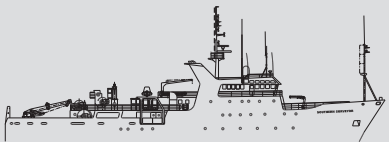


MARINE
NATIONAL FACILITY

2008 program

RV *Southern Surveyor*

CSIRO

voyage**summary** SS09/2008

SS09/2008

Carbon Chemistry of the Great Barrier Reef

Voyage period

start: 24/07/2008
end: 11/08/2008
PORT OF DEPARTURE Cairns, Australia
PORT OF RETURN Gladstone, Australia

RESPONSIBLE LABORATORY

Centre for Australian Weather and Climate Research
PO Box 1538, Hobart TAS 7001 Australia

CHIEF SCIENTIST(S)

Dr Bronte Tilbrook
Centre for Australian Weather and Climate Research, CSIRO-BOM

Dr Richard Matear
Centre for Australian Weather and Climate Research, CSIRO-BOM

OBJECTIVES AND BRIEF NARRATIVE OF VOYAGE

Scientific Objectives

The uptake and storage of carbon dioxide in the ocean is causing a decrease in carbonate saturation states and increasing the acidity of ocean waters. The changes in water carbonate chemistry that will occur in the coming decades are expected to cause a decline in calcification in corals and other organism that produce calcium carbonate skeletons and help form reef structures. Increased stress on the corals due to acidification is likely to be compounded by bleaching events associated with warming of waters, pollution and perhaps increased storm activity. The resilience of the coral reef system to these changes is a major area of concern, particularly for the Great Barrier Reef.

The voyage was designed to provide data needed to study the regional-scale carbonate chemistry of the Great Barrier Reef. This is the first detailed baseline data of the carbonate chemistry through the region during the dry season in late July/early August. These measurements are significant for investigations of the vulnerability of the reef system to ocean acidification. They provide input

to biogeochemical modelling and allow an assessment to be made of how the carbonate chemistry of the region is influenced by the production and calcification on the reef and in the adjacent Coral Sea, the source waters of the GBR.

The voyage also provided an opportunity for researchers from James Cook University and University of Sydney to obtain benthic grab samples and to improve the bathymetry of the region.

The ships EM300 multibeam swath mapper and Topas sub-bottom profiler was used to map the GBR continental shelf and slope. The ship track covered range of depths, from 20 metres on the inner shelf to over 2000 m in the Queensland Trough and provide data to assist in understanding biodiversity-habitat relationships on the GBR shelf and margin, and for updating navigational charts.

In 2007, dense beds of brittle stars (Ophiopsila pantherina) were observed in underwater dune fields at Hydrographers Pass using Autonomous Underwater Vehicle (AUV) imagery. These brittle star beds are likely due to favourable currents and geology, and represent a previously unknown deep habitat of the Great Barrier Reef. The brittle stars appear to feed by extending a 'wall of arms' to capture material swept past the site and the may be important for pelagic-benthic coupling in the region. The dune field site was revisited to determine if the same brittle star beds still existed and to collect grab samples to investigate the taxonomy, diet and substrate preferences of the brittle stars. Another component of the voyage was to take opportunistic grab samples from Halimeda mounds in the northern GBR. There are no publications on the biota associated with Halimeda on the GBR, and this initial study will provide insights into whether this might be considered for future targeted research.

Specific objectives are:

1) determine the variability in carbonate chemistry and related biogeochemical parameters (macronutrients, oxygen, salinity and temperature) through the Great Barrier Reef region.

2) utilise these data with models to estimate the net calcification rate in the GBR for the voyage period and determine how the carbonate chemistry of the Coral Sea waters that flow onto the reef are modified by local production and calcification.

3) obtain high resolution bathymetry in the GBR region.

4) collect benthic grab samples of brittle stars off Hydrographers Passage and bottom samples of the Halimeda mounds of the Northern GBR.

Voyage Objectives:

Large scale carbonate chemistry of the Great Barrier Reef waters:

A major aim of the voyage was to characterise the carbonate chemistry through the reef region and compare this to the carbonate chemistry of the offshore source waters in the Coral Sea. Inshore-offshore sections and stations along the length of the GBR lagoon and offshore were used to characterise gradients in carbonate chemistry.

Water samples during the voyage were obtained using Niskin bottle mounted on a CTD rosette and ship's underway seawater supply. These samples were be analysed onboard for total dissolved inorganic carbon, titration alkalinity, macronutrients, oxygen and salinity. Continuous underway measurements of O2/Ar ratio (net community production estimate) and the surface partial pressure of carbon dioxide (air-sea CO2 flux estimate) were also made.

Bathymetry

The ships EM300 multibeam swath mapper and Topas sub-bottom profiler were run for the entire duration of the voyage from Cairns to the arrival at Gladstone, with down-time restrictions in accordance with the GBRMPA permit for the survey. The collection of the bathymetry data was coordinated and run by Dr Robin Beaman, James Cook University.

Benthic samples:

On the current voyage, brittle star sampling was carried out when the ship transited through Hydrographers Passage. Previous AUV images over the dune field provide targeted locations for sampling the brittle star beds with a Smith-MacIntyre sediment grab device. Similarly, Halimeda mound sampling was carried out in the LADS Passage region after suitable sites were identified using the ships swathmapper and sub-bottom profiler. Underwater video transects over these sites were used to provide additional ground-truthing of the seabed habitats and sample site selection. The grab samples were organised by Dr Robin Beaman in collaboration with Dr Jodie Webster (James Cook University) and Prof. Maria Byrne (Sydney University).

Results

Water column Sampling

Water column samples were collected and analysed for carbon parameters over most of the GBR, extending from near Cape Weymouth in the North to Lady Musgrave Island in the South (figure 1), a track of over 5400km length. The 8m draft of the ship, complex reef structures, many unsurveyed regions, and strong tidal currents in narrow passages between reefs influenced the ship track and where samples could be collected. The voyage sampling schedule and locations needed to be revised each day in order to complete the sections in narrow passages in daylight hours. Work at night was typically restricted to well charted shipping channels and to waters offshore of the reef. In the pre-voyage plans, the possibility of launching the ship's workboat to sample closer to reefs was considered. However, this was not done on the voyage because of time limitations.

The data collected represent the first regional scale survey of the carbonate chemistry of most of the GBR complex. The CTD profiles for this dry season voyage showed that the water column on the shelf was well mixed between the surface and bottom. Changes in the water mass properties were apparent both along the GBR lagoon and between the inshore and offshore waters.

As of December 2008, the finalisation of the carbon measurements made on water samples is awaiting the hydrochemistry bottle data. The analysis of duplicate samples and comparison to certified reference material for seawater, indicate the carbon system measurements meet accuracy and precision targets of ± 2 micromol/kg, for both titration alkalinity and total dissolved inorganic carbon.

Underway data

The underway instruments operated on the voyage were an equilibrator inlet mass spectrometer (EIMS) used to determine O2/Ar ratios in surface waters and a pCO2 system. These instruments were on the same seawater supply line with the EIMS in the General Purpose laboratory and the pCO2 system in the CTD room. The ships underway water supply could not be started in port before the voyage because of concerns the harbour waters might contaminate the seawater supply lines. The water flow to the pCO2 system was started soon after the ship departed the port. This outlet is on a part of the seawater supply line that is used every voyage and is well flushed. The water line to the General Purpose laboratory is not used often and flow to the EIMS system was poor. Leaking drains in the laboratory were also a problem during the first few days of the voyage. The flow and drainage were improved after many hours effort and the EIMS system was started. Intermittent problems with power and water supply caused some data loss of EIMS data during the voyage.

Comparisons of oxygen concentrations measured in surface CTD samples and at the sampling point in the underway line for the EIMS showed some oxygen consumption was occurring in the underway line as the seawater flowed through the line. The oxygen consumption was most prevalent in the first week of the voyage and made data for this time unusable. After this time, the differences in dissolved oxygen measured in surface CTD sample bottle and at the EIMS sampling point were generally below the level of precision for the measurements indicating the oxygen consumption had been reduced. The voyage has provided the first EIMS data through the region, although the first week or more of data appear to be compromised by the oxygen consumption and water supply problems.

The pCO2 system worked throughout the voyage and provided good data. The surface underway pCO2 measurements do show an increase between the offshore waters of the Coral Sea and the waters overlying the GBR (Figure 2). The increase is expected due to net calcification in the GBR complex. The pCO2 values, normalised to a sea surface temperature of 23C, are shown in figure 2. The normalisation removes local effects on pCO2 that are caused by warming or cooling of the waters. In the figure, the values in the southern third of the reef are increased somewhat due to the actual surface waters being less than 23C, while waters in the northern half are usually warmer

than 23C, causing a decrease in the normalised value. Nevertheless, the changes from lower values in waters just offshore compared to those over the reef do show a net calcification effect. A more detailed analysis of these data will require finalised TCO2 and titration alkalinity data. The salinity data in figure 2 show some evidence of freshening of surface waters close to shore near Bowen and Mackay, and perhaps in the far north of the reef. High salinity values are apparent in the southern part of the GBR lagoon.

Bathymetry

The voyage permit from GBRMPA restricted the use of both instruments to the daylight hours, or during night when offshore of the GBR and greater than 500m from the reef edge. During daylight operations the equipment had to be shut down if any whales or dugongs were sighted within 2km of the ship, and restrictions also applied for restarting the equipment. With these restrictions, the voyage mapped about 1600 km along the GBR continental shelf and slope, with depths ranging from 20 m on the inner shelf to over 2000 m in the Queensland Trough. A diverse suite of seabed habitats were surveyed, including muddy inner shelf environments, to vast inter-reefal Halimeda bioherms, numerous palaeo-channels and outer shelf drowned reefs. On the continental slope, multiple submarine canyons were found to incise the margin and were co-located with landslide scarp and debris flows at the base of the canyons into the Queensland Trough. Additionally, detailed images were obtained of extensive drowned reefs found near the Swains Reef complex that substantially increase the known extent of these underwater features (Figure 3).

Benthic Sampling

The substrate of a Halimeda bioherm was sampled by Smith-MacIntyre grab and underwater video on the northern GBR shelf on 28 August. The associated invertebrate biota was preserved in ethanol for post-voyage taxonomic analysis and the sediment frozen for post-voyage analysis.

The brittle star sampling off Hydrographers Passage was conducted after dawn on 5 August at slack water to reduce the drift of the ship due to the typically strong tidal stream currents in the region. Four sediment grabs were obtained on the dune field at precisely-targeted sites. All grabs successfully recovered well-sorted medium-grained carbonate sand indicative of this dynamic environment, in addition to many individual O. pantherina brittle stars (Figure 4). The animals were preserved in ethanol for post-voyage isotope analysis and the sediment frozen for standard sedimentological analysis. In addition, an underwater video within a PVC tube was lowered over the site and the video transect provided information of the seabed substrate and habitat conditions of the brittle star beds. Similarly, the substrate of a Halimeda bioherm was sampled by Smith-MacIntyre grab and underwater video on the northern GBR shelf on 28 August. The associated invertebrate biota was preserved in ethanol for post-voyage taxonomic analysis and the sediment frozen for post-voyage analysis.

Voyage Narrative

July 24-25: The ship departed Cairns at 1600hrs local time on the 24th of July, with a 30 knot wind blowing. The ship sailed offshore through Trinity Opening and tests were carried out on underway instrumentation and the CTD. On board the first night were journalists from the ABC, Cosmos Magazine and the Marine National Facility.

The ship sailed overnight to a position offshore of a passage between Agincourt reef no. 4 and Escape Reef. At first light a Niskin bottle leak check was carried out at the offshore location (15° 54.25'S145° 54.9'E) in about 1160m of water. The same station was then used as a starting point for a CTD section that ran onto the shelf and to the coast. Once on the shelf sampling from a workboat launched from the ship was attempted, but 15 knot winds and waves made the work difficult. The workboat was returned to the ship and the section across the shelf continued. At the completion of the section the ship sailed to off Port Douglas to the transfer four journalists for more science crew. The ship began to move north along the Great Barrier Reef shipping channel at night with occasional CTD's (approx 15-20nm spacing).

July 26-27: The ship arrived north of Cooktown (CTD 15; 15° 20.9'S 145° 20.3'E) in the early morning and started an easterly section to the back of Ribbon Reef no. 5, followed by a series of CTD's in a north and westerly direction arriving at the shipping channel off Cape Flattery (CTD 26; 14° 58.9'S 145° 25.3'E) in the early evening. In the evening the ship worked north of CTD 26, past Lizard Island, with hourly CTD's (CTD 30-37) were made about 3nm south of One and a Half Mile Opening to determine if a tidal signal due to inshore-offshore exchange could be detected in the shelf seawater properties on the shelf. The ship sampled out through One and a Half Mile Opening in the early morning before moving back onto the shelf through Two Mile Opening. The ship carried out a number of CTD on the shelf near Lizard Island and in the late afternoon headed off to the entrance to Fairway Channel CTD50 13° 50.7'S 144° 13.5'E), arriving at about 0400hrs on July 28.

July 28-29: The continued North with occasional CTD's in the LADS Passage. The region contains extensive Halimeda mounds and on August 28 a Smith–MacIntyre grab sample was used to obtain a sample of surface sediment near 12° 54.7'S 143° 46.8'E, close to the location of CTD55. The most northerly part of the voyage was reached at CTD57 (12° 34.8'S 143° 44.8'E). A series of CTD's at about 4nm spacing were then completed across the shelf, following the Kupuntutu Passage, and finished on the western side of the shipping channel at CTD 61 in the early evening of July 28. At night the ship travelled down the LADS Passage before turning West past the Fairway Channel entrance (CTD 64) at about 0540hrs and moving south of Corbett Reef. The ship turned North along the two way shipping route and reached CTD 70. One of the science crew was ill and it was decided to curtail any work further north and to head back South, towards Cairns for a personnel transfer. The transfer was not urgent, but did result in a few stations being cut to the north to ensure the ship could complete a section (CTD70 to CTD77) across the shelf and exit one of the few available reef openings before heading back towards Cairns.

July 30-31: After completing the section out into the Coral Sea, the ship travelled South offshore of the reef with stations at approximately 25nm spacing. The ship path offshore was largely determined by the need to follow a track where bathymetry is available on charts. The ship arrived off the Grafton Passage entrance on the morning of July 31, with the transfer of the ill science crew member planned for the evening. An offshore to inshore section was completed in the Grafton Passage (CTD 87; 16° 28.5'S 146° 22.9'E to CTD 92; 16° 51'S 146° 03.8'E), finishing at 1520hrs. The transfer was completed with a new science crew member replacing the ill person at about 1830 hrs off Cairns. The voyage continued to CTD 94 (17° 11'S 146° 10'E), located west of the Frankland Islands, the starting point for a series of inshore-offshore sections.

August 1-3: CTD sections from the GBR lagoon to offshore were completed in the Flora Pass, Geranium Passage, Palm Passage and Flinders Passage (CTD 94 to 129).

August 4-6: A series of stations (CTD 130 to 147) were sampled along the GBR lagoon as the ship travelled towards Mackay. This included a short section from near Hook Island to the northern entrance to the Whitsunday Passage (CTD 133 to 137), where large clumps of Trichodesmium were observed on calm surface waters. At noon on August 4 the ship arrived at the site of CTD 147, off Mackay. A section was begun across the lagoon and along Hydrographers Passage. At the offshore entrance in the early morning of August 5, the ship moved about 4 nm east of the section to take four grab samples of brittle stars in a dune field at about 19° 52'S 150° 27'E (figure 2). The brittle star population was identified on a Southern Surveyor voyage in the previous year. After finishing grab sampling, the last station in the section was then completed ending offshore of the GBR at CTD161 at 1400 hrs on August 5. The ship then travelled around the offshore edge of the Swain Reefs, with sample stations at about 20-25nm spacing.

August 7-11: The remaining days of the voyage were used to sample the Capricorn Channel, both along its axis and in cross section from the Swain Reefs to the shallow waters near the coast. A section was completed across the Capricorn Channel from CTD171 on the southeast edges of the Swain Reefs to CTD185, located near Facing Island, off Gladstone. A section was also completed from near Bustard Head, passing south of Lady Musgrave Island, and into the Capricorn Channel (CTD186 to CTD192), with another from Port Clinton across the channel to Heralds Prong Reef (CTD196 to CTD 202). A number of stations were then occupied in the central part of the channel and along the southern edge of the Swain Reefs (CTD203 to CTD210) before surveying in detail a sunken reef identified from the EM300 swathmapper on the eastern edge of the Swain Reef complex (figure 3). The ship docked in Gladstone at 1330hrs on August 11.

Summary

The voyage was successful in providing comprehensive data on the large-scale carbonate chemistry over most of the Great Barrier Reef. These data will be used to investigate how net production and calcification on the reef is influencing the chemical composition of waters that flow into the reef. All major objectives were met, pending the delivery of final hydrochemistry data which will allow the final quality control of carbonate chemistry data.

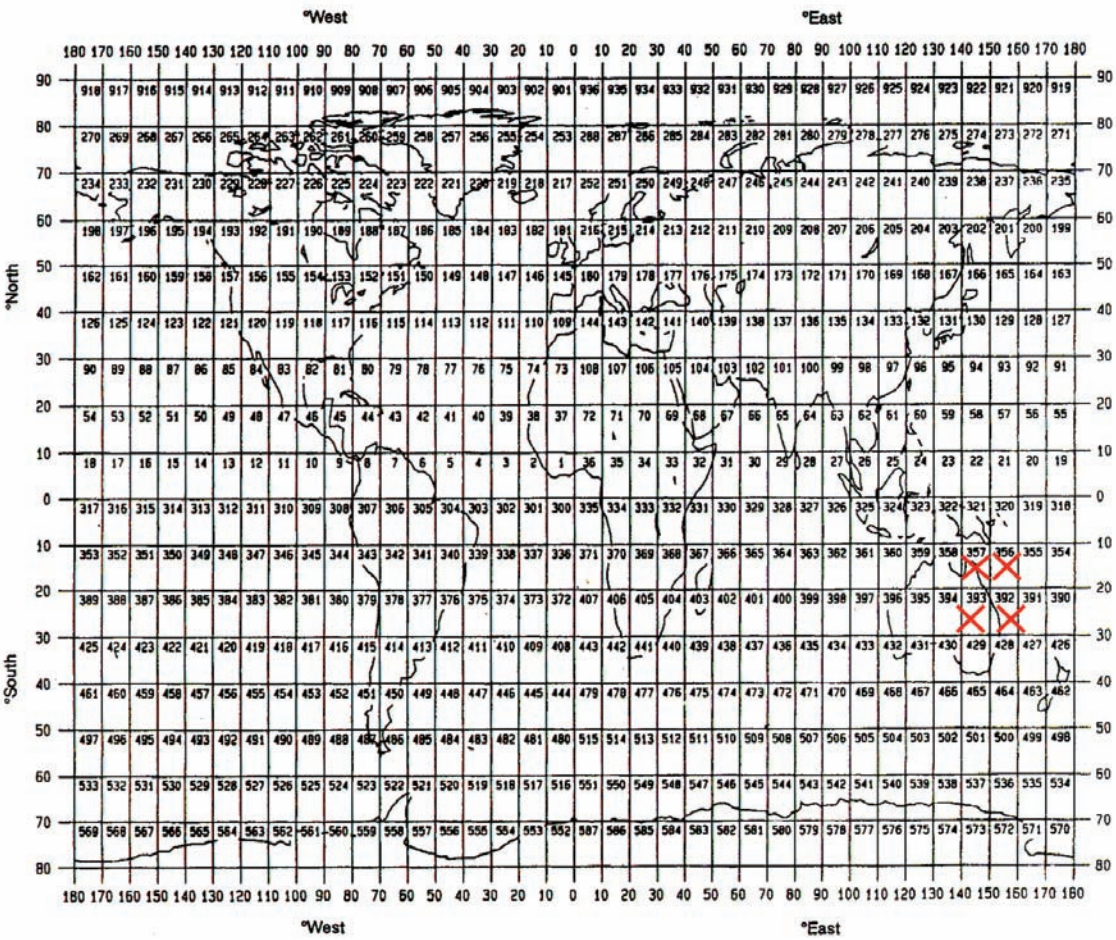
PRINCIPAL INVESTIGATORS

A. Bronte Tilbrook, Centre for Australian Weather and Climate Research, BOM-CSIRO, PO Box 1538, Hobart TAS 7001

B. Richard Matear, Centre for Australian Weather and Climate Research, BOM-CSIRO, PO Box 1538, Hobart TAS 7001

MARSDEN SQUARES

GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED



Summary of measurements and samples taken

Item No.	PI	NO	UNITS	DATA TYPE	DESCRIPTION
1	A	206	casts	H21	Dissolved oxygen measurements on Niskin bottle water samples
2	A	206	casts	H22	Dissolved phosphate measurements on Niskin bottle water samples
3	A	206	casts	H24	Dissolved nitrate measurements on Niskin bottle water samples
4	A	206	casts	H26	Dissolved silicate measurements on Niskin bottle water samples
5	A	206	casts	H27	Titration alkalinity measurements on Niskin bottle water samples
6	A	206	casts	H74	Carbon dioxide measurements on discrete water samples
7	A	17	days	H74	Underway measurements of partial pressure of carbon dioxide
8	A	10	days	H90	Underway measurements of O2/Ar ratio in surface water
9	A	17	days	H71	Underway sea surface temperature and salinity data
10	A	17	days	M06	Underway meteorological data
11	RB	4	grabs	G02	Grab samples, Halimeda mounds near Bligh Reef,12.91°S 143.78°E
12	RB	4	grabs	G02	Grab samples from Hydrographers Pass dunes, 19.87°S 150.45°E
13	RB	1600	km	G74	Multibeam echo sounder data
14	RB	1600	km	G90	Acoustic Topas sub-bottom profiling

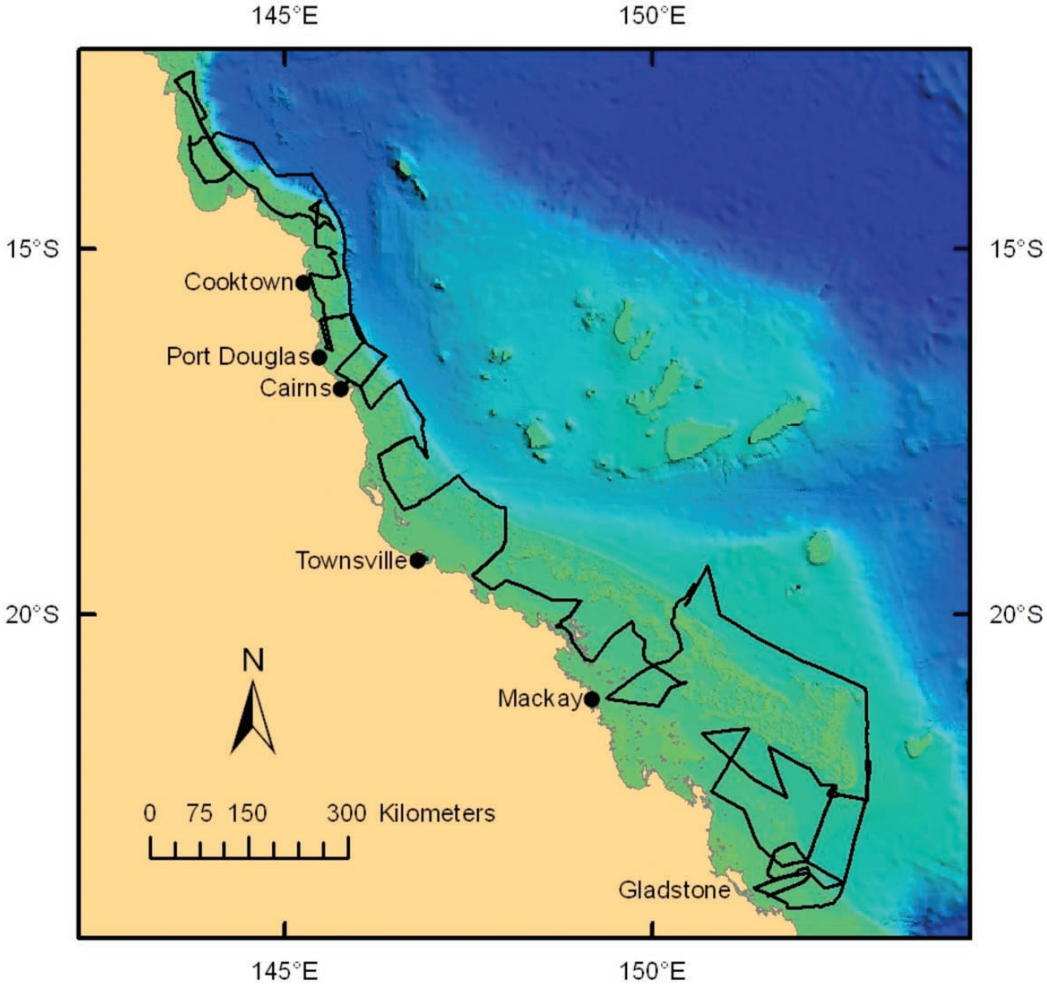
Curation report

Item No.	DESCRIPTION
1	Marine national facility data centre
2	Marine national facility data centre
3	Marine national facility data centre
4	Marine national facility data centre
5	Marine national facility data centre
6	Marine national facility data centre
7	Marine national facility data centre
8	Marine national facility data centre
9	Marine national facility data centre
10	Marine national facility data centre
11	Samples of ophiuroids Ophipsila pantherina – stored in ethanol at U Syd (Byrne Laboratory) Bulk frozen sediments frozen and stored at James Cook University (Dr Robin Beaman)
12	Invertebrates sorted and stored in ethanol at U Syd (Byrne labooratory) Bulk frozen sediment stored at James Cook University (Dr Robin Beaman)
13	Marine national facility data centre
14	Marine national facility data centre

Voyage track

GENERAL OCEAN AREA(S): Coral Sea

SPECIFIC AREAS:mGreat Barrier Reef.



Personnel list

Scientific Participants

Name	Affiliation	Role
Bronte Tilbrook	CSIRO	Chief scientist
Richard Matear	CSIRO	Co-Chief scientist
Kate Berry	CSIRO	Carbon chemistry
Kristina Paterson	CSIRO	Carbon chemistry
John Akl	CSIRO	Carbon chemistry
‡Matt Chamberlain	CSIRO	CTD watch
‡Erika Woolsey	USYD	Biology, CTD watch
Rob Beaman	JCU	Marine Geophysics
Bob Beattie	CMAR	MNF Voyage manager, computing support
‡Anne Kennedy	CMAR	MNF Swath Support
‡Tony Veness	CSIRO MNF	MNF Swath Support
Lindsay MacDonald	CMAR	MNF Electronics Support
Dave Terhell	CMAR	MNF Hydrochemistry Support
*Alicia Navidad	CMAR	MNF Hydrochemistry Support
**Mark Rayner	CMAR	MNF Hydrochemistry Support
†Peter McCutcheon	ABC	Journalist
†Brett Ramsay	ABC	Journalist
†John Pickrell	COSMOS	Journalist
†Edwina Hollander	CSIRO	Communications

† left ship July 25

‡ joined ship July 25

* left ship July 31

** joined ship July 31

Marine Crew

Name	Role
Peter Pearson	Master
John Boyes	1st Mate
Darren Lack	2nd Mate
John Morton	Chief Engineer
Graham McDougall	Bosun
Paul Brown	Cook
Dave Jonker	1st Engineer
Martin Klein	2nd Engineer
Rob Artaud	IR
John Hall	IR

Acknowledgements

The competence and help of the officers and crew of the RV Southern Surveyor were greatly appreciated and made the voyage a success. The ship master, Peter Pearson, first mate, John Boyes, and second mate, Darren Lack, are very experienced sailors on the reef. Without their knowledge and patience, the coverage managed would have been much reduced and would have impacted the success of the voyage. The engineers led by Chief Engineer, John Morton, were helpful and responsive to all requests. The ship bosun, Graham McDougall, and crew made deck work and sample collection a smooth and professional operation. The cooks and staff in the mess led by Paul Brown provided excellent food. GBRMPA, and in particular Mel Cowlishaw, are thanked for working with us to obtain the permits for the sampling and in explaining the many issues raised to ensure the requirements for research and sampling on the reef were met. The Marine National Facility helped above and beyond normal responsibilities. Fred Stein, director of the Marine National Facility helped with pre-voyage planning and Don MacKenzie and Lisa Woodward did an excellent job of ensuring the voyage achieved maximum outcomes. Ron Plashcke helped with obtaining medical advice when a member of the science crew became ill and this helped minimise a loss of sampling time. The ABC and Cosmos magazine are thanked for sending journalists (Peter McCutcheon, Brett Ramsay and John Pickrell) who were gave excellent coverage to the voyage. The voyage was supported by the Australian Climate Change Science Program funded through the Australian Department of Climate Change.

Bronte Tilbrook
Chief Scientist

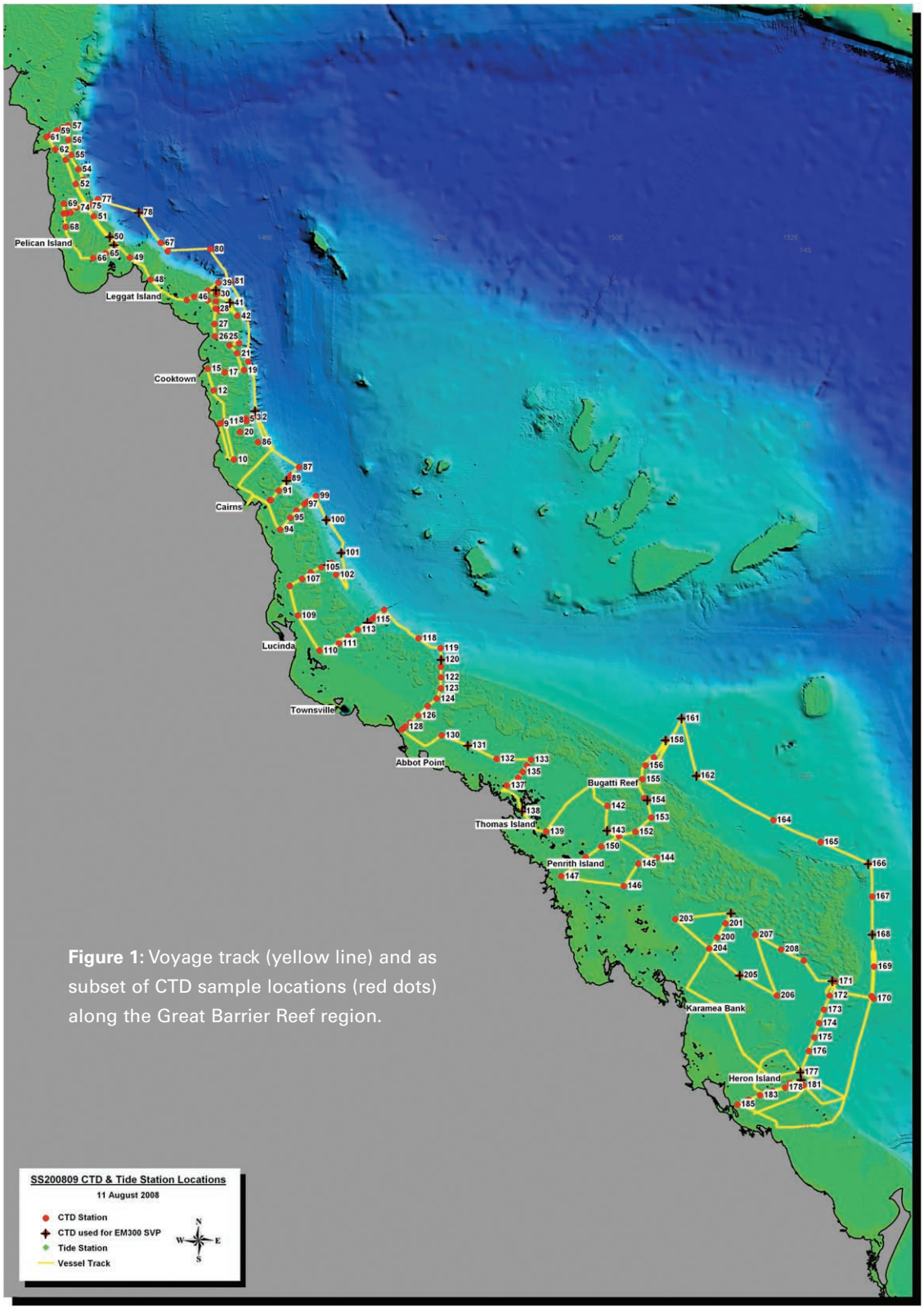


Figure 1: Voyage track (yellow line) and as subset of CTD sample locations (red dots) along the Great Barrier Reef region.

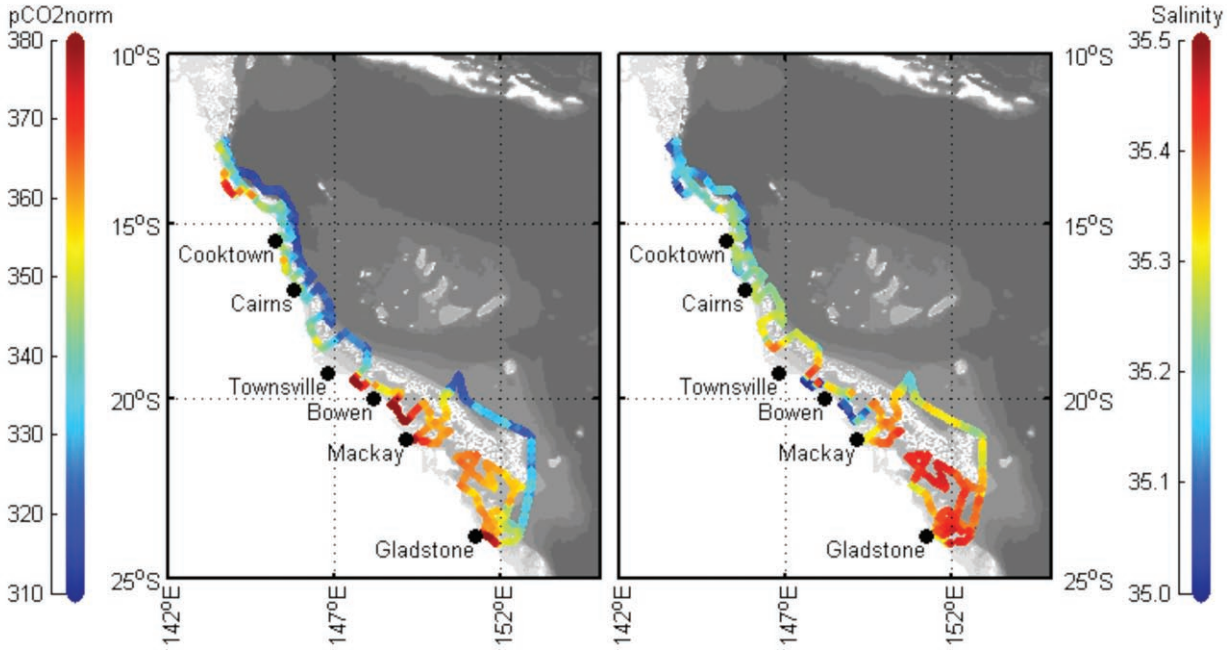


Figure 2: Surface pCO_2 (left panel), normalised to 23°C sea surface temperature, and sea surface salinity (right panel) measured along the Southern Surveyor voyage track.

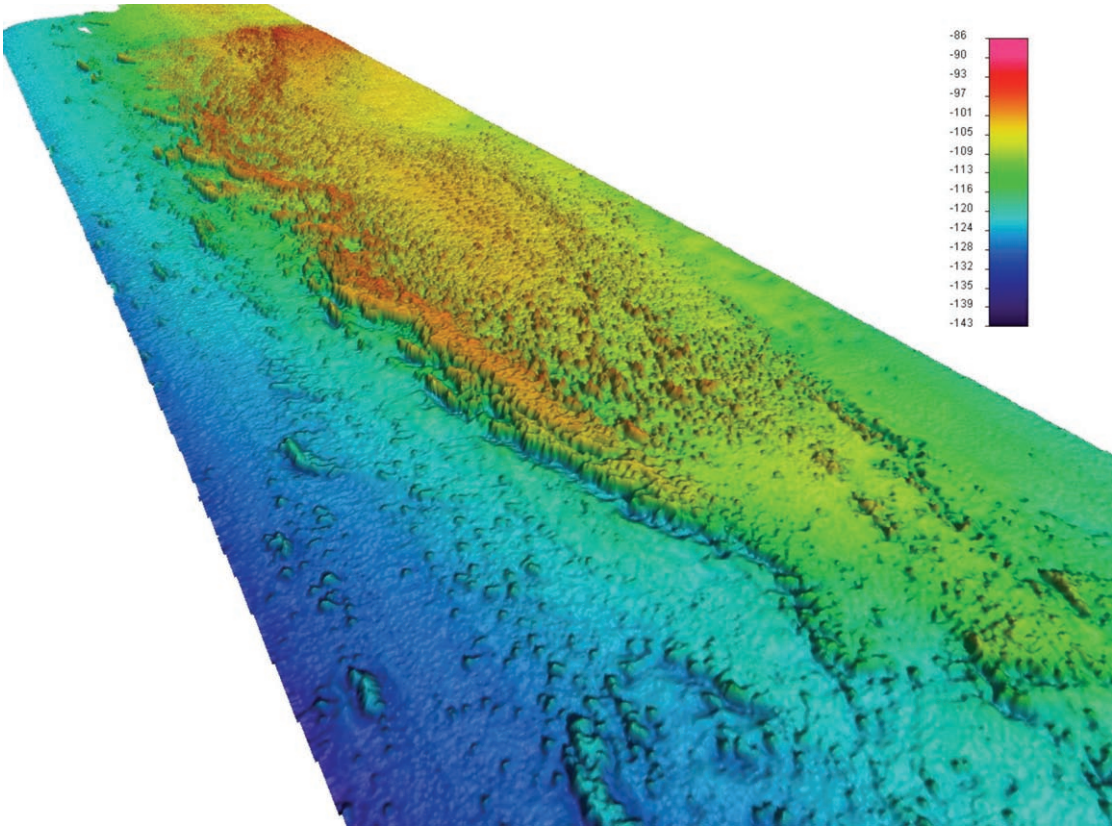


Figure 3: Three-dimensional image of a drowned reef near the Swains Reef complex surveyed using the EM300 multibeam swath sonar. Depth (m) are shown by the colour legend. Survey area 20 km x 4 km. Courtesy R. Beaman, JCU.

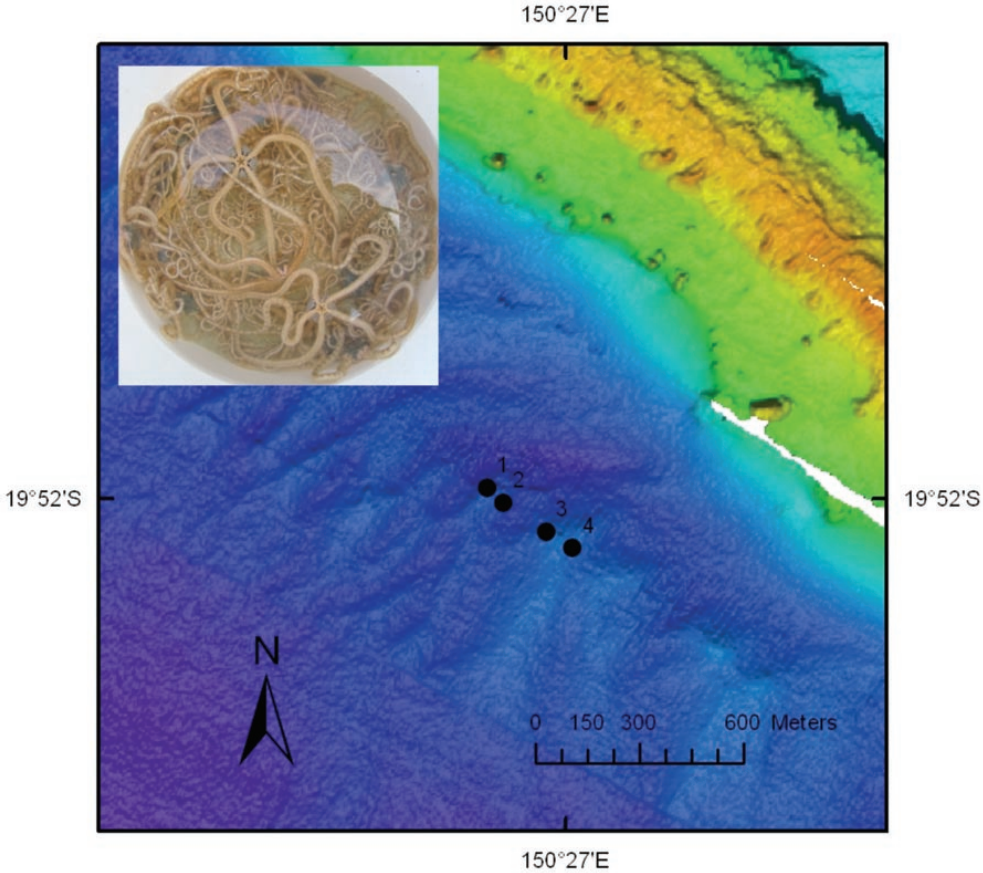


Figure 4: The underwater dune field at Hydrographers Pass with brittle star grab sample locations shown by black dots Inset image shows numerous *O. pantherina* brittle stars from a sediment grab. Courtesy R. Beaman, JCU.

CSR/ROSCOP PARAMETER CODES

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