Australia's Marine National Facility

VOYAGE SUMMARY ss2011_t01

Pre-industrial sea-surface temperature reconstructions in the Australian region; Part 1 eastern Australia

Voyage period:
05/05/2011 to 12/05/2011

Port of departure:
Hobart

Port of return:
Brisbane

Responsible laboratory:
The Australian National University
Research School of Earth Sciences,
Building 47, Canberra ACT 0200

Chief Scientist(s)
Professor Patrick De Deckker,
Dr Tony Rathburn, Dr Sabine Schmidt

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OBJECTIVES AND BRIEF NARRATIVE OF VOYAGE

Scientific Objectives

To reconstruct past sea-surface temperatures in the Tasman Sea across a large temperature gradient for comparison with northern hemisphere record spanning the last millennium. In addition, collect calcareous nanoplankton to identify levels of calcification and for comparison with sub-fossil material to be extracted from short cores. Also, to examine the nature of magnetic minerals in undisturbed and uncompressed sediments. Finally, to sample air during the voyage for the determination of its microbial composition under clean conditions.

Voyage Objectives

This project aims at generating high-resolution records of sea-surface temperature [SST] changes that have occurred the oceans surrounding Australia. Part 1 covers the Tasman Sea, whereas part 2 will cover the ocean south of Australia [going from Fremantle to Hobart]. A variety of innovative proxies will be employed on the samples we have collected and used for comparison with lake records on mainland Australia. Our objectives were to obtain short cores along the Australian coast line [at approximately 1,000 m water depth] across a temperatue gradient. The innovation is to use organic biomarkers that can be used to reconsruct past SST

Additional small project were conducted during this voyage. These are:

(1) to collect material from some of the cores of an extensive study of magnetic minerals in marine sediments;

(2) to filter air at the front of the vessel during the entirety of the voyage, and those samples will be treated in the laboratory at ANU, and should be determined by the DNA;

(3) to examine the nature of the sea floor and its microbiota [to determine if they all at the sediment water interface] or below; and

(4) to obtain samples from the cores for dating purposes using radionuclides. All these supplement our research into calibrating past environmental records;

(5) to collect plankton samples and filter waters at the same collection sites for calcareous nanoplankton and water samples for chemical analysis [eg trace elements and $\delta^{18}O$].

Results

The main objective was partly fulfilled as we obtained some cores, but did not manage to obtain some along the middle of our N-S transect. The reason being that we encountered bad weather that either prevented us from deploying the corer, or when the latter could be deployed, rough conditions such as big waves caused the corer to trigger itself before reaching the sea floor. In addition, due to the nature of the sea floor, we never obtained long [>50cm] cores. Nevertheless, it until we date the bottom of those cores that we will know if our material spans 1,000 years of deposition.

VOYAGE NARRATIVE

DAY 1

[May 5]: We departed from Hobart on May 5, 2011 under calm weather, but as soon as we reached the open ocean, the sea became rough. This affected a number of the science crew who had never been on a large vessel before. We directly sailed towards Station 1, but along the way, we stopped to take a plankton tow [at station A] and also took a few water samples obtained from the side of the ship using a large bucket. The water at each site is collected so as to filter up to 5 litres of water for trace element analysis, and more importantly for the extraction of coccoliths to be studied by Luna Brentegani. In addition, at sea site we took a water sample for stable isotopes of oxygen and carbon for interpreting the isotopic composition of calcareous organisms such as foraminifera and pteropods. During the night, we reached station 1 after checking our coring gear as the equipment was new and many adjustments were made by Tony Rathburn, Ashley Burkett and Graham Nash, all 3 being familiar with the equipment. We were very disappointed when the multicorer was returned on deck as all the tubes were empty. The explanation was that the multicorer touched a very hard sea floor, and as a result, one tube was chipped at its base.

Since we had lost quite some time travelling through rough conditions, we decided to head north, instead of going for the alternative which was located further south, and at a greater depth. While travelling north, we saw clearly from the swath mapping equipment that for quite a while the sea floor consisted of a hard ground.

DAY 2

[May 6]: The seas were still rough, but still managed to stop at 2 stations [B & C]. We finally arrived at station 2 where we deployed the multicorer. We were delighted to see that the corer functioned very well as all 8 tubes contained sediments. The average tube contained 15cm of sediments. It was clear that this site is under the influence of some winnowing as coarse grained sediment and small shell fragments were visible. The tedious task of subsampling the cores commenced, and we now estimate that it takes 4 hours to subsample the cores, using different protocols. The 2 longest tubes were selected with each sample slice being divided into 3, one for radionuclides [Sabine Schmidt], one for organic biomarkers [Marita Smith] , and the other for microfaunal analysis [including stable isotopes and trace elements, coccoliths and radiocarbon of calcareous foraminifera] for Luna Brentegani and Patrick De Deckker. Another tube was selected for David Heslop who is studying magnetic mineral preserved in sediments that had not suffered from compaction as does occur with gravity piston cores. The other 4 cores were sampled by Tony Rathburn and Ashley Burkett who are studying live benthic foraminifera and their distribution at depth. At the same coring site, we deployed the CTD and obtained numerous water samples at specific depths for chemical analyses upon our return in Canberra. Parameters to be analysed are: stable isotopes of oxygen and carbon, as well as trace elements for calibrating against the composition of material gathered in the plankton nets. Several samples were also obtained for radiocarbon analysis so as to establish the [relative] ages of the different water masses. Other samples were taken by Dave Terhell for dissolved oxygen and salinity [those 2 for calibrating the CTD] and nutrients.

Sea conditions improved tremendously, and it became more easy to sample the multicores, with everyone now in good spirit.

DAY 3

[May 7]: A plankton tow and water sample were taken prior to reaching the next coring site [station 3 which is located opposite to Mallacoota]. Once again, the multicorer functioned but the surface-water interface in 7 cores was at an angle, being evidence that the core sat on the sea floor at an angle, with some legs of the multicorer having probably rested on a hard substrate. As for the previous coring station, the sediment was much finer, an indication that we penetrated pelagic mud. A CTD profile was obtained at the same station, and water samples were selected as previously done. Afterwards, a plankton tow was obtained and returned ample amount of zooplankton, mostly consisting of copepods and salp.

DAY 4

[May 8]: The sea continued to be very calm, to the surprise of most people, and of course very welcomed by those who had suffered from seasickness. Our sampling campaign continued as planned. Our multicoring station had been well selected as we returned 7 tubes which we subsampled according to the protocol listed above. Unfortunately, several displaying an upper surface not perfectly horizontal Two plankton tows and water samples were obtained during our transit to station 5.. One CTD profile was obtained from above the coring site, followed by a plankton tow and water sample.

We have more than 5 hours of transit time before reaching the next station for plankton and water analysis.

The sea remained calm during the entire day and night, to the relief of everyone. Of note also that we were greeted by many seals when we deployed our plankton net.

DAY 5

[May 9]: The day started with a plankton tow and surface water sample early before the sunrise. The next coring station had to be modified as the original site was to have been in the restricted area offshore Sydney. The sky is now grey and we are offshore Sydney. Our air sampler is still working so it will be interesting to see what sort of micro-organism is collected.

We deployed the multicorer offshore Sydney, where the sea floor looked promising with respect to a suitable pile of sediments, but when the equipment was returned on board, all the tubes were empty. We believe that the tubes may have been triggered by the strong wave motion, but also when the corer hit the seafloor, an important bolt had been pushed into the central shaft located above the coring gear. The impact of hitting the seafloor may have caused the damage. Tony Rathburn identified the problem and the engineers came to our rescue by providing 2 hollow metal rods that could prevent the incident to happen again. It took well over an hour to fix the problem as the corer had to be dismantled to insert the 2 rods.

By the time, the repair was completed, the sea had become rough with 44 knot winds, so coring was cancelled.

We decided then to return on our route towards Brisbane, hoping the weather would improve as we desperately need more cores to support our project. At 8pm, we collected a plankton tow and a water sample before resuming our northward course, with the decision to take another plankton tow, and decide then if the weather conditions are suitable for coring.

DAY 6

[May 10]: we took a plankton tow and water sample at 2am, but the sea was still too rough to envisage using the multicorer. Wind speeds fluctuated between 25 and 40 knots, and it was also raining quite heavily. In the morning we took another plankton tow and water sample, but the weather remained too rough for any other activity. We took a plankton tow and water sample. We also turned the ship in preparation for coring, but the swell was far more too high to allow safe coring. We abandoned that site and redirected the ship in a northward position, hoping for conditions to improve with time and be suitable for coring. We are moving only at 8 knots as we are confronting the East Australian Current that is moving at about 2 knots. This is causing further delay with respect to our schedule.

Despite the rough conditions early in the evening, we identified a suitable core site, then deployed the multicorer which finally entered in the water when the waves very at least 6 m high. Disappointingly, an hour later it came back on deck with no sediment. We believe that the corer may have triggered itself on the way down to the sea floor as a result of the extra tension on the cable due to the rough conditions. This was a great disappointment as we really need at least 2 additional sets of cores to ensure that our project is successful.

DAY 7

[May 11]: we woke up to a clear sky and with gentle winds up to 11 knots, but still with a strong swale. Coring was scheduled for 9am and we faced disappointment again with little sediment recovered in only 2 cores. We decided to move about 1/4 mile from that site and this time we had success with our coring gear below 680m of water. Several of the tubes showed some slight disturbance near the top of the sediment pile that probably occurred during the coring process. The sediment recovered appeared sandy, and the prognosis was that we had a foraminifer sand. Those cores were successfully sub-sampled.

We had 3 consecutive attempts at using the multicorer at the same site, and finally retrieved 3 short cores in total. Despite the fact that we only obtained a small amount of material, we will be able to process the sediments for o=all our objectives except for the study of magnetic minerals. This was our last coring site. We then started heading towards the site where to meet the pilot early in the morning. The voyage proved a moderate success, and we are all satisfied with the outcome despite the rough sea conditions.

DAY 8

[May 12]: arrival in Brisbane and offloading all the gear for transport back to Canberra, Bordeaux and Indiana.

Additional note: Patrick De Deckker has taken the opportunity while conducting this voyage to take on students who, for the first time, gained experience at sea. This is an important to provide this training for future marine scientists.

SUMMARY

Despite the fact that we encountered rough weather, the main goals of the voyage were met. We obtained sufficient material to enable us to commence reconstructing past sea-surface temperatures over several centuries for the western side of the Tasman Sea, going from the southern tip of Tasmania up to the latitude of Brisbane. Thus, we obtained core sediments across a large temperature gradient. In addition, we gathered sufficient samples to examine the preservation status of calcareous nannoplankton across the same temperature gradient as well as through the same time frame. In addition, we collected a good set of living plankton and water samples that will enable us to interpret the sub-fossil representatives of the same organisms in the short cores.

A separate project aimed at collecting sufficient material to determine the nature of magnetic particles in the short cores, and this was achieved. Finally, we collected adequate material to determine the nature of the benthic microbiota in the cores at the sediment/water interface so as to determine their ecological habitats. In addition, we also returned with sufficient water samples from near the sea surface and at great depths so as to radiocarbon date them in order to better understand water circulation in the Tasman Sea.

PRINCIPAL INVESTIGATORS

A PI : Patrick De Deckker, Research School of Earth Sciences, ANU, Canberra ACT 0200

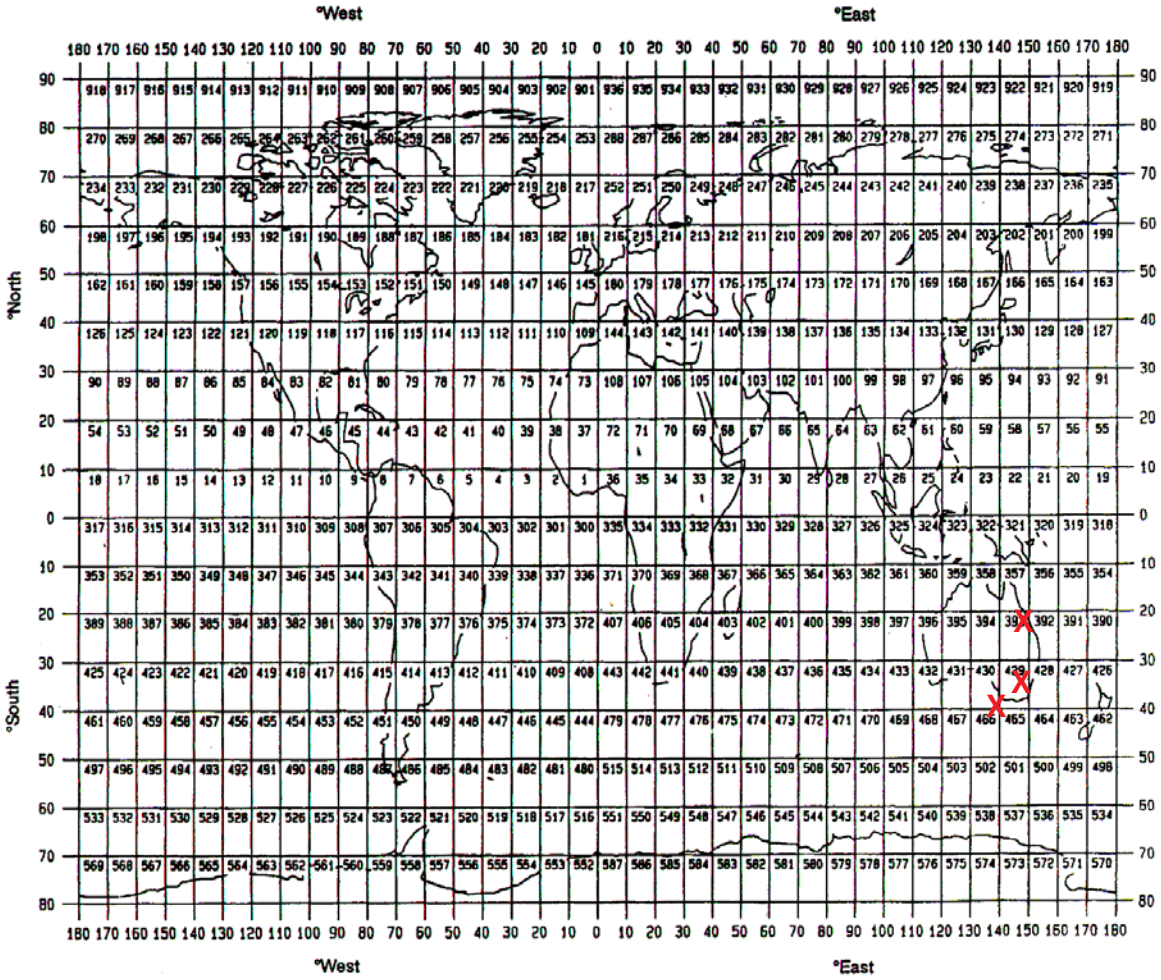
B CI : Sabine Schmidt, UMR CNRS 5805 EPOC, University of Bordeaux, Avenue des Facultés, 33405 Talence cedex. France

C CI : Tony Rathburn, Indiana State University, Earth and Environmental Sciences, Geology Program, Science Bldg 159, Terre Haute, IN 47809, USA

D Dr David Heslop, Research School of Earth Sciences, ANU, Canberra ACT 0200

MARSDEN SQUARES

Additional small project were conducted during this voyage. These are: (1) to collect material from some of the cores of an extensive study of magnetic minerals in marine sediments; (2) to filter air at the front of the vessel during the entirety of the voyage, and those samples will be treated.



CURATION REPORT

ITEM NO.	DESCRIPTION
	The Australian National University : samples to be treated for a variety of tasks such as sedimentolgy, microfossil extraction and dermination, organic biomarkers [in collaboration with Dr .S. Schouten from NIOZ in Holland] and radiocarbon analysis], calcareous plankton, with respect to ttheir calcification; and for the study of magnetic properties of fine grained marine sediments.
	University of Bordeaux I, France :samples for radionuclide analyses.
	Indiana State University, USA : samples for the extraction of benthic foraminifera and , eventually, for DNA analyses.

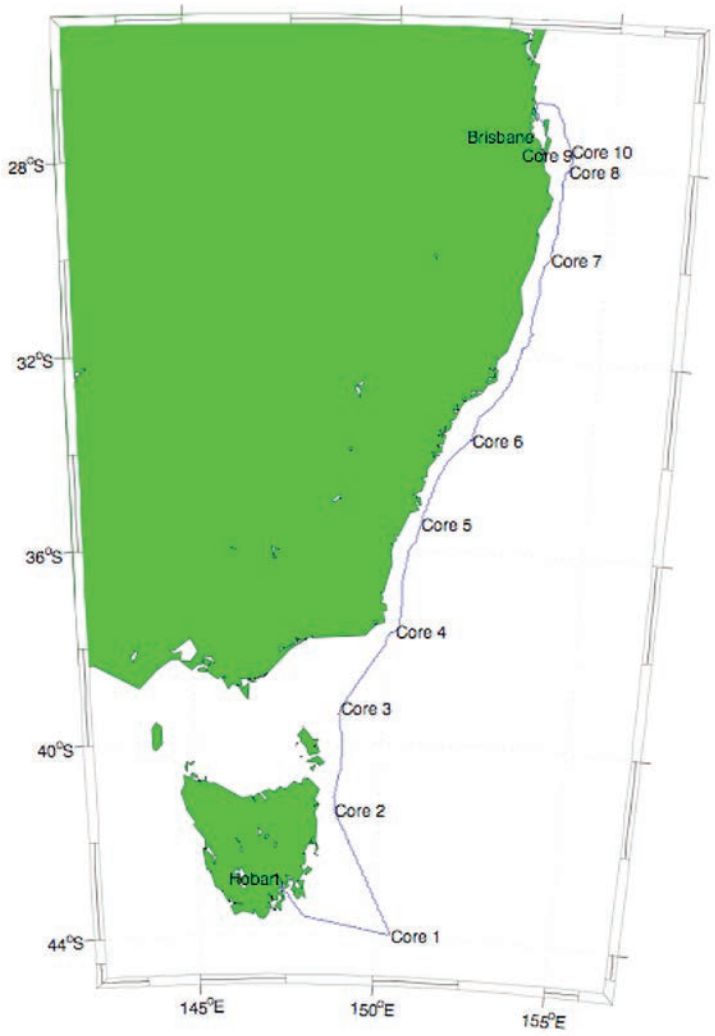


Figure 1: Map showing the itinerary taken during the voyage.

TRACK CHART ✔

GENERAL OCEAN AREA(S)

Tasman Sea

SPECIFIC AREAS

Our voyage concentrated along the western side of the Tasman Sea from Hobart to Brisbane

PERSONNEL LIST

Scientific Participants

Name	Affiliation	Role
Patrick De Deckker	ANU	Coordinate all the projects listed below and decide where to gather the data in consultation with the 2 co-CIs.
Sabine Schmidt	University of Bordeaux I, France	Collect samples for radionuclides for analysis in France
Tony Rathburn	Indiana State University	Collect samples containing viable microfauna, in particular foraminifera and relate their presence to environmental conditions
David Heslop	ANU	Collect samples for identifying the magnetic properties of fine-grained material.
Marita Smith	ANU Honours student	Collect samples for organic biomarker analysis that will help reconstruct past sea-surface temperatures [samples will be analysed at ANU and a NIOZ, Holland
Luna Brentegani	ANU PhD student	To extract remains of calcareous nannoplankton to identify their ecological niches and study the calcification; a topic aiming at identify a possible ocean acidification. Also examination of coccoliths in surface waters by filtering sea water
Ashley Burkett	Indiana State University, PhD student	Collect samples containing viable microfauna, in particular foraminifera
Lyndsay Dean	ANU Honours student	To learn methods used on a research vessel and help other scientists
Chris Munday	ANU PhD student	To collect aerosols for their DNA extraction using 2 different types of aerosol samplers.
Nathan Coleman	ANU, undergraduate student	To learn methods used on a research vessel and help other scientists.
Lindsay Pender	CSIRO	MNF Voyage Manager/Computing support
Lindsay MacDonald	CSIRO	MNF Electronics support
Dave Terhell	CSIRO	MNF Hydrochemistry support
Tara Martin	CSIRO	MNF Swath Mapping support

MARINE CREW

Name	Role
John Barr	Master
Mick Tuck	Chief Officer
Tom Watson	Second Officer
Upendra	Chief Engineer
Jason Searle	First Engineer
Graeme Perkins	Second Engineer
John Howard	Chief IR
Gareth Gun	Integrated Rating
Jonathan Lump	Integrated Rating
Ellen Smith	Integrated Rating
Peter Taylor	Trainee IR
Michael O'Connor	Chief Steward
Robert Ditko	Chief Cook
Rooke Saal	Cook

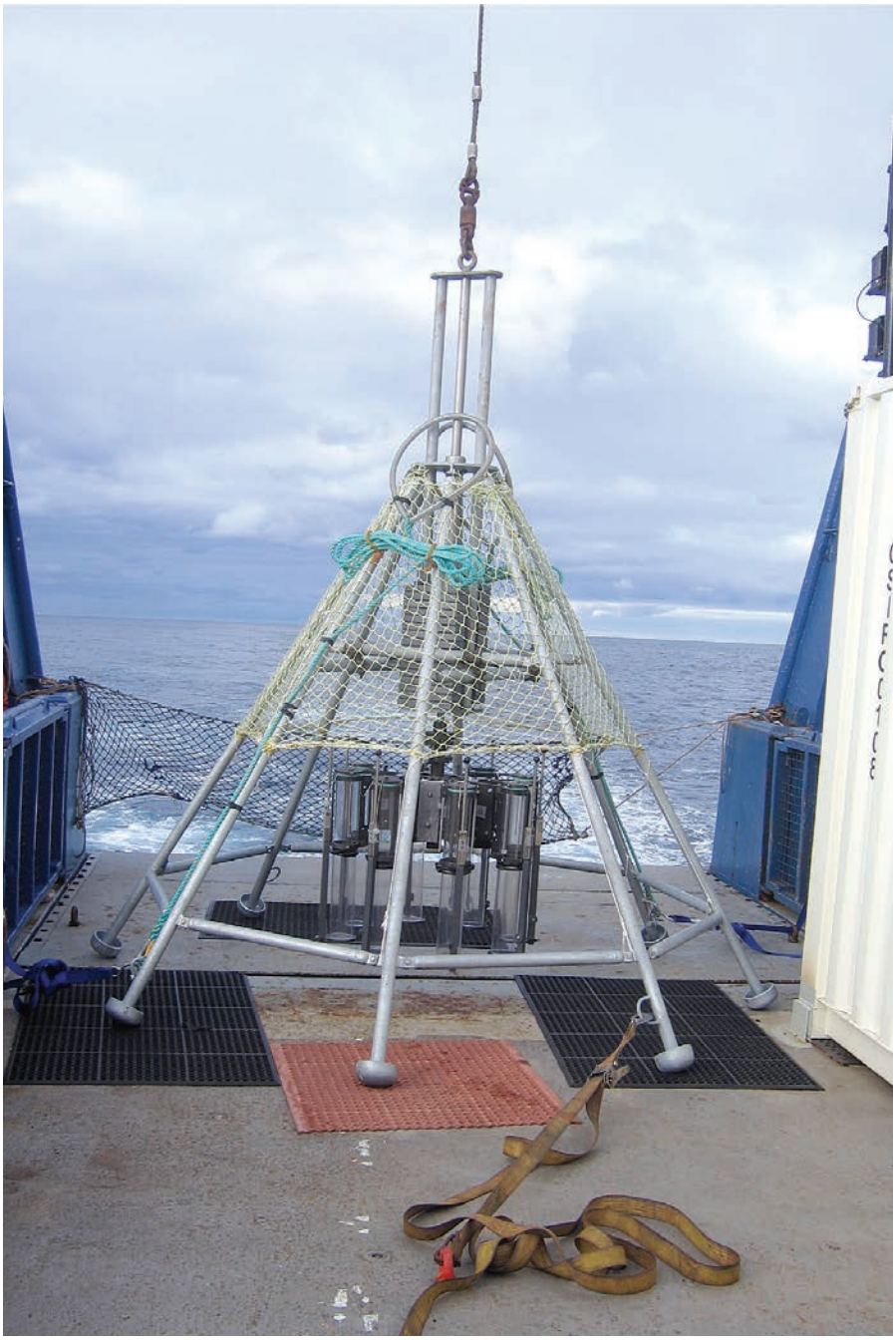
ACKNOWLEDGEMENTS

Patrick De Deckker and Sabine Schmidt wish to acknowledge the Australian Research Council for funding the participation on the voyage. Tony Rathburn acknowledges receipt of a Research Council Grant from Indiana State University.

We are all very thankful to the Master John Barr and his crew for excellent support and very friendly and helpful attitude.

We are also grateful to the CSIRO support staff who were always ready to help and give advice when needed. These are Lindsay Pender [Voyage Manager], Lindsay MacDonald [Electronics support], Dave Terhell [Hydrochemistry support] and Tara Martin [Swath Mapping support] who worked extra hours to help us in finding the most suitable coring sites. **A sincere thank you to all.**

Patrick De Deckker
Chief Scientists



Photograph of the multicorer on the rear deck, ready to be deployed. Note that there are 8 tubes which, once triggered on the sea floor, can potentially retrieve up to 50cm of sediment below the sediment interface.

CSR/ROSCOP PARAMETER CODES RELEVANT TO VOYAGE SS2011-T01 ARE COLOURED IN RED

METEOROLOGY

M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

PHYSICAL OCEANOGRAPHY

H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys
D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

CHEMICAL OCEANOGRAPHY

H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

MARINE CONTAMINANTS/POLLUTION

P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

MARINE BIOLOGY/FISHERIES

B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans
B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

MARINE GEOLOGY/GEOPHYSICS

G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements