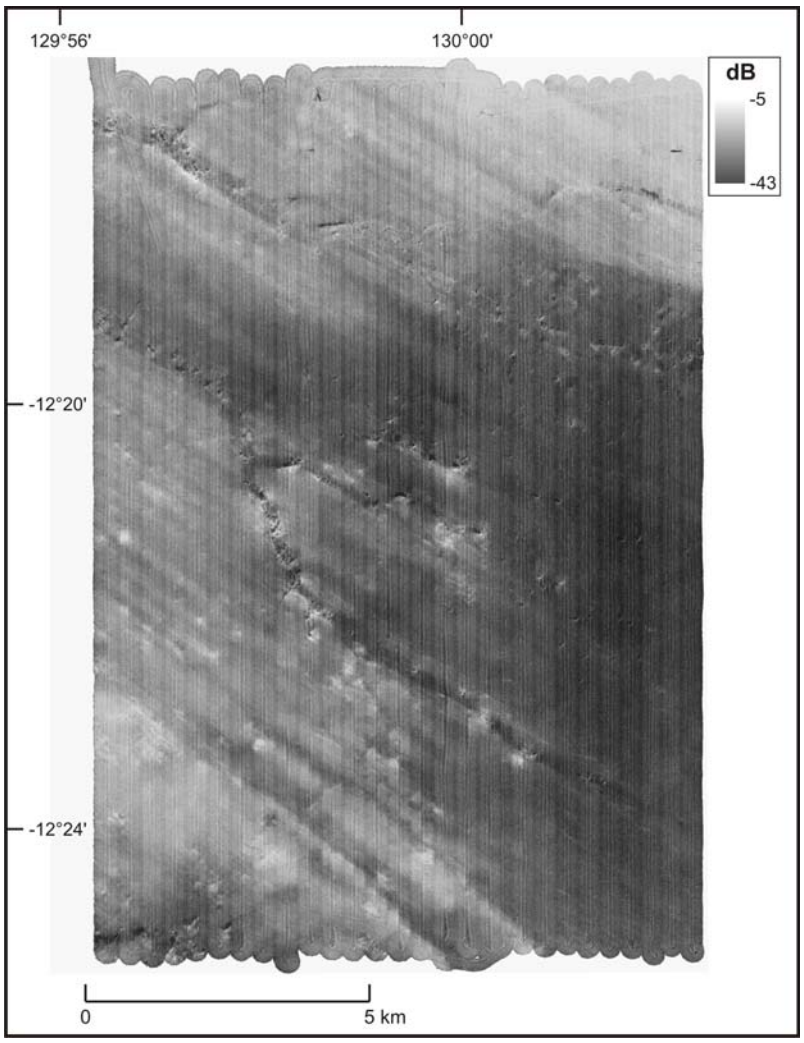

Figure 3.14. Greyscale image of seabed reflectance (backscatter) from Area D. Note that deep/hole/valleys have relatively lower backscatter values than the surrounding plain. A very distinct NW-SE trending pattern of alternating high and low backscatter values is evident in the data. The cause of this pattern is unknown, and is not linked to the geomorphology as it is not visible in the bathymetry data. Possibly, this pattern is associated with the strong tidal currents in this region.

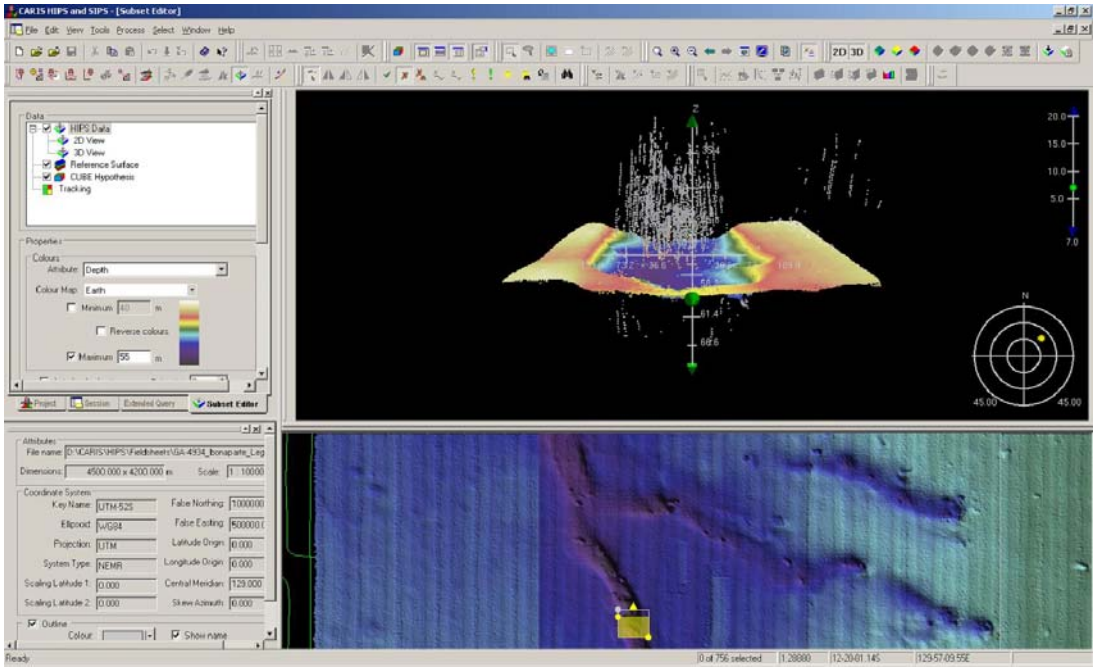

Figure 3.15. Screen capture showing acoustic scattering in the water column above pockmarks in Area D. The cause of the scattering is unknown, although escape features are identified below pockmarks (Fig. 3.16).

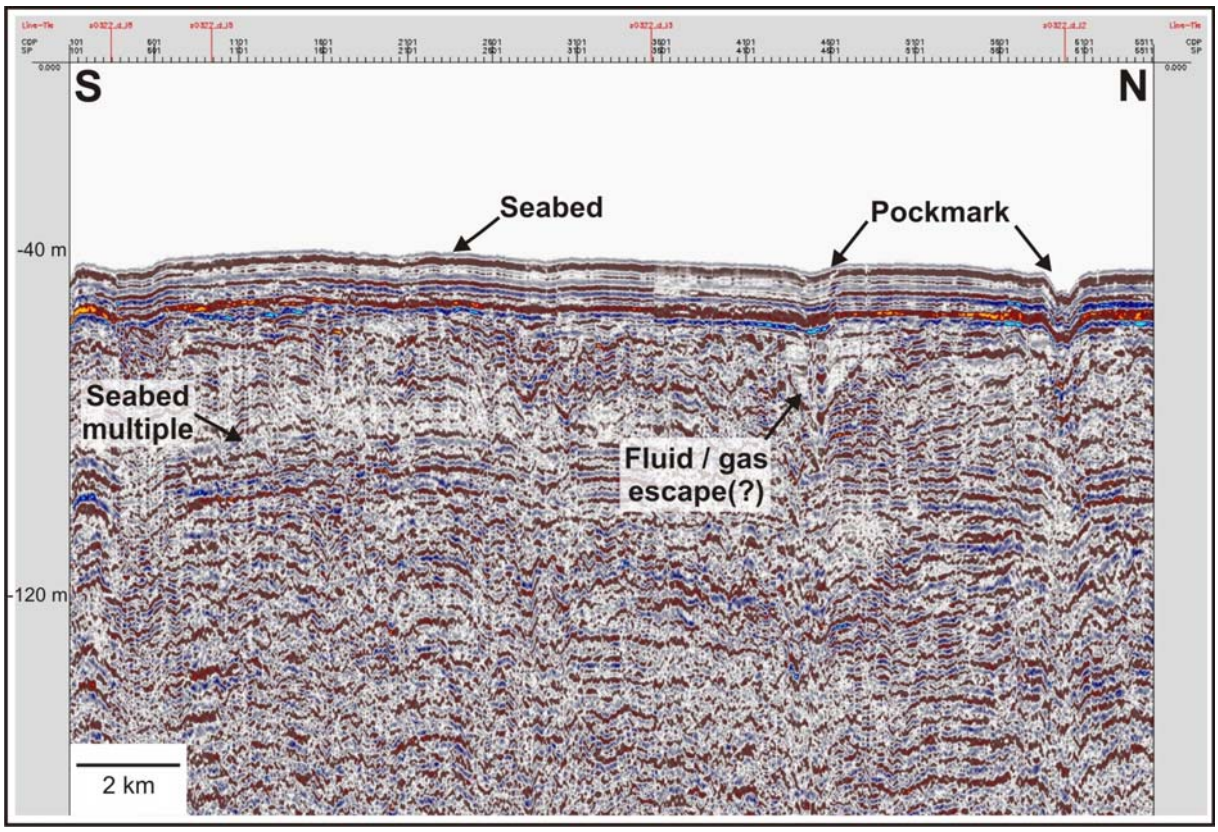

Figure 3.16. Profile of SOL4934_D_SBPL9 showing multiple sub-bottom reflectors that are characteristic of the area, and their preliminary interpretations. Depths are in metres below sea surface assuming a sound velocity in shallow sediments and water column of 1,500 m s^{-1}.

Figure 3.17. Typical sled haul from sediment plain environments in Area D characterised by relatively rich infauna, dominated by polychaetes and amphipods. Composition of sled hauls generally reflected biota seen in the video footage.

4. Concluding Remarks

While the preliminary results contained in this record are promising, a significant amount of additional sample analysis will be completed to elucidate the full picture of seabed habitats in northern Australia. Information contained in this initial post-survey report will be supplemented with data and information contained in a further report that synthesises the regional late Quaternary seabed environments and geology of the Joseph Bonaparte Gulf. It is envisaged that these reports can be used as baseline information for planned infrastructure development by Australia's offshore oil and gas industry and to characterise proposed marine protected areas by the Department of the Environment, Water, Heritage and the Arts.

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APPENDIX A

Table A1. Ship's complement.

Leg 1 – 27/08/2009-08/09/2009	
Science Crew	
Chief Scientist	Dr Scott Nichol (GA)
AIMS Cruise Leader	Dr Chris Battershill (AIMS)
Scientist (Geochemistry)	Dr Lynda Radke (GA)
Science Technician (Geochemistry)	Janice Trafford (GA)
Scientist (Ecology)	Dr Rachel Przeslawski (GA)
Scientist (Ecology)	Neil Smit (NRETAS)
Multibeam Acquisition/Processing	Dr Justy Siwabessy (GA)
Electrical Technician	Stephen Hodgkin (GA)
Mechanical Technician	Craig Wintle (GA)
Underwater Video Technician	Marcus Stower (AIMS)
Ship's Crew	
Master	Greg Lambert
First Officer	Toby Mills
Second Officer	Leo Zidek
Chief Engineer	Rob Williams
Second Engineer	Gary Davis
Deck Hand	Jason Smith
Deck Hand	Anthony Bilshen
Cook	Tracey Biggs
Leg 2 – 09/09/2009-24/09/2009	
Science Crew	
Chief Scientist	Dr Andrew Heap (GA)
AIMS Cruise Leader	Dr Steve Whalan (AIMS)
Scientist (Geochemistry)	Dr Lynda Radke (GA)
Science Technician (Geochemistry)	Mathew Carey (GA)
Scientist (Ecology)	Dr Rachel Przeslawski (GA)
Multibeam Processing	Cameron Mitchell (GA)
Multibeam Acquisition/Processing	Dr Justy Siwabessy (GA)
Acoustics Technician	Mike Sexton (GA)
Electrical Technician	Jack Pittar (GA)
Mechanical Technician	Craig Wintle (GA)
Underwater Video Technician	Jamie Colquhoun (AIMS)
Ship's Crew	
Master	Greg Lambert
First Officer	Toby Mills
Second Officer	Brett Cross
Chief Engineer	Rob Williams
Second Engineer	Gary Davis
Deck Hand	Jason Smith
Deck Hand	Anthony Bilshen
Cook	Amara Sansoni

APPENDIX B

Geoscience Australia
Seabed Mapping Survey SOL4934
Joseph Bonaparte Gulf, Northern Australia

Geoscience Australia Chief Scientist Daily Log
Leg 1: Scott Nichol; Leg 2: Andrew Heap

Note: all times listed are Universal Time Constant (UTC)

Leg 1: 27/08/2009-08/09/2009
Thursday, 27 August 2009
In Port. Fisherman's Wharf, Darwin. Geoscience Australia science crew arrived at wharf at 23:45 hrs to assist with vessel mobilisation. Michael Hughes finalised programming of the four oceanographic instruments, and departed approx 04:30 hrs following briefing on deployment requirements with Scott Nichol and Craig Wintle.

Scott Nichol met with AIMS Cruise Leader (Chris Battershill – AIMS) and Skipper (Greg Lambert – AIMS) to discuss voyage plan and the plan for the following 24 hrs. Aim for next 24 hrs is to transit to Area C and deploy the four oceanographic moorings at pre-determined locations. Deployment to be preceded by swath mapping across each site to confirm water depths are appropriate for each instrument. Also plan to collect sediment grabs at each mooring station outside the appropriate no-go zone. Aim to be transiting north to Area A by mid afternoon. Welcome on board meeting with Skipper followed by safety briefing held on board for all Geoscience Australia science staff and support crew.

Departed Darwin at 11:00 hrs (time determined by tide) under escort from the pilot. Transited to Area C completing system check (patch test) of multibeam system en route.

Friday, 28 August 2009
Arrived Area C approximately 21:30 hrs. Proceeded to southern-most and shallowest mooring station and swath small area (~1 km^2) over site. Repeated procedure at other three stations. Successful deployment of all mooring at following locations:

Instrument	Latitude	Longitude	Depth (m)	Time of deployment
ADV (Little Jim)	-11° 38.679	129° 50.556	22	23:20
ADP (Big Jim)	-11° 35.468	129° 49.563	33	00:35
BRUCE	-11° 34.235	129° 50.241	50	01:50
ADCP	-11° 32.783	129° 51.157	100	04:10

CTD cast also completed at all four mooring stations. Sediment grab collected at three mooring stations (ADP, BRUCE, ADCP) using Smith-McIntyre grab for grain size analysis; plus a Shipek grab at ADCP station for geochemistry. Successful benthic sled also completed at ADCP site. Note that these sampling activities was added to the day's programme for three reasons: 1) to give Geoscience Australia staff an opportunity to check gear and systems for sample handling and processing, 2) to expedite sampling activities on Leg 2, and 3) we were on station at planned sampling sites.

Commenced transit to Area A by 05:30 hrs, passing along the eastern edge of Area B to collect one swath line en route. Emergency drill to muster station held in afternoon; all went smoothly and to plan.

Arrived Area A approx 10:30 hrs and commenced swath mapping on north-south lines, starting at eastern edge. Lines are 20 km long and approx 60 min duration at 9-10 knots. Seas in Area A smooth with 1 m swell.

Some Geoscience Australia science staff feeling slightly seasick; most retired early after dinner. Stephen Hodgkin developed a mild fever today; he rested for 12 hrs with medication supplied by the skipper and seemed improved when he came onto multibeam sonar watch at 14:30 hrs.

Saturday, 29 August 2009

Continued swath mapping of Area A all day, completing approx 500 km. All of the area mapped today is flat and featureless and likely muddy; judging from low backscatter returns. Water depths range from 90-110 m. The only feature of note is a low ridge in the southeastern corner of the survey area. Planned activities for following day are to sample at four stations covered by mapping today; to include grabs (Smith-McIntrye and Shipek), tow video, benthic sled at all stations plus a CTD with Niskin bottles at the first station. Order of stations to be determined by position of boat at 22:30 hrs on 29/08/09.

GA staff worked on samples collected yesterday; turned out to be a useful exercise for the geochemical analyses in terms of providing a chance to sort out procedures, including sample naming and entry into database. All samples from yesterday entered onto samples database today (Scott Nichol)

Some problems with the MBES late in the afternoon, resulting in loss of about 45 min of survey time. Problem due to hard disk on MBES filling up; requiring system re-boot. I'm advised that we are still storing swath data from the two previous surveys (Scott Reef and Broome to Darwin transit). Steve Hodgkin reluctant to delete this data to free up space for this survey until he is sure the data has been safely lodged and checked back at base. A. Steve seems to be able to manage this data volume problem satisfactorily.

Scott Nichol, Greg Lambert, Chris Battershill meeting on a regular basis (2-3 times daily) to discuss operations and plans. All working well together. Weather continues to be fine and warm. Swell now 2 m but smooth with light winds. Solander rolling noticeably all day with beam-on swell. Some Geoscience Australia science staff still getting sea legs; but all on duty and eating.

Sunday, 30 August 2009

Continued swath mapping until 22:30 hrs. Data quality remains quite noisy due to muddy seabed; beam width maximised to about 250 m. Each 20 km line requires 60+ minutes to complete. By 09:30 hrs we had completed 30 lines of an estimated total of 90 lines. Note this is an increase from the pre-survey estimate of 80 lines. Sampling completed today at four stations as follows:

Station	Latitude	Longitude	Depth (m)	Operations
005	-10° 28.08	129° 42.08	78	CTD with Niskin bottles (CTD005) Benthic sled (BS002) Camera tow (CAM001) Grab – Shipek (GR005) Grab – Smith McIntyre (GR006)
006	-10° 22.71	129° 42.71	88	Benthic sled (BS003) Camera tow (CAM002) Grab – Shipek (GR008) Grab – Smith McIntyre (GR007)
007	-10° 18.73	129° 40.71	100	Benthic sled (BS004) Camera tow (CAM003) Grab – Shipek (GR009) Grab – Smith McIntyre (GR0010)
008	-10° 22.60	129° 38.67	93	CTD with Niskin bottles (CTD006) Benthic sled (BS005) Camera tow (CAM004) Grab – Shipek (GR012) Grab – Smith McIntyre (GR011) Box core (BC001)

Samples recovered all of good quality in terms of yielding sufficient sediment or biota for sub-sampling and analysis. The benthic sled at station 5 was particularly bountiful, with abundant sponge and gorgonians recovered; from a rocky habitat. Other sites were sediment dominated and have much lower abundance of epibenthic organisms. Typically yielded a tray of samples.

Issue with the MBES resolved today. While on station the crew raised the transducer assembly from the hull and inspected the cabling that feeds the sound velocity data (which had ceased logging over the past 24 hrs). The cable was abraded, broken and partly corroded inside. Stephen Hodgkin repaired and rewired. As of 07:30 hrs the sound data feed was restored. Requested a replacement cable for Leg 2.

Issue with USBL positioning system for tow video arose during setup over the past 24 hrs. We are advised by AIMS that the USBL does function but it provides a zig-zag tow path, which is clearly incorrect. Also, it's not possible to feed the USBL signal to two logging systems; which is what we require (a feed to the Geoscience Australia characterisation system and another to the AIMS system). Resolved to determine position of video via the triangulation (layback) algorithm supplied by AIMS. Resumed swath mapping approx 07:30 hrs. Weather continues to be fine and warm. Swell now less than 1 m with light winds.

Monday, 31 August 2009

Continued swath mapping overnight and all day. Coverage remains similar width and quality as previous days. Conducted manual sound cast at 2300 hrs. Samples database updated today from activities of the previous day. Physical samples checked and organised from previous day. Processing of geochemistry samples continued most of the day. Backing up of video and lab photos from yesterday completed. Planning of sampling at 6 stations for tomorrow completed. Geochemistry and multibeam sonar staff communicated by fax to

Geoscience Australia regarding details of water sampling and swath processing, respectively.

A note on general workload of staff – the arrangement of mapping and sampling on alternate days is working well, as it allows science staff the chance to clear the backlog of work from sampling while we map. Back-to-back sampling would introduce risk of errors with processing and backups. Also, the physical space in the labs really precludes us from collecting a large volume of material too quickly. In terms of multibeam sonar data processing, Justy Siwabessy is about 24 hrs behind the data acquisition. This is through no fault of his; but is due to noisy data that requires time to clean. He is working as hard and fast as he can. As a result, our selection of sites for sampling is based on watching the new data come in (wheelhouse display) and comparing the bathymetry to existing charts. Fortunately, the existing charts (and the 250 m grid) are accurate enough so that we can select sites with confidence and target representative geomorphic features.

The rate of mapping this is taking longer than planned. I now calculate the mapping will require about 92 hrs. Decided to reduce the time allocated for sub-bottom profiling by 6-8 hrs and to reduce sampling time in Area B by 10 hrs. May need to revise again as we proceed. Ship running well; minor issue today with blocked drains on lower deck resulting in pungent odour through cabins and lower deck. Issue resolved by engineer during the day.

Man overboard drill at 11:10 hrs. Ship's crew successfully recovered the MOB life-ring. All science staff responded by assisting with spotting the MOB and maintaining an operation, which took about 20 min. Weather – scattered cloud at times today. Light winds. Swell 1-1.5 m, smooth seas. Very pleasant conditions for working.

Tuesday, 1 September 2009

Successful completion of six sampling stations today, starting at 20:20 hrs, as follows:

Station	Latitude	Longitude	Depth (m)	Operations
009	-10° 28.89	129° 36.30	92	CTD with Niskin bottles (CTD007) Box core (BC002) Benthic sled (BS006) Camera tow (CAM005) Grab – Shipek (GR014) Grab – Smith McIntyre (GR013)
010	-10° 25.88	129° 39.52	107	Benthic sled (BS007) Camera tow (CAM006) Grab – Shipek (GR016) Grab – Smith McIntyre (GR015)
011	-10° 26.84	129° 33.28	92	Benthic sled (BS008) Camera tow (CAM007) Grab – Shipek (GR018) Grab – Smith McIntyre (GR017)
012	-10° 22.25	129° 33.43	105	Benthic sled (BS009) Camera tow (CAM008) Grab – Shipek (GR020) Grab – Smith McIntyre (GR019)
013	-10° 18.40	129° 33.78	90	Benthic sled (BS010) Camera tow (CAM009) Grab – Shipek (GR022) Grab – Smith McIntyre (GR021)
014	-10° 18.52	129° 37.01	87	CTD with Niskin bottles (CTD008) Light cast Benthic sled (BS011) Camera tow (CAM010) Grab – Shipek (GR024) Grab – Smith McIntyre (GR023)

All stations yielded excellent physical samples. Towed video is working well, with excellent visibility in clean waters. Sampling for water quality confirms very low turbidity through the water column in this area. Video shows dense sponge and coral gardens are generally associated with rocky ledges and ridges where sediment cover is relatively thin to patchy. One sled tow across a rocky ledge recovered coral(?) cobbles at 100 m depth. Sled tows also recovering abundant representative biological material (sponges, soft corals, gorgonians, sea cucumbers and various crustaceans). Sedimentology samples showing noticeable variability across the area, ranging from muddy sands to very coarse clean sands and gravel; all carbonate. Resumed swath mapping at 07:45 hrs. Multibeam sonar system working well, although the grid engine is running slower as we gather more data. Weather – scattered cloud, moderate breeze from the east. Swell 1-1.5 m with slight chop.

Wednesday, 2 September 2009

Continued swath mapping until 10:30 hrs. MBS system required a reboot in the morning because the grid engine had stalled. Re-boot successful. Setup vibrocorer on back deck during the morning in preparation for tomorrow. Setup Sparker sub-bottom profiler during

the morning. Started Sparker profiling at 14:00 hrs, running east-west lines first to be followed by two north-south lines. All at 5 knots and running one engine. Data quality generally good; some noise from the engine. Continued SBP overnight. Weather – scattered cloud to overcast, moderate breeze from the east. Swell 1-1.5 m with slight chop.

Thursday, 3 September 2009

We finished SBP at 01:30 hrs and proceeded to the first of six vibrocore sites. Core sites were chosen along SBP lines and to represent valley and terrace geomorphic features across a range of water depths. Vibrocore operations went smoothly, despite quite challenging sea conditions for safe deployment of the tower. All went ahead without any issues. A total of six cores were collected as follows:

Station	Latitude	Longitude	Water Depth (m)	Core Length
015	-10° 27.00	129° 41.64	109	2.80 m
016	-10° 26.98	129° 38.01	100	1.30 m
017	-10° 24.00	129° 39.99	82	1.55 m
018	-10° 24.02	129° 41.48	100	0.86 m
019	-10° 20.99	129° 41.49	110	1.52 m
020	-10° 21.00	129° 38.75	92	2.00 m

Following the coring operations, core tubes were cut to 1 m lengths, capped, labelled and stored vertically in the refrigerated container. Unfortunately cores from stn 017 and 020 were sloppy at the top and in the process of cutting the upper 20 cm lost stratigraphic integrity; this part of the core was bagged. In addition to coring, grab samples (Smith-McIntyre and Shipek) were collected at stations 018 and 019. These both provided deep water samples for biology and geochemistry analysis.

Weather – overcast with 15-20 knot easterly wind all day. Swell rising to 2 m and seas choppy. Somewhat uncomfortable working conditions and a couple of people felt mild symptoms of seasickness. No major problems though.

Friday, 4 September 2009

Completed swath mapping in Area A overnight and started transit to Area B. Arrived at northwest corner of Area B at 00:30 hrs and conducted a sound cast for multibeam sonar system. Multibem sonar system then crashed at 00:35, despite running fine overnight and during the transit. We also lost the on-board sound velocity feed; assume the temporary cable repair from a few days ago has failed. Justy Siwabessy tried several re-boots but no signal from the transducer head. Had to get Steve Hodgkin out of bed to deal with the problem. After conducting software tests he decided it was a hardware issue and that we needed to lift the heads up the moon pool.

At 01:20 we decided that the multibeam sonar system was going to require some time to sort out, so we steamed to a shoal ground (Moss Shoal) in the southeast corner of Area B to inspect water depths. The skipper was keen to do this during daylight to confirm the chart depth of 7 m. Arrived at the shoal approx 01:45 hrs and crossed it easily; minimum water depth of 9 m at mid tide. Proceeded to sample Moss Shoal (a planned station) by running tow video from 30 m to 10 m water depth across the shoal. Mostly muddy sand with low density of epibenthic organisms. Collected Smith-McIntyre and Shipek grabs (muddy sand), conducted a CTD cast, light cast and Niskin bottle water sampling. Also a benthic sled that pulled up mostly carbonate gravels with some biota. Station details as follows:

Station	Latitude	Longitude	Depth (m)	Operations
021	-11° 08.44	129° 54.82	24	CTD with Niskin bottles (CTD009) Benthic sled (BS012) Camera tow (CAM011) Grab – Shipek (GR030) Grab – Smith McIntyre (GR029)

MBES system restarted at 05:30 hrs; all seems ok but the reason for the loss of transducer signal remains unclear. Swath mapping began by mapping the extent of Moss Shoal in daylight before proceeding with east-west lines across Area B, starting at 10:30 hrs along the northern edge of the box. We chose this line to provide more comfortable sleeping conditions in the swell (now down to less than 1 m). Weather – fine, winds less than 10 knots. Swell easing. Comfortable sailing conditions.

Saturday, 5 September 2009

Today was spent swath mapping in Area B. We are running east-west lines, filling from the north. The lines have been shortened to avoid an area of shoal ground that extends north-south in the western third of the survey area. The plan is to map the shoal and surrounding waters in a north-south direction, probably on Monday. Progress is steady, with only one short interruption when the Windows PC connected to the multibeam sonar system required a reboot. Only 10 minutes of time lost. The raw acoustic data in this area is much cleaner than in Area A (still running dual heads), with swath width approaching 300 m in 70-80 m water depth.

The day was also used to finalise sorting of sediment samples from Area A and put into refrigerated storage on the upper deck. The samples database was also brought up to date today. Lynda Radke and Janice Trafford finalised analyses of water and sediment geochemistry from samples collected yesterday. All up to date. Rachel Przeslawski provided a one page summary of her observations of the biology from Area A, with a GIS map of sample stations and the new bathymetry. Justy Siwabessy has finished preliminary processing of swath data for Area A; this will need additional cleaning back in the office. Data backup to external hard drive bought up to date for swath, video and sub-bottom profiler data. Scott Nichol also reviewed the data from the sub-bottom profiler collected in Area A. Generally, very good data that will allow us to correlate bathymetry with valley fills and adjacent terraces (interfluves). I compiled a summary log of the SBP files with brief notes and screen shots of representative data. Weather – fine, calm seas. Swell about 1 m. Very comfortable sailing conditions.

Sunday, 6 September 2009

Swath mapping continued overnight and through the morning. All gear running smoothly and data quality remains good with swath width of about 250 m in 70-90 m water depth. Area B is characterised by broader areas of uniform (flat) seabed than Area A. The main bathymetric variation is across shoals and narrow channels, located in the western half of the mapped area. The shoals rise about 50 m from channel margins, with channel depths up to 110 m. All channels and shoals are broadly aligned north-south.

At 05:30 hrs we broke from mapping to sample at three stations located in the northwest sector of Area B; we opted to collect these samples before leaving this part of the box. All sampling operations were successful, with the exception of a shortened tow video (5 min) at

the final station. The video light failed during this run, cutting short the operation (no major issue, as the station was a uniform channel floor). Station details as follows:

Station	Latitude	Longitude	Depth (m)	Operations
022	-11° 00.52	129° 47.38	82	Benthic sled (BS013) Camera tow (CAM012) Grab – Shipek (GR032) Grab – Smith McIntyre (GR031)
023	-11° 02.13	129° 48.86	70	Benthic sled (BS014) Camera tow (CAM013) Grab – Shipek (GR034) Grab – Smith McIntyre (GR033)
024	-11° 02.46	129° 46.72	105	CTD with Niskin bottles (CTD010) Camera tow (CAM014) Grab – Shipek (GR036) Grab – Smith McIntyre (GR035)

During the transit between stns 022 and 023 we conducted a path test for the multibeam sonar system, under supervision of Steve Hodgkin. This was done to confirm calibration of the transducers given that they had been lifted in the moon pool twice during the survey. Patch test successful. Resumed swath mapping at 10:00 hrs. Weather – Fine with calm seas. Swell <1 m. Very comfortable sailing conditions.

Monday, 7 September 2009

Swath mapping continued overnight and through the whole day. All gear running smoothly and data quality remains good. Discussion by phone and fax with Andrew Heap and Ray de Graaf regarding gear requirements for Leg 2. The matter of excess weight for Leg 2 was resolved when the skipper re-ran his stability calculations for the gear to come aboard. We resolved to remove the box corer and three spare rock dredges to reduce weight and allow enough capacity for the drill rig. All ok.

Identified waypoint for sampling in Area B tomorrow. Four stations are planned, two for vibracoring and two for benthic sled sampling. All stations to have a towed video deployment and sediment grabs. Note that space limitations on the aft deck do not allow for both vibracore and sled operations at one station (without wasting time swapping gear with the crane). Continued to liaise with the skipper regarding timing and arrangements for our port call on Wednesday and Thursday. Weather – Fine with calm seas. Swell <1 m. Very comfortable sailing conditions.

Tuesday, 8 September 2009

Swath mapping continued overnight until 23:00 hrs, at which time we broke from mapping to start sampling. Four stations were completed by 03:15 hrs. Station details as follows:

Station	Latitude	Longitude	Depth (m)	Operations
025	-11° 09.65	129° 49.73	69	Benthic sled (BS015) Camera tow (CAM015) Grab – Shipek (GR038) Grab – Smith McIntyre (GR037)
026	-11° 05.79	129° 52.09	79	Benthic sled (BS016) Camera tow (CAM016) Grab – Shipek (GR040) Grab – Smith McIntyre (GR039)
027	-11° 03.99	129° 53.95	73	CTD with Niskin bottles (CTD011) Vibracore (VC007) Grab – Shipek (GR042) Grab – Smith McIntyre (GR041)
028	-11° 07.50	129° 48.28	106	Vibracore (VC008) Grab – Shipek (GR044) Grab – Smith McIntyre (GR043)

Swath mapping resumed at 03:30 hrs and continued uninterrupted until 11:00 hrs. Sparker sub-bottom profiler deployed at 11:00 hrs. Ran two 20 km lines in east west direction across shoals and valleys in the southern part of Area B, followed by one north-south tie line. Excellent data quality, with clean signal due to flat seas. Boat speed increased to 7.5 knots with no impact on data quality. This demonstrates that a smooth sea surface is important for a clean Sparker signal return. Sparker lines continued until 16:20 hrs. Multibeam sonar mapping resumed 16:30 hrs. Weather – Fine with calm seas. Swell <1 m. Very comfortable sailing conditions.

Wednesday, 9 September 2009

Sub-bottom profiling continued until ~11:30 hrs. All planned lines completed. Some problems on line 2 with noise related to a bad connection. Steve Hodgkin did his best to minimise the noise. Generally good data quality. Swath mapping resumed at 1630 hrs and was complete by 22:00 hrs. Area B now fully mapped (400 km^2). Today used to finalise sorting and packing of sediment and biological samples; final entries into the samples database and back up of all digital data to external hard drives.

Transit to Darwin commenced from southern edge of Area B at 22:00 hrs via the eastern side of Area C; to add a swath line alongside the line we ran on the transit from Darwin. Steve Hodgkin noted that the multibeam sonar system's grid engine is struggling (needs to be cleaned out and re-started), meaning that the helmsman control is lacking some functionality and that the line may not be perfectly aligned with the adjacent one. Arrived Port of Darwin, Fisherman's Wharf at 04:00 hrs.

End of Leg 1.

Thursday, 10 September 2009
Change over of staff and equipment from Leg 1 to Leg 2 of survey. Geoscience Australia's underwater rotary corer was put on the vessel and several other items, including the box corer were removed. The rotary corer will be used for collecting samples of the limestone banks in Area C. Spare cables for the sound velocity profiler on the multibeam sonar system were brought from Canberra, as requested by Steve Hodgkin. All staff successfully completed their hand-over. In most cases this was completed by 03:30 hrs.

Leg 2 10/09/2009 – 24/09/2009

Friday, 11 September 2009
Departed Fisherman's Wharf, Darwin at 22:00 hrs. Pilot disembarked at 22:30 hrs. Began transit to Area C. Broken underway sound velocity cable for multibeam sonar system was repaired and we commenced mapping on the transit line at 01:00 hrs. A patch test was completed at 02:45 hrs. Re-commenced transit to Area C to begin mapping at 03:00 hrs. Mapping will begin in the centre of Area C over the shallow banks.

Commenced mapping of Area C at 06:30 hrs. Began mapping in the central western part of the study area to get initial data for rotary corer sites. The first few lines show a broadly undulating seabed with several flat-topped terraces of inferred hard-grounds. The north of the study area shows a sinuous over-deepened channel over >90 m water depth. In the south and centre of the area are SW-NE oriented ridges, up to 10 m in height, which are interspersed with flat areas of inferred softer sediments. Some of the ridges have sinuous crested sand-waves superposed on the margins. The sand-waves appear to have symmetrical morphologies. We will continue to map Area C until tomorrow morning when we will begin a programme of sampling of the mapped area. A fire drill was completed by all Leg 2 staff at 10:30 hrs. All staff were completed the drill successfully and were accounted for.

Saturday, 12 September 2009
Completed first phase of multibeam mapping of Area C over night and commenced sampling at 5 stations at 22:00 hrs, as follows:

Station	Latitude	Longitude	Depth (m)	Operations
029	-11° 42.54	129° 48.56	60	Camera tow (CAM017) Benthic sled (BS017) Grab – Smith McIntyre (GR045) Grab – Shipek (GR046)
030	-11° 40.82	129° 49.67	50	CTD with Niskin bottles (CTD012) Camera tow (CAM018) Grab – Smith McIntyre (GR047) Grab – Shipek (GR048)
031	-11° 38.13	129° 49.34	30-40	Camera tow (CAM019) Benthic sled (BS018) Grab – Smith McIntyre (GR049) Grab – Shipek (GR050)
002	-11° 35.38	129° 49.56	40	Camera tow (CAM020) Benthic sled (BS019) Grab – Smith McIntyre (GR051) Grab – Shipek (GR052) Grab – Smith McIntyre (GR053)
032	-11° 32.68	129° 49.45	50-80	CTD with Niskin bottles (CTD013) Camera tow (CAM021) Benthic sled (BS020) Grab – Smith McIntyre (GR054) Grab – Shipek (GR055) Rock dredge (DR002)

The 5 stations were designed to cover depth ranges (30-80 m) and representative environments (hard-grounds, sandwaves, ridges, platforms and reefs) mapped during the previous 15 hours. Interestingly, the banks (terraces and platforms) here are dominated by luxurious sponge communities overlying a very highly weathered and porous limestone. Unlike the Sahul Banks further to the NW in the gulf, we have not observed any *Halimeda* thus far. Unconsolidated sediments on and bounding the banks are poorly sorted muddy carbonate sands and gravels. We also collected three pieces of terrigenous sandstone and siltstone in a dredge collected on the flank of the deepest channel in this area. Also seen is an area characterized by numerous sinuous crested sandwaves with superimposed sand ripples, indicating strong near-bed currents.

The ship's single-beam echo-sounder indicates that the channel in this region is up to 200 m deep (our multibeam system's depth limit). We have changed to the single head configuration on the multibeam system to improve the depth to which we can map. Completed head change over and patch test at 12:00 hrs and continued multibeam mapping deep channel in Area C.

Sunday, 13 September 2009

Continued swath mapping Area C in single head mode. Due to the reduction in coverage we have decided to concentrate on the main environments of banks and channel. The single head is giving us very good data that requires minimal cleaning, compared with the dual head. Also, the single head has given us the opportunity to map most of the bottom of the deep channel (up to 170 m so far, and the deepest channel yet charted on these banks). To map the channel we have been slowing down to 6 knots, which has helped with data quality.

Mapping in single head mode meant we have had to run some infill lines to cover gaps in coverage. The multibeam system had to be restarted twice: first because the Helmsman display would not update, and second because the positioning system and GPS were out of range. These restarts did not adversely affect the progress of mapping today. Tomorrow we will continue sampling at stations in the area mapped today.

Monday, 14 September 2009

Continued to map Area C overnight. Commenced sampling at 7 stations at 21:00 hrs (13/09/09 UTC), as follows:

Station	Latitude	Longitude	Depth (m)	Operations
001	-11° 38.49	129° 50.56	20	Camera tow (CAM021) Benthic sled (BS022) Grab – Smith McIntyre (GR056) Grab – Shipek (GR057)
033	-11° 39.14	129° 49.86	20	Camera tow (CAM022) Benthic sled (BS022) Grab – Smith McIntyre (GR058) Grab – Shipek (GR059)
034	-11° 37.40	129° 50.43	30	Camera tow (CAM024) Benthic sled (BS023) Grab – Smith McIntyre (GR060) Grab – Shipek (GR061)
035	-11° 32.35	129° 50.89	40	Camera tow (CAM025) Benthic sled (BS024) Grab – Smith McIntyre (GR062) Grab – Shipek (GR063)
036	-11° 33.26	129° 50.94	180	CTD with Niskin bottles (CTD014) Benthic sled (BS025) Grab – Smith McIntyre (GR064) Grab – Shipek (GR065) Rock dredge (DR003)
037	-11° 32.69	129° 50.76	140	Grab – Smith McIntyre (GR066) Grab – Shipek (GR067) Grab – Smith McIntyre (GR068)
038	-11° 43.00	129° 50.39	70	CTD with Niskin bottles (CTD015) Camera tow (CAM026) Vibrocore (VC009) Grab – Smith McIntyre (GR069) Grab – Shipek (GR070) Benthic sled (BS026)

The 7 stations were designed to cover depth ranges (20-180 m) and representative environments (hard-grounds, sandwaves, ridges, platforms and reefs) previously mapped. Again we found that the terraces and banks were dominated by luxurious sponge communities, however, limestone outcrops were also found. Interestingly, no algae or hard corals have been observed yet. We dredged a large piece of calcareous partially-indurated limestone from 180 m water depth in the deep channel and the benthic sled recovered assorted fragments of terrigenous siltstones and sandstones from the southern part of the study area. We tried vibrocoring in the deep channel, and although we cored the sediment it

was not recovered in the barrel and ripped out the core catcher. We successfully cored the sedimented slopes in the southern part of the study region where a 2.2 m core terminated in sticky green-grey carbonate mud. We completed sampling at 09:00 hrs (14/09/09 UTC) and re-commenced swath mapping the area. We will complete swath mapping the area before running Sparker lines and commence drilling of the banks and terraces mid week.

Tuesday, 15 September 2009

Continued to multibeam map Area C. Completed mapping at 08:30 hrs. Set up and deployed Sparker system. Unfortunately, a fault was found with one of the cables so that the source would not work. After several hours of work by Jack Pittar and Craig Wintle the fault was found and fixed. Commenced sub-bottom profiling of Area C at 12:30 hrs. Intend to continue collecting sub-bottom profiler data until morning and then undertake several rotary cores of the area. Target sites have been prioritised and focussed on the terraces and banks that were observed in the video stations we sampled earlier.

Wednesday, 16 September 2009.

Continued to collect sub-bottom profiles in Area C. Completed SBP lines at 02:30 hrs. Collected 117 line-kms (63 NM) of SBP data. Data quality is very good, with sub-bottom penetration to 80 mbsf. Channels 1 and 4 were noisy, but channels 2 and 3 were of very good quality. Sea conditions were perfect, with only a lazy 1 m swell on a calm sea. Mike Sexton believes not too much processing will be needed post-survey. Completed a CTD at:

Station	Latitude	Longitude	Depth (m)	Operations
032	-11° 32.821	129° 49.38	48	CTD (CTD016)

This CTD was undertaken due to CTD013 previously taken at this site having bad data. Commenced rotary coring programme at 04:30 hrs UTC. Six priority sites have been identified. Rotary cores were collected at the following sites:

Station	Latitude	Longitude	Depth (m)	Operations
001	-11° 38.49	129° 50.85	20	Rotary core (RD001) Rotary core (RD002)
039	-11° 37.35	129° 50.13	25	Rotary core (RD003) Rotary core (RD004)

All four rotary cores at the two sites penetrated the seabed the full 3 m but only returned up to 0.25 m of sediment. The sediment in the cores was limestone, and carbonate rubble and coarse sand. I believe that a limestone crust occurs at the surface and is underlain by carbonate rubble and coarse sand which is being removed during the coring. This rubble overlies cemented limestone, which each of the cores terminated in. A large piece of hard coral (acropora? – age unknown) was recovered at the base of RD004. This indicates that hard corals were once living in this vicinity – no modern corals have been observed in the video footage or sampled from the seabed. Unfortunately, at site 039 while recovering RD004 the ship was blown off course, which caused the underwater corer to be dragged across the seabed damaging the derrick. The damage sustained has put an end to our short rotary coring programme for this survey. We will commence a series of stations to sample tomorrow to make up for the rotary core sites that we are unable to sample. A very long day by all accounts, but special thanks must to go to Craig Wintle who, after dealing with the stresses and strains of the drilling program today, stayed up to complete transfer of the dual

head multibeam sonar so that we could resume mapping. Unfortunately, we had a problem of the system recognising the dual head units. Mike Sexton, Justy Siwabessy and I worked late into the night to try and rectify the problem. Today was also international "Talk-Like-a-Pirate" day, as reflected in the daily report.

Thursday, 17 September 2009

The problem with the multibeam system was not resolved by morning and we commenced sampling in Area C at 23:30 hrs. Sampling was completed at 09:00 hrs, after occupying six stations as follows:

Station	Latitude	Longitude	Depth (m)	Operations
039	-11° 32.64	129° 50.31	170	Grab – Smith-McIntyre (GR071) Grab – Shipek (GR072) Vibrocore (VC010)
036	-11° 33.67	129° 51.08	200	Vibrocore (VC011)
040	-11° 34.76	129° 57.07	188	Grab – Smith-McIntyre (GR073) Grab – Shipek (GR074)
003	-11° 34.40	129° 50.36	52	Camera (CAM027) Benthic Sled (BS027) Grab – Smith-McIntyre (GR075) Grab – Shipek (GR076)
041	-11° 37.40	129° 50.27	26	Camera (CAM028) Benthic Sled (BS028) Grab – Smith-McIntyre (GR077) Grab – Shipek (GR078)
030	-11° 40.487	129° 49.67	41	CTD (CTD017)

The two vibrocores in 200 m water depth in the deep channel terminated in stiff, cohesive blue-grey clay. This clay appears estuarine or marginal marine, containing no fossils. This sediment may have been deposited either in an over-deepened lake during lowstand or in an estuarine environment during transgression. Numerous lithic fragments (zst, mst, cst) also occur in the grabs from the channel (they are not found elsewhere). Many of these are rounded, implying that they might be river gravels. However, they may have been eroded from the sides of the canyon, and represent the rocks imaged as sub-bottom reflectors on the SBP, cropping out on the channel walls.

During the day, the problem with the multibeam system was resolved by Mike Sexton, Justy Siwabessy and Jack Pittar to be faulty cable to the starboard transducer unit. It was replaced and we completed a patch test in Area C before transiting to Area D to begin multibeam mapping. We began mapping Area D at 14:30 hrs.

Friday, 18 September 2009

Continued multibeam mapping of Area D. Multibeam data have been excellent, with only a little noise in the outer beams and an average swath width of 250 m, which is close to 6x the water depth. The multibeam data show this region to be a sediment plain lying between 42 and 38 m with two sinuous gutters up to 5 m deep that trend E-W across the area. A shoal to 27 m marked on the chart has been shown not to exist. Several pockmarks up to 100 m diameter also occur in the south of the region. Interestingly, the pock-marks and most of the gutter's floors are at similar depths (48 m), which would suggest their depth is controlled by

the underlying geology, perhaps a hard rock layer. Our sampling will try to determine if this is the case.

On the transit from Area C we crossed over an existing pipeline on the seabed. The pipeline was clearly visible in the multibeam data at -12° 01.00, 129° 53.70. Seven stations have been identified in Area D for sampling tomorrow. I estimate that it will take approximately 54 hours to fully map Area D, about 20 hours less than I first calculated. Providing all of the sampling goes to plan, I expect we will be able to leave this area a day ahead of schedule and return to Area C to pick up the moorings early and then complete additional swath mapping in that area before heading to Darwin.

Saturday, 19 September 2009

Continued to multibeam map Area D until 21:30 hrs (UTC). The gutters continue across the study area and have revealed a nice dendritic pattern. I am wondering whether they are related to underlying structures. We will test this by picking several sites on the gutters to vibrocore on Monday. Successfully completed 7 stations in western region of Area D, as follows:

Station	Latitude	Longitude	Depth (m)	Operations
042	-12° 17.35	129° 58.56	46	Camera (CAM029) Benthic Sled (BS029) Grab – Smith-McIntyre (GR079) Grab – Shipek (GR080)
043	-12° 17.41	129° 57.20	52	CTD (CTD018) Camera (CAM030) Benthic Sled (BS030) Grab – Smith-McIntyre (GR081) Grab – Shipek (GR082)
044	-12° 19.50	129° 57.34	46	Camera (CAM031) Benthic Sled (BS031) Grab – Smith-McIntyre (GR083) Grab – Shipek (GR084)
045	-12° 19.89	129° 57.24	47	Camera (CAM032) Benthic Sled (BS032) Grab – Smith-McIntyre (GR085) Grab – Shipek (GR086)
046	-12° 21.33	129° 57.20	45	Camera (CAM033) Benthic Sled (BS033) Grab – Smith-McIntyre (GR087) Grab – Shipek (GR088)
047	-12° 23.31	129° 58.71	44	Camera (CAM034) Benthic Sled (BS034) Grab – Smith-McIntyre (GR089) Grab – Shipek (GR090)
048	-12° 24.21	129° 58.13	41	CTD (CTD019) Camera (CAM035) Benthic Sled (BS035) Grab – Smith-McIntyre (GR091) Grab – Shipek (GR092)

Generally, the sites were characterised by relatively flat ground, comprising poorly-sorted muddy fine to medium carbonate sands. Area D is subject to very strong tides, and sampling revealed that the seabed is current winnowed and armoured, with a 1-2 cm thick layer of carbonate sand overlying carbonate mud. Major constituents of the sediment are fragments of molluscs, bryozoans and foraminifers, with a good quantity of echinoids. The region is depauperate in benthic biota, with most specimens being sponges, crinoids, hydroids and sea whips. A site over a pock-mark had the most abundant biota, and several species of fish. We collected a CTD over the site to investigate the water chemistry to see if there was anything unusual. Given that the region is subject to very strong currents it will be hard to detect anything. The AIMS camera is providing fantastic footage and stills, which is making the biologists on board very happy.

Sunday, 20 September 2009

Finished multibeam mapping Area D at 22:00 hrs. Today we occupied 9 stations in the central and eastern regions of Area D, as follows:

Station	Latitude	Longitude	Depth (m)	Operations
049	-12° 17.46	130° 01.70	45	CTD (CTD020) Camera (CAM036) Benthic Sled (BS036) Grab – Smith-McIntyre (GR093) Grab – Shipek (GR094)
050	-12° 18.64	130° 01.09	43	Camera (CAM037) Benthic Sled (BS037) Grab – Smith-McIntyre (GR095) Grab – Shipek (GR096)
051	-12° 20.33	129° 59.73	48	Camera (CAM038) Benthic Sled (BS038) Grab – Smith-McIntyre (GR097) Grab – Shipek (GR098)
052	-12° 20.96	130° 01.37	40	Camera (CAM039) Benthic Sled (BS039) Grab – Smith-McIntyre (GR099) Grab – Shipek (GR100)
053	-12° 21.00	129° 58.28	52	CTD (CTD021) Camera (CAM040) Benthic Sled (BS040) Grab – Smith-McIntyre (GR101) Grab – Shipek (GR102)
054	-12° 21.49	129° 59.26	41	Camera (CAM041) Benthic Sled (BS041) Grab – Smith-McIntyre (GR103) Grab – Shipek (GR104)
055	-12° 22.95	129° 59.24	43	Camera (CAM042) Benthic Sled (BS042) Grab – Smith-McIntyre (GR105) Grab – Shipek (GR106)
056	-12° 23.14	130° 00.94	40	Camera (CAM043) Benthic Sled (BS0434) Grab – Smith-McIntyre (GR107) Grab – Shipek (GR108)
057	-12° 23.83	130° 02.67	40	CTD (CTD022) Camera (CAM044) Benthic Sled (BS044) Grab – Smith-McIntyre (GR109) Grab – Shipek (GR110)

Significantly, we sampled hard corals (acropora sp.) in several of the benthic sleds. In the first sample, this hard coral coincided with siltstone (including one sample with a tree root growing through it). We interpreted this to be a hard ground on the edge of one of the gutters that we managed to sample. Subsequent benthic sleds also sampled hard corals on what are supposed to be sediment plains. The camera run's showed acropora corals growing in the carbonate sands, surrounded by small moats. Perhaps, they are growing on the siltstone, which may lie only a few metres below the surface. We will try to answer these

questions tonight with the Sparker SBP and by vibrocoring tomorrow. The area is characterised by strong tides, so we may have to wait until slack tide before we can attempt vibrocoring.

Monday, 21 September 2009

Finished sub-bottom profiles for Area D at 18:00 hrs. The data are very good revealing numerous sub-bottom reflectors, some that crop out at the surface in the vicinity of the gutters. We then completed two further swath lines in the western margin of the area before getting into position for vibrocoring at 21:30 hrs. A total of 8 stations were occupied, as follows:

Station	Latitude	Longitude	Depth (m)	Operations
043	-12° 17.41	129° 57.20	52	Vibrocore (VC011)
058	-12° 20.67	130° 00.56	36	Grab – Smith-McIntyre (GR111) Grab – Shipek (GR112)
059	-12° 24.21	129° 57.59	38	CTD (CTD023) Grab – Smith-McIntyre (GR113) Grab – Shipek (GR114)
060	-12° 22.10	130° 01.14	36	Grab – Smith-McIntyre (GR115) Grab – Shipek (GR116)
061	-12° 20.67	130° 00.59	45	Vibrocore (VC013)
053	-12° 21.00	130° 58.28	52	Vibrocore (VC014)
062	-12° 20.67	129° 57.18	45	Vibrocore (VC015)
044	-12° 19.50	129° 57.34	49	Vibrocore (VC016)

After the first station (STN043) the vibrocorer stopped working. The fault was found to be a loose connector in the head unit, which had shaken loose. After 4.5 hours of troubleshooting by Jack Pittar and Craig Wintle, the head unit was fixed and we collected another 4 cores by 08:00 hrs. While the vibrocorer was being fixed we completed 3 stations to fill in a couple of gaps in the sampling coverage for Area D.

Vibrocores collected in the gutters contained less than 2 m of marine sediment and terminated in stiff (dewatered) grey-brown clay. This clay appears to be the weathered (Pleistocene?) land surface. This surface has been imaged in the sub-bottom profiles, and occurs near the surface or crops out in places. We infer that this relatively hard layer is the layer that the corals are growing on in this highly turbid and otherwise muddy sand seabed. Elsewhere, the cores terminated in sticky marine mud. All in all, a tiring but ultimately successful day.

Tuesday, 22 September 2009

Overnight we transited back to Area C. We then continued to map the western extent of the area until 21:30 hrs. The additional mapping has revealed that shallow hard topped banks that were covered in sponge gardens extend far to the west, beyond the extent of our study area. We then occupied one last sampling station on a steeply-sided ridge, as follows:

Station	Latitude	Longitude	Depth (m)	Operations
063	-11° 40.73	129° 49.46	22	Camera (CAM045) Grab – Smith-McIntyre (GR117) Grab – Shipek (GR118) Benthic Sled (BS045)

The station occupied on the steep ridge shows that the flanks are dominated by hydroids, sponges, and soft corals, with good quantities of fish. The top of the banks is completely barren of epifauna, and characterised by coarse carbonate sand and gravel fashioned into sand waves and small dunes. Although there was significant current running, there was not a lot of bedload transport.

We recovered all four of the moorings (Little Jim, Big Jim, BRUCE, ADCP), as follows:

Instrument	Latitude	Longitude	Time	Comments
ADV (Little Jim)	-11° 38.49	129° 50.53	12:40	All intact; significant biological growth on surfaces. Instruments washed in fresh water and cleaned.
ADP (Big Jim)	-11° 35.53	129° 49.65	05:57	All intact; significant biological growth on surfaces. Instruments washed in fresh water and cleaned. CTD stored in bucket of salt water and turned off in Darwin.
BRUCE	-11° 34.29	129° 50.29	06:47	All intact; significant biological growth on surfaces. Instruments washed in fresh water and cleaned.
ADCP	-11° 32.84	129° 51.13	09:22	All intact; relatively clean of biological growth on surfaces. Instruments washed in fresh water and cleaned.

In each case we had to drag for their ground lines as the floats did not appear at the surface after triggering the acoustic releases. Upon inspection we found that the acoustic releases had worked but the line had not fully payed out of their canisters or had become fouled on the frames. Strong tidal currents in the region probably also are compounding the problem. Some re-assessment of the acoustic release mechanisms is required for future deployments.

Wednesday, 23 September 2009

Completed swath mapping of additional areas in the eastern regions of Area C. Began multibeam mapping at 03:30 hrs. The newly mapped areas reveal the eastern edge of the shallow banks we have been mapping, before they descend into the deep channel. On the banks, superb "comet marks" occur in the lee (south) of isolated reefs, as well as a myriad of other geomorphic feature types.

Got word this morning from Greg Lambert that the RV *Solander* needs to meet the Darwin pilot at 03:00 hrs. To make this rendezvous we finished mapping the eastern section of Area C at 00:30 hrs and began the transit back to Darwin. Pilot embarked at 08:15 hrs. Tied up at Fisherman's Wharf for bunkers at 08:45 hrs. Science crew went ashore for dinner.

Thursday, 24 September 2009

Demobilisation of Geoscience Australia and Australian Institute of Marine Science equipment and samples.

Summary

Overall, SOL4934 has been a thoroughly successful survey. All of the survey objectives were met. Specifically, we occupied all four proposed survey sites, mapped them, and collected a suite of geological and biological samples that have increased our knowledge of the major seabed environments of the eastern Bonaparte Gulf, including one of the deepest shelf channels known on the northern Australian shelf. The data collected reveal the regional environmental context that, when incorporated with existing data, will provide the basis for producing datasets and technical advice on the broad-scale seabed habitats for the region.

The Geoscience Australia and Australian Institute of Marine Sciences officers have again distinguished themselves at sea, with a consummate performance on survey. For their part, the ship's crew could not be faulted for their professionalism, dedication and perseverance to all the tasks asked of them, no matter how onerous. It has been a pleasure sailing aboard the RV *Solander* and with her officers and crew.

APPENDIX C

Geoscience Australia
Seabed Mapping Survey SOL4934
Joseph Bonaparte Gulf, Northern Australia

AIMS Survey Leader Daily Log
Leg 1: Chris Battershill; Leg 2: Steve Whalan

NB: All times are local time (LT).

Introduction

Survey SOL4934 is a collaborative venture between the Australian Institute of Marine Science (AIMS) and Geoscience Australia (GA). The mission is to provide regional biophysical data and information on the shallow seabed environments of the Van Diemen Rise. A full Voyage Plan (CMCG2780A) is available from Geoscience Australia. This report is a log of events for Legs 1 and 2 of the survey. A written account of morning and evening toolbox meetings is attached.

Leg 1

Day 0: 26-08-09

1600 AIMS and GA crew arrive at Pearl Marine Engineering for a Safety Induction to the wharf area. Check on loading of the RV *Solander* with heavy GA equipment (vibrocorer, winch and moorings). All well progressed.

Day 1: 27-08-09

0700 AIMS/GA crew arrive onboard RV *Solander*, load airfreight, pickup Perkins Freight and load. Begin gear setup where possible (noting need for transit tie down). GA begin check and setup of GA in transit sampling gear (water chemistry). AIMS review thermosalinograph operations.

1300 Toolbox meeting and ships induction all crew (science and ship). Emphasise safety, house keeping and discussion of the science plan in general as well as initial sequence of events. Arrangement for Chief Scientist, Cruise Leader and Master to meet twice a day (toolbox meeting at 06:30 and 19:00 hrs) to discuss plans for the day in detail, and review the days activities, issues, safety each evening. Translate the meeting outcomes to Crew at 0700 hrs and again review events at 19:30 hrs. Toolbox notes recorded daily.

1600 Toolbox meeting to discuss detail of activities for day 1 of the survey with all science staff and key RV *Solander* crew. Leave port around 20:00 hrs, transit to Area C, swath as much of the seabed as needed to safely deploy the four moorings. Water sampling in transit and at each mooring location for Chl-a etc., CTD at each mooring site, and a grab. Benthic sled if possible. Then steam to Area A. Multibeam, water samples on the way. Initiate thermosalinograph from Area C (cannot be started in the harbour or close to it because there is too much sediment).

2000 Steam out of Port (delayed from 16:00 hrs due to low tide). Setup/check CTD.

2100 Muster drill.

2200 Patch test for multibeam, then begin swath run to Area C.

Day 2: 28-08-09

0400 Arrive the southern eastern corner of Area C. Multibeam mapping for two hours around the mooring deployment locations. Average depth is -22 m.

0600 Start setup of thermoslinograph. A ridge that rises to approximately -17 m is observed running diagonally across the mapped seabed and through a number of the proposed mooring deployment sites. New sites therefore selected south of the ridge to avoid any 'reef' hook-up.

0700 Toolbox meeting GL, CB, SN to discuss details of days activities, safety, sequence, relay to crew.

0900 CTD cast at ADV deployment site. Smith-McIntyre Grab. Deploy ADV. Several grabs misfired (hard substrate), no sample.

ADV mooring:	-11° 38.6785	129° 50.5562	-22 m

*NB: Actual latitude and longitude for precise grab/TVA and sled start/finish co-ordinates provided on the site and data sheets/AIMS excel files. The figures listed here are the target co-ordinates.

0950 CTD and grab at ADP mooring site. Deploy ADP. Thermosalinograph pumps activated, recording, but not displaying. Grabs failed several times because of hard substratum. Water samples at each site for Chl-a/chemistry.

ADP mooring:	-11° 35.4750	129° 49.5792	-33 m

1130 CTD, Grab, Water Chemistry at BRUCE site. Deploy BRUCE.

BRUCE:	-11° 34.266	129° 50.2406	-49 m

1400 CTD, Grab Water Chemistry at ADCP site. Deploy ADCP

ADCP:	-11° 32.564	129° 51.0824	

1419 Benthic Sled (250 kg shell and bryozoan sediment). Samples processed (as were grab samples). Weighing each species / OTU, photography and fixation. 04BS01 Samples: 28471-28480.

Start: 14:19	11° 32.298	129° 51.061	-82.0 m
Finish: 14:22	11° 32.395	129° 51.092	-76.1 m

1440 Begin swath run to Area A. Thermosalinograph data capture and live imagery issues OK. Area C logging saved to file. Transit Area C to Area A file initiated. NB: significant salinity and temperature discontinuity observed between Areas C and A.

1900 Toolbox meeting GL, CB, SL. Safety review. Rope snapped bringing very heavy sled cod-end on board. Agreed to shorter tow (2 mins) and using the back deck for initial sorting to avoid any potential injury. Steve Hodgkin ill with early onset flu possibly. Medicated and sent to rest.

2100 Arrive Southeast corner of Area A. Commence Multibeam runs north/south moving from east to west. Create new thermosalinograph file for Area A. Multibeam through

the night and next 24hrs to achieve mapping of at least half Area A before sampling commences.

Day 3: 29-08-09

0600 ToolBox meeting: M, SL, CL. Work to continue as planned. Steve Hodgkin well and staff who were feeling a little seasick also checked. All now well.

0730 Improve visual replay from back deck in readiness for TVA, sled and grab work. Improve geostamping etc. on digital recordings from TVA devices. Ready photoquad cameras etc. Check thermosalinograph operation/ recording. Multibeam proceeding well, although the absorbance of the benthic material on the seafloor is high, hence the swath width is low and the reflectance also low. The benthos in the southeast corner of Area A has higher reflectivity that the region to the north and west (so far).

1800 Planning for the remainder of Leg 1 assuming good weather.

1900 Toolbox meeting: M, CL, SL. No issues, all well (seasickness/flu) now. Review voyage plan as above. Discuss sequence of deployments (grab, CTD, light probe, TVA, grab, sled). Shakedown: 30/08/09 first station.

Day 4: 30-08-09

Area A, Swath continued all night.

0630 Thermosalinograph off line. Identified the issue and will reboot once the sampling has finished at the days stations.

0700 ToolBox meeting: M, CL, SL. Confirm today's activities and order of back deck deployments at each station.

0815 <u>Station 5</u>
CTD Cast -10° 28.083 129° 42.079' -78.0 m

0830 Shipek Grab -10° 28.087 129° 42.084 -78.0 m [05GR06 = 3.1 kg]

0900 Niskin profile: -5 m and -70 m -10° 28.037 129° 42.166

0905 05CAM01 (500 m transect)

Start: 09:10 -10° 28.019 129° 42.180
Finish: 09:32 -10° 20.099 129° 41.994

Sandy mud bottom with tufting hydroids, signs of substantial bioturbation; Soft corals @ 1/20 m^2; Cinachyra 1/30 m^2; Oceanapia as TVA approaches a raised reef (ridge) 1-3 /5 m^2 (rocky ridge/reef is 7 minutes into transect and can be observed for 10 minutes). Very dense gorgonian/SC/Sponge field on the reef 5-10 orgs m^{-2} at peak. Good fish abundance. Reef runs out again into sed flats as before.

0945 Smith-McIntyre Grab -10° 28.097 129° 42.087 -80 m [05GR06 = 3.1 kg]

1000 LiCor depth profile same co-ordinates (0-50 m).

1000 Niskin Bottle profile same co-ordinates (-5 m and -70 m).

1030 05BS02 sled station 5.

Start: 10:30 -10° 28.088 129° 42.136 -80 m
Finish: 10:32
Samples 28481-28552 70 samples Macro fauna (70 + spp).

Taxa	**Bulk Weight**
POR	19 kg
Sea Whips	100 g
Soft Corals	500 g
Black Coral	360 g
Gorgonians	1.8 kg

11:10 Station 6
Smith-McIntyre grab -10° 379059 129° 71178 [06GR07 = 12 kg] (GA samples 001638,001639, 001641)

Shipek grab same co-ordinates.

11:30 TV 06TV02 (500 m transect) [06CAM02]

Start:
Finish:

Soft sediment, bioturbated, little macrofauna.

11:45 Shipek grab same co-ordinates as 06GR07.

12:00 06BS03 sled Station 6 (2 mins on bottom @ 200m) -96 m

Start: -10° 22.481 129° 42.813
Finish: -10° 22.566 129° 42.774

Very little/no live material landed only shells (debris). Samples AIMS: 28498, 28499, 28531, 28532.

14:00 Station 7
Smith-McIntyre grab -10° 18.724 129° 40.664 -102 m [07GR10 = 11.7 kg]

Shipek grab (07GR11) same co-ordinates as 07GR10.

07TV03 (500 m transect) [07CAM03]
Sediment flats, bioturbated, little macrofauna.

14:20 07BS04 (BS004 GA files) Samples 28553-28556 (4 spp.)

Start: -10° 18.494 129° 40.807
Finish: -10° 18.342 129° 40.740

14:40 Station 8
Smith McIntyre grab -10° 22.656 129° 38.676 -95 m [08GR12 = 13.5 kg]

Shipek grab same co-ordinates at 08GR012

15:30 08TV04 (-98.6 m water depth) [08CAM04]

Start:	-10° 22.616	129° 38.664
Finish: 15:40	-10° 22.433	129° 38.816

Sediment flats, a few sea whips, low diversity of macrofauna.

15:40 08BS05 (BS005 GA files) Samples 28557-28564 (8 spp)

Start:	-10° 22.443	129° 38.812
Finish:	-10° 22.637	129° 38.659

16:00 CTD and niskin profile -5 m and -70 m. LiCor cast 0-50 m water depth.

16:45 Box Core: deck crew and GA review procedure before start.
(8 cm depth recovered) -92 m water depth

08BC01:	-10° 22.605	129° 38.683

17:00 Swath Mapping continues Area A, north to south, moving westwards. Continue through night and all of 31-08-09.

19:00 Toolbox meeting: M, CL, SL. Discussion on how to improve back deck efficiency: Large haul of biomass slows wetlab work with backlog - slow to process properly. Niskin and LiCor deployment slow.

Day 5: 31-08-09

00:00 Swath Mapping Area A

06:00 Thermosalinograph data capture.

07:00 Toolbox meeting: M, CL, SL. Review days activities. ID catch-up projects (check on GPS recording systems; backup all tape and digital files; start-up ThermoSalin and review data files for integrity; check Geostamp system on TVA). Water sampling/chemistry continues.

1800 Half of Area A now mapped. Ridge systems running through the lower (southern) centre. Rearrange station co-ordinates to cover a range of habitats, sediment flats and rocky reef/ridge. Back-up data files, data entry, etc. Moss Shoal appears very shallow (to -9 m), detailed mapping required.

1900 Toolbox meeting: M, CL, SL. Check waypoints for sampling six stations 01-09-09. 0600 hrs on station and deploy CTD, Niskin, Grab (Smith-McIntyre, Shipek), Box core, CAM, sled at each station (Box core/niskin only 2 stations).

2030 'Man over board' drill.

Day 6: 01-09-09

0530 <u>Station 9</u>
Toolbox meeting: M, CL, SL. Confirm days activities/sequence as per plan.

0555 CTD and niskin cast: -10° 23.936 129° 36.293

0625 Box Core: -10° 23.913 129° 36.282 -93.3 m

0640 Smith-McIntyre grab: -10° 23.923 129° 38.676 -93.7 m

Shipek grab: -10° 23.909 129° 32.286 -93.7 m

GA Samples: 001653-001655 for 09GR12.

0700 09TV05 [09CAM05]

Start: -10° 23.983 129° 36.326 -92.7 m
Finish: -10° 23.586 129° 36.448 -93.7 m

Bioturbated sediment flats, some whips in patches 1-5 / m^2.

0727 09BS06

Start: -10° 23.629 129° 36.434 -93.5 m
Finish: -10° 23.731 129° 36.377 -92.9 m

Samples 28565-28568 - gorgonians and whips.

0815 Station 10
Smith-McIntyre grab: -10° 25.898 129° 39.526 -109 m
Shipek grab: -10° .25.883 129° 39.521 -92.7 m

GA Samples: 001657-001659 for 10GR16.

0838 10TV06 [10CAM06]

Start: -10° 25.932 129° 39.313 -89.7 m
Finish: -10° 25.793 129° 39.551 -104.2 m

Sediment flats then sponge and gorgonian garden; dense 5 individuals/m^2 up to 20/m^2; rocky ridges and trenches.

0904 10BS07

Start: -10° 25.860 129° 39.386 -94.7 m
Finish: -10° 25.846 129° 39.402 -103.1 m

Redo, Sled too short run time:

Start: -10° 25.848 129° 39.322 -93.5 m
Finish: -10° 25.803 129° 39.372 -98.3 m

Total weights: Sponges = 12 kg, Gorgonians = 1.5 kg, soft corals = 1 kg
Samples: 28569-28600 for 10BS07.

0955 10RD01 (Rock Dredge)

Start:	-10° 25.854	129° 39.395	-92.6 m
Finish:	-10° 25.846	129° 39.402	-91.1 m

Total weights: sponges = 10 kg, gorgonians = 10 kg, rocks)
Samples :28587, 28601-28605.

1100 Station 11

Smith-McIntyre grab:	-10° 26.851	129° 33.296	-94.6 m
Shipek grab:	-10° 26.807	129° 33.280	-96 m

GA Samples: 001656, 001661, 001662.

1122 11TV07 [11CAM07]

Start:	-10° 26.789	129° 33.194	-95.9 m
Finish:	-10° 26.527	129° 33.227	-88.7 m

Sediment flats, some bioturbation.

1151 11BS08

Start:	-10° 26.522	129° 33.240	-89.8 m
Finish:	-10° 26.617	129° 33.238	-91.1 m

Samples: 28606-28624.

1238 Station 12

Smith-McIntyre grab:	-10° 22.226	129° 33.425	-107.7 m
Shipek grab:	-10° 22.264	129° 33.462	-107.3 m

GA Samples: 001664-001666.

1311 12TV08 [12CAM08]

Start:	-10° 22.442	129° 32.263	-90 m
Finish:	-10° 22.248	129° 33.415	-107.3 m

Gorgonian and whip garden 6-10 individuals/m^2, rock outcrops, then open sand flats, bioturbated.

1344 12BS09

Start:	-10° 22.396	129° 33.280	-91.1 m
Finish:	-10° 22.359	129° 33.321	-106.4 m

100 kg whole shot; Pink knob sponge 20 kg (60 individuals); Cinachyra 17 kg (250 individuals); Llithistid? 6 kg; Oceanapia? 1.5 kgk sandy sponge 1 kg; rest rocks/rubble. Samples: 28625-28674.

1425 Station 13

Smith-McIntyre grab:	-10° 18.428	129° 33.761	-90.9 m
Shipek grab:	-10° 18.406	129° 33.807	-90.7 m

GA Samples: 001669-001672.

1438 13TV09

Start	-10° 18.369	129° 33.670	-91.2 m
Finish	-10° 18.400	129° 33.389	-97.4 m

Gorgonian Gdns and sed flats Gdns 10-15m dia. Cinachyra v dense in patches.

1517 13BS10

Start	-10° 18.393	129° 33.559	-91.7 m
Finish	-10° 18.400	129° 33.512	-94.2 m

Cinachyra = 1.7 kg, gorgonians = 140 g. Samples: 28676-28680.

1558 Station 14

CTD, niskin and LiCor cast:	-10° 18.563	129° 37.118	-89.8 m

1620	Smith-McIntyre grab:	-10° 18.377	129° 37.035	-89.4 m
	Shipek grab:	-10° 18.472	129° 36.991	-89.6 m

GA Samples: 001673-001675.

1635 14TV10 [14CAM10]

Start:	-10° 18.505	129° 36.950	-89.8 m
Finish:	-10° 18.288	129° 37.051	-89.2 m

Course sand, sunken patches of sponges and fans; patches 10 m apart and 5 m diameter; 10 individuals and 8 spp. on av/m^2 inside patches.

1705 14BS11

Start:	-10° 18.350	129° 37.014	-89.1 m
Finish:	-10° 18.424	129° 36.960	-90.2 m

Shell, sponges, gorgonians = 17 kg total, sponges = 3.2 kg, gorgonians = 600 g rest rocks (miscellaneous = 500 g). Samples: 28681-28707.

1930 Toolbox meeting: M, CL, SL. Review day. Successful. Mapping now until 0800 03-09-09.

Day 7: 02-09-09

0730 Toolbox meeting: M, CL, SL. Mapping continues, some issues with the swath software, but survivable.

0830 Set up vibrocorer back deck.

0900 Attempt to reboot thermosalinograph.

1300 Thermosalinograph still not operational, TCP/IP issue. Work continues on it. Resolve geostamping display issues for GA. Biological data workup all day.

1900 Toolbox meeting: M, CL, SL. Review days activities, on target although some time lost due to narrow swath width (high signal absorbency of sediments through much of Area A). Run the Sparker sub bottom profiler through the evening as at least four tie lines (east – west).

1930 Deploy Sparker and acoustic eel.

Day 8: 03-09-09

0630 Toolbox meeting: M, CL, SL, confirm completion of tie-line runs (sub-bottom profiling) and vibrocore stations.

0700 Thermosalinograph data download. New file for next run.

1000 <u>Station 15</u>

Vibrocore	-10° 26.997	129° 41.675	-109.1 m	[15VC01]

1230 <u>Station 16</u>

Vibrocore	-10° 26.950	129° 37.992	-104.1 m	[16VC02]

1320 <u>Station 17</u>

Vibrocore	-10° 23.980	129° 40.016	-84.4 m	[17VC03]

1350 <u>Station 18</u>

Vibrocore	-10° 23.986	129° 41.477	-116.1 m	[18VC04]

1405 Smith-McIntyre grab: -10° 20.022 129° 41.483 -100.5 m

1413 Shipek grab: -10° 24.059 129° 41.481 -121.3 m

1440 <u>Station 19</u>

Vibrocore	-10° 20.982	129° 41.525	-115.4 m	[19VC05]

1455 Smith-McIntyre grab: -10° 129°

1500 Shipek grab: -10° 129°

1500 <u>Station 20</u>

Vibrocore	-10° 20.959	129° 41.492	-88.2 m	[20VC06]

1615 Swath mapping remainder of Area A.

1930 Toolbox meeting: M, CL, SL. Review days activities, improvements to vibrocoring deployment and retrieval (safety features). Very successful day. Six cores and grabs in addition to sub-bottom profiling lines with good data retrieval. Core barrels are 3 m long, most sediment cores of at least 2 m achieved. Six tie line sub-bottom profiles carried out (4 east-west and 2 north south as per diagram using the Sparker and hydrophone). Good data

collected as per geologists comments, with good penetration @ 70 mbsf. A 3 m over layer of 'recent' sediments present. SN, SH indicated that there was evidence of in-filled terraces and valleys.

Day 9: 04-09-09 - Transit Area A to B

0500 Prepare to sample water across the observed discontinuity between Area A and B. Analysis of thermosalinograph profiles indicates that the water within Area A is different to that immediately south of the study area. In addition a further much steeper gradient in water quality (increase in salinity of 1 PSU and 1 °C) is expected (as seen on the northern transit at the beginning of the voyage.

0700 Sample water as the thermosalinograph plot indicates a steep rise in salinity and temperature and a slight drop in fluorescence.

0830 Water salinity and temperature has plateaued at -10° 47.840, 129° 41.800.

1100 Arrive NW Area B. Commence Swath Mapping of Area B

1105 Swath sounder fail. Discontinue swath to fix. Change plan to begin sampling of the shallow areas (Moss Shoal). Weather 10-20 knots, but relatively low swell, good visibility, therefore priority to get the shoals done until swath repaired. Steam to shoals.

1300 <u>Station 21: Moss Shoal</u>
Camera 21TV?? [21CAM??]

Start:	-11° 08.050	129° 55.367	-44.1 m
Finish:	-11° .1395696	129° 54.926	-30.5 m

1330	CTD	-11° 08.374	129° 54.840	-26.6 m	
1340	Niskin	-11° 08.514	129° 54.784	-11.9 m	
1345	LiCor	-11°	129°		
1410	Smith-McIntyre grab:	-11° 08.339	129° 55.002	-36.5 m	[21GR20]
	Shipek grab:	-11° 08.376	129° 55.025	-44.1m	[21GR21]
1445	Benthic sled [21BS12]				

Start:	-11° 08.568	129° 54.863	-32.5 m
Finish:	-11° 08.582	129° 54.941	-37.3 m

300 kg rock and rubble collected. AIMS Samples: 28709-28759. 50 species minimum, again a large variety of gorgonians and sponges. A different assemblage to the communities observed in Area A with many reef building/accreting species present (Tubipora, Ircinia and Cacospongia sponges, some ascidians – Didemnids). Noteworthy is the near absence of algae (given the shallow shoal habitat), only a small number and very small biomass of filamentous reds, and only a hint of *Halimeda* (n=1 branch in the 300 kg haul).

1450 Swath mapping area B begins (sounder unit repaired).

1900 Toolbox M, CL, SL. The delay caused by the sounder on the Multibeam going down was not too serious, as a sampling station was completed within the time it too to fix it. All well, no incidents.

2000 Multibeam mapping well. Much better data acquisition than Area A as the bottom is providing good reflection of signals (shallower also), hence swath is wider. Faster progress expected to map Area B. (NB running West-East to reduce ships movement in the prevailing weather).

Day 10: 05-09-2009 - Area B

0800 Toolbox meeting: M, CL, SL. Continue as per plan. Swath mapping Area B. Expect to focus sampling in the North West area due to some complexity observed on the seafloor in that region. Benthic sampling backup if the sounder issue repeats.

0830 Swath mapping all day. Workup data transcription, maintenance and associated tasks. Continue water sampling. Thermosalinograph logging continuously. Work up data, backup files.

1930 Toolbox meeting: M, CL, SL. Successful day. Close to 200 Nm swath mapped so far in Area B. Decision to map the shallow shoal area to the northwest corner within the area over night given favourable sea conditions.

Day 11: 06-09-2009 - Area B

0800 Toolbox meeting: M, CL, SL. Swath map until approximately 3 pm, then three benthic stations. Re-commence swath through the night.

0900 Down load CTD data and transform into readable data files, verify SOL 4934 CTD profiles all captured.

1100 Download thermosalinograph hexadecimal files and save to GA/AIMS. Reboot TSG (clean fluorometer head), and start-up new file for remainder of Area B.

1500 <u>Station 22</u>
22TV12 [22CAM12]

Start:	-11° 00.512	129° 47.388	-82.5 m
Finish:	-11° 00.508	129° 47.081	-60.4 m

Transect across and upward on a mound like feature on the bottom. Sediment flats with low diversity (soft corals) and *Oceanapia*, midway through transect, reef outcrops and Gorgonian patches (6010 individuals/m^2 diverse; patches 5-10 m apart. Merges to sponge gardens in shallower areas, very dense and diverse.

1529 Smith-McIntyre attempt, no sediment; move to deeper part of the transect to redo.

1540 Benthic sled [22BS13]

Start:	-11° 00.517	129° 47.132	-54 m
Finish:	-11° 00.449	129° 47.099	-53.2 m

100 kg total weight landed mainly sponges and gorgonians: gorgonians = 2 kg; Halichondrids (sponges) = 25 kg; Spongosorites = 6.5 kg; Knobbly sponges sp. = 12.5 kg; Xestospongia = 6 kg; Mixed and diverse spp. weighed separately (total = 5.6 kg); rubble sponge fragments = 12 kg; rest rocks. AIMS Samples: 28760-28815.

1550 Smith-McIntyre grab: -11° 00.515 129° 47.386 -82.7 m [22GR31]

GA Samples: 001689-001691.

1600 Shipek grab: -11° 00.496 129° 47.363 -81.1 m [22GR32]

1735 Station 23
23TV13 [23CAM13]

Start:	-11° 02.293	129° 48.997	-82.7 m
Finish:	-11° 02.335	129° 48.767	-55.2 m

Transect across and upward on a mound like feature on the bottom. Sediment flats with low diversity (soft corals) and Oceanapia, well bioturbated, Stomatopod holes and other scour patches. Infrequent but very large Xestospongia barrels. Increasing Oceanapia as slope increases (shallower). Rise crest: reef outcrops and Gorgonian patches (6010 individuals/m^2 diverse; patches 5-10 m apart. Merges to sponge gardens in shallower areas, very dense and diverse. Similar to Station 22.

1800 23BS14

Start:	11° .0383208	129° .81193996	-54.8 m
Finish:	11° .0371423	129° .81181241	-55.7 m

Bulk Weights: Total haul 250 kg; mostly Haplosclerid sponges particularly Xestospongia (30 kg); Halichondird knobbly sponge (48 kg) and gorgonian fans = (1.5 kg) with much rubble both rock and sponge fragments. Samples: 28816-28883

1815 Smith-McIntyre grab: -11° 02.146 129° 48.847 -76.5 m [23GR33]
GA Samples: 001693-1695.

1825 Shipek grab: -11° 02.146 129° 48.847 -76.5 m [23GR34]

1900 **Station 24**
24TV14 [24CAM14]

Start:	-11° 02.713	129° 46.797	-106.5 m
Finish:	-11° 02.590	129° 52.673	-104.9 m

TVA transect cut short as light failed (depth limit exceeded, fixed on return to surface). Sediment flats as predicted with bioturbation. Some fine hydroid turfing, but sparse. No sponges and few macro inverts. Benthic sled run decided against in interests of time.

1915 CTD and niskin profiles: -11° 02.461 129° 46.734 -105.4 m

1915 Smith-McIntyre grab: -11° 02.461 129° 46.734 -105.4 m [24GR34]
GA Samples: 001695-001698.

1918 Shipek grab: -11° 02.461 129° 46.734 -105.4 m [24GR35]

Day 12: 07-09-2009 - Area B

0630 Swath mapping since last grab recovered on 06-09-09 within the central/southern section of Area B. Power supply changeover on the ship caused the Swath display/capture (mouse and keyboard failed), non function on re-power. Had to reboot; possible memory loss. Lost data may be available on back-up system, but delayed swathing for about half an hour. The power change over also stopped the thermosalinograph pump, the system needed rebooting.

0730 Continue swath mapping, data work-up/reporting. Water chemistry continues.

1550 Thermosalinograph exibits increasing variability in temperature and salinity plots. This co-occurs with observation of Trichodesmia(?) slicks in the region. A series of water samples are therefore taken through the afternoon to complement those taken on the 6th which exhibited very high levels of micro-plankton (clogged the filters, samples kept). Water chemistry continues to be monitored by GA scientists. Filters are kept from water sampling through the afternoon to identify the planktonic constituents.

2100 Download CTD data and convert files for reading.

Day 13: 08/09/2009 - Area B

0600 Good progress on swath mapping through the night. One area east of Moss Shoal omitted as it became quite shallow (<9 m). Will be done during daylight. Estimates suggest 24 hrs of swathing ± 2 hrs remaining. Plan for 4 stations of benthic sampling in prioritised order, will attempt at least 2 during the next 24 hrs.

0730 <u>Station 25</u>
25TV15 [25CAM15]

Start:	-11° 09.633	129° 49.926	-73.6 m
Finish:	-11° 09.756	129° 49.601	-44.1 m

Sediment flats with few hydroids and sporadic urchins. Finger sponges. Macro-invertebrates few about 1 per 5-10 m^2. Bioturbated, mounds and holes. Some crinoids on the sand.

0807 Seafloor rising (base of reef feature.) still deep sediments, but increasing sponges - Oceanapia, Thorecta, Ianthellas predominate. Crest of ridge has rock outcrops 5-6 individuals/m^2. Moderate diversity and biomass. Many red gorgonian fans. Three colour morphs: Ianthella (possibly 2-3 spp., I. basta, I. flabelliformis).

0820 Smith-McIntyre grab: -11° 09.686 129° 49.601 -69.7 m [25GR36]
GA Samples: 00-00

0830 Shipek grab: -11° 09.634 129° 49.731 -70.8 m [25GR37]

0844 Benthic sled [25BS15]

Start:	-11° 09.751	129° 49.567	-44.3 m
Finish:	-11° 09.671	129° 49.559	-51.3 m

Approximately 200 kg collected. Orange gorgonians (10.5 kg; Ianthella = 5 kg; Lithistid = 6.5 kg; Xestospongia = 34 kg; Xestospongia flat morph = 13 kg; Halichondrid knobbly = 58 kg). AIMS samples:.

0935 Station 26
26TV16 [26CAM16]

Start:	-11°	129°	
Finish:	-11° 05.861	129° 52.082	-73.6 m

Flat bottom. Fine sediment bottom, very low diversity of macro-benthos. Strong current (kicking up fines), sparse finger sponges and whips 1/20+ m^2.

0955 Smith-McIntyre grab: -11° 05.775 129° 52.096 -79.8 m [26GR38]
GA Samples: 00-00.
1000 Shipek grab: -11° 05.477 129° 52.132 -78.6 m [26GR39]
1015 Benthic sled [26BS16]

Start:	-11° 05.556	129° 52.116	-78.9 m
Finish:	-11° 05.301	129° 52.183	-78.3 m

Light Haul, <1 kg. Urchins, shell fragments and small gorgonians. AIMS samples:.

1110 Station 27

Vibrocore:	-11° 03.593	129° 53.962	-74.7 m	[27VC07]
1130 Smith-McIntyre grab:	-11° 03.990	129° 53.954	-75.0 m	[27GR40]
GA Samples: 00-00.				
1140 Shipek grab:	-11° 03.910	129° 53.964	-75.2 m	[27GR41]
1145 CTD and niskin casts:	-11°	129°		

NB: No benthic sled/TV (CAM). This is a flat sediment habitat.

1220 Station 28

Vibrocore:	-11° 07.480	129° 48.286	-74.7 m	[28VC08]
1230 Smith-McIntyre grab:	-11° 07.512	129° 42.270	-108.3 m	[28GR42]
GA Samples: 00-00.				
1237 Shipek grab:	-11° 07.300	129° 48.385	-106.3 m	[28GR43]

NB: No benthic sled or TV (CAM).

1240 Continue swath mapping remainder of Area B. Complete chirper lines for backscatter.

Summary Statements: Biodiversity

Area A and B had some species in common (the abundant orange gorgonian fan, Lithistid, *Xestospongia* and Halichondrid species). The biomass of assemblages was higher in Area B. There were however significant numbers of species that were found either in areas A or B, not both. Within Area A most stations were significantly different. Area B had a higher homogeneity in terms of diversity within any taxonomic group (Phyla) across stations sampled. In both areas related to water depth and sediment quality. Benthic sediment flats were generally highly bioturbated and had low diversity/biomass of macro-faunal elements (1 individual/species per 25 m^2 on average estimated). As sediment flats gave way to rises in the topography toward rocky reef crests/outcrops, species diversity rapidly increased to communities characterised by gorgonian fans and massive sponges. Densities of organisms/ species could be as high as 10-20 individuals and 10+ species per m^2.

Of note is the presence of Lithistid sponges (if indeed these are identified correctly; spicule analysis needed). These are a deep water (usually cold temperate) group of ancient sponges (sometimes called the 'stony sponges'). They create reef structure, as do the Halichondrids, and Choristids which are also present in abundance. Reef accreting species such as *Ircinia* and *Sarcotragus*/*Cacospongia* were evident in very shallow stations (influenced by very high currents), intermixed with *Tubipora*. These species can significantly consolidate and stabilise reef systems encouraging biodiversity build up from successional species.

Overall in established areas of rocky reef outcrop and ridges, biodiversity per 100 m^2 scale is very high, on a par with Ningaloo Reef, if not a little higher. Over large geographic scales, the diversity is lower than Ningaloo Reef by reference example. The assemblages are different from the WA west coast (although there is a need to check against the Kimberley fauna which is also sediment tolerant). The assemblages are distinct from the East Coast and Torres Strait (apart from *Ianthella*, but species to be confirmed). Over 750 samples have been collected representing over 200 (estimated minimum) taxonomically distinct units across the stations sampled to date. The species are representative of organisms that can tolerate high levels of sedimentation. The sponges present can contribute to reef formation and consolidation.

Samples of *Ianthella* have been kept for genetics to add to ongoing AIMS studies of the biogeography and possible speciation of this Genus. Some disease was also observed in this species (as is apparent in GBR *Ianthella*); samples taken.

Biologically, this has been a very successful voyage to date with some important collection/ecological contributions permitting expansion of our knowledge of the biogeography of this little studies region as well as permitting advance in understanding some of the ecological drivers of habitats examined.

SOL4934 Leg 1: Overall Summary

This has been a very successful first leg with all objectives being met. Inevitably there were some technological issues to deal with given the high use/reliance on sophisticated sampling equipment (multibeam; CTD; thermosalinograph; grabs; vibrocorer). All issues were satisfactorily and speedily dealt with. The skill (and dedication irrespective of the time of day/night and conditions) of the GA swath mapping staff and ship's crew deserve acknowledgement. The RV *Solander*'s increasingly diverse suite of under-way marine monitoring equipment came into its own on this voyage enhancing planning and information capture to significantly value add the planned work. There are some issues with current SOPS with some of the AIMS equipment, to be expected with bedding these new tools down, but these are being speedily resolved. Given science projects increasing reliance

on seamless and continuous monitoring services, there is a need to review UPS availability to reduce down time with generator change over. In short, the first leg is complete in all aspects with areas A and B fully mapped and the full set of sampling stations with some extras completed.

Leg 2

Continuing from Leg 1 this report is a Log of events for Leg 2 of the Voyage. Details of swath mapping provided by Andrew Heap of Geoscience Australia.

Day 0: 9-09-09

AIMS and GA crew arrive at Pearl Marine Engineering Yards/Dock for a Safety Induction to the Wharf area (active marine dry dock and yard). Load supplies and gear including drill for GA for leg 2 onto RV *Solander*). Transport biological samples, collected during leg 1, tot ATRF labs in Darwin pending delivery to final storage in Townsville. All work progressed well. Handover of operational procedures for all GA and AIMS staff changes. Due to crew fatigue and unfavourable tides night spent onboard in harbour. ETD tomorrow at 0730.

Day 1: 10-09-09

Depart Darwin and begin gear setup where possible (noting need for transit tie down). GA begin check and setup of GA in transit sampling gear (water chemistry). AIMS review thermosalinograph operations. Engineer undertakes some plumbing repairs to thermosalinometer before it can be started.

Tool Box meeting 1 and Ships Induction all crew (science and ships). Emphasise safety, house keeping and discussion of the Science Plan in general as well as initial sequence of events. Arrangement for Science Leader, Cruise Leader and Master to meet once /twice a day, as necessary. (Toolbox at 0630 and 1900 hrs) to discuss plans for the day in detail, and review the days activities, issues, safety each evening. Toolbox 2, discuss detail of activities for Day 1 of the voyage with all science staff and key ship's crew.

Day 2: 11-09-09

Transit to Area C. Swath mapping all day

Day 3: 12-09-09

Sampling day using towed video, benthic sled, CTD and benthic grabs form five different stations. All towed videos ranged between 30-60 m and showed high diversity and numbers of sessile benthic invertebrates with the exception of the first station (29) which showed little biota. Bottom composition was generally of a flat relief with a mixture of sand/mud and unconsolidated rubble/rocks. Of note was the large numbers of sponges from the genera Ianthella and Xestospongia. To a lesser extent soft corals (Juncella), stalked crinoids and gorgonians were observed in video transects.

Benthic sleds were deployed at sites based on the video tows, each sled dragged over 100m. Benthic sleds generally yielded significant hauls, dominated by large individuals of Ianthella and Xestospongia sponges, some hauls recording up to 50 kg (per sled) for each of these genera. Several species of Oceanapia were also collected. Numerous crinoids, crustaceans and hydroids were also collected. Fish and molluscs were also present but in smaller numbers.

Summary of species diversity from benthic sleds (across all stations)
Sponges up to 25 (Stn32)
Gorgoanians 1 sp (Stn32) to 7 spp (Stn32)
Echinoderms 2 spp (Stn02) -10 spp (Stn02)
Soft corals (including whips) up to 3 spp (Stn02)
Crustaceans up to 7 spp (Stn29)
Molluscs(including cephlapods) up to 6 spp (Stn32)
Fish up to 3 spp (Stn32)

Benthic grabs yielded very little epifaunal or infaunal invertebrates.

CTD data was obtained at two stations and the thermal salinometer continues to capture data. Of note were large spikes in fluorescence readings which appear to correspond to movement through Trichmodesmium blooms.

Day 4: 13-09-09
Swath mapping all day Area C.

Day 5: 14-09-09
Sampling day, completing six stations including a deeper station to approximately 180m.
Sampling included towed video, benthic sled, CTD, grabs at most stations although towed video could not be completed at station 36 due to the depth of 180 m. Vibrocores were completed at stations 36 and 38 and a rock dredge was also undertaken.

Towed videos showed similar results to surveys undertaken on the 12-09-09, habitats generally comprising flat relief topography with sand/mud/ rock platforms supporting moderate to high benthic biodiversity. Predominant groups were sponges, crinoids and octocorals. Station 34 showed significant benthic invertebrate biomass and biodiversity while station 38 showed very little obvious signs of biology, characterised by a depauperate sandy bottom. This was also seen in the benthic sled which yielded a light haul mostly with echinoderms (crinoids and asteroids). The majority of other stations sampled showed moderate to large hauls the community compositions comparing well with yields from surveys undertaken on the 12 09 09.

Benthic grabs yielded very light hauls of infauna which were mostly polychaetes. Approximately 160 samples were collected from benthic sleds across all six stations.
Summary of species diversity from benthic sleds (across all stations):
Sponges: up to 12 spp (Stn34
Soft corals: up to 16 spp (Stn34)
Gorgonians: up to 8 spp (Stn34)
Echinoderms: up to 10 spp (Stn34)
Bryozoans: up to 7 spp (Stn35)
Ascidians: up to 11 spp (Stn34)
CTD data was obtained at two stations and the thermosalinometer continues to capture data.

Day 6: 15-09-09
Swath mapping all day Area C.

Day 7: 16-09-09

Swath mapping all morning as well as Sparker deployment. During this time the drill rig was also assembled and subsequently deployed at four different sites. Cores were retrieved but only sections approximately 30 cm in length were recovered probably because of unconsolidated sections of substrata being lost on drilling. Coral pieces were recovered from cores suggesting previous coral reefs existed in this region. The drill was damaged on the last deployment and cannot be used again on this trip. Problems with the operation of the multibeam worked on overnight to remedy.

Day 8: 17-09-09

Morning spent working on multibeam, which is still out of action. Sampled by vibrocore but unsuccessful due to moderate current and unsuitable terrain. In the afternoon two stations were sampled deploying towed video, sled, grabs and CTD.

Station 27: Towed video showed flat relief substrate with a sandy bottom. Depauperate benthic biology with only limited individuals of crinoids and soft corals (e.g. Juncella spp observed). Benthic sled deployed but was snagged for a short period, the resultant load bringing up a large quantity of mud and debris. The net also had a large hole which required repairs. Very little biology was recovered from the mud load.

Station 28: Towed video showed flat topography of sand and rock pavement supporting moderate to high benthic biodiversity, many sponges including Ianthella spp; Xestospongia spp, Spongia, Sarcotargus and Axinellids. Other benthic taxa included crinoids urchins and soft corals. Benthic sled captured a significant haul with high diversity of sponges, octocorals, bryozoans, crustaceans, ascidians and echinoderms. Of interest was the recovery of a pipefish.

Summary of benthic diversity from sleds at two stations. A total of 153 samples were collected showing the following species diversity (all from station 28):

Sponges: 53 spp (total weight 40 kg)
Gorgonians: 5 spp
Ascidians: 3 spp
Echinoderms: 44 spp
Crustaceans: 10spp
Bryozoans: 6 spp
Fishes 3: spp

Afternoon and overnight transit to Area D.

Day 9: 18-09-09

Swath mapping all day Area D.

Day 10: 19-09-09

Sampling plan to include 7 stations in Area D. Swath mapping indicative of flat bathymetry throughout mapped parts of Area D to date. Towed Video conformed this with 7 stations (stations 43-48) showing flat bottom profiles comprising sandy /mud compositions with no obvious signs of hard substrates. Most sites had strong currents associated with tides of up to 7 m also resulting in very turbid water conditions making video observations difficult. Video footage also showed low abundances and diversity of benthic taxa in comparison to Area C. Of interest was the observation that discrete patches of hard branching corals exist in these turbid, low-light conditions (35-45 m).

Samples retrieved from benthic sleds (all stations) were very light recovering only a handful of material from each station. In excess of 70 samples (72 species) were collected from all 9 stations with a summary of species diversity listed below. Species diversity was low when compared to Area C, the most diverse assemblage was associated with station 42.
Summary of benthic diversity (Station 42):
Sponges: 4 spp
Echinoderms: 10spp
Octocorals: 1sp
Crustaceans: 5 spp
Ascidians: 3spp
Bryozoans: 3 spp

Day 11: 20-09-09
Sampling plan to include 9 stations in Area D. Results of sampling consistent with the yesterdays sampling (19-0-9-09) in terms of habitat compositions (towed video) and numbers and diversity of taxa collected by both grabs and sleds. Eighty eight species across all stations were collected the diversity and biomass being consistent with yesterdays sampling. Seismic mapping undertaken overnight.

Day 12: 21-09-09
Morning attempted to sample using the vibrocore. One successful core retrieved, but vibrocore malfunctioned on a second attempt and most of the day was used to undertake repairs. Two further stations were sampled using benthic grabs. Vibrocore repaired by late afternoon and used to sample another two stations. Overnight transit to Area C for further benthic sampling and to retrieve moorings

Day 13: 22-09-09
Sampled one station with towed video and benthic sled (Station 63). Flat sand at 37 m rising to a ridge 21 m) and falling again but with significant sandwaves. Very little benthic taxa seen, but with relatively large numbers of hydroids on flat sand regions. Almost no taxa seen on sand waves. Very light haul form benthic sled, with a mixture of bryozoans, crustaceans (decapods), ascidians, bryozoans and fish. Retrieved moorings late morning and afternoon. Acoustic releases systems malfunctioning requiring moorings to be retrieved using grapple. Swath mapping overnight.

Day 14: 23-09-09
Swath mapping early morning. Return to Darwin ETA 1730 hrs. Fuel and expected to berth at 2000 hrs.

APPENDIX D

Images of Sub-bottom Profiles

This appendix contains images of the sub-bottom profiles collected in study areas A-D located on the accompanying CD Rom. The filenames are the following format: *SurveyName_AreaLetter_Linenumber* (e.g., SOL4934_A_SBPL1).

Instructions for Data CD

Geoscience Australia Survey SOL4934, Post-survey Report:
Seabed Environments of the Eastern Joseph Bonaparte Gulf, Northern Australia by Andrew D. Heap, Rachel Przeslawski, Lynda Radke, Janice Trafford and Shipboard Party.

The CD contains the above-titled report as: Record2010_09.pdf.

View this .pdf document using Adobe Acrobat Reader (click Adobe.txt for information on readers).

Double click on **Record2010_09.pdf** to launch the document.

Directories on data CD
Appendices Directory:
with sub-directories of Appendix D.