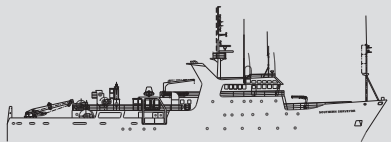

MARINE
NATIONAL FACILITY

2008 program

RV *Southern Surveyor*

CSIRO

voyage summary SS02/2008

SS02/2008

The role of submarine canyons in upwelling, sediment transport, and productivity hotspots off the Bonney Coast and Kangaroo Island, South Australia

Itinerary

Depart Hobart 1600hrs, Monday 4 February, 2008
Arrive Port Adelaide 0800hrs, Tuesday 26 February, 2008

Principal Investigator(s)

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Scientific Objectives

Canyons provide a source for upwelling through their influence on currents, nutrient flux, sediment transport, and influence marine productivity and deep-scattering layers (prey for exploited fish, marine mammals and birds). Off the Bonney Coast-Kangaroo Island, numerous canyons exist, and, together with wind-forced upwelling near the coast, may provide nutrient and sediment paths between the deep ocean slope and coast. The Bonney Coast canyons are of particular importance because the area is being explored for hydrocarbons. Tar ball strandings along the Bonney coast may be transported up the canyons from natural leaks at the base of the slope. If proven, this may indicate oil-bearing sediments buried in up to 4000 m deep water, in this un-drilled region. During summer, westward currents over the slope generated by the Flinders Current and meso-scale eddies could produce currents within the canyons sufficient to move sediments and nutrients up slope. It is imperative to understand the importance of the canyons to regional productivity before a need arises to manage hydrocarbon extraction.

We will integrate measurements into numerical models to answer:

1) What are the roles of meso-scale eddies and the Flinders Current in driving upwelling within the canyons?

2) Does this deep-slope upwelling, in conjunction with wind-forced upwelling, lead to nutrient (and tar-ball) fluxes from the deep-slope to the coasts of the region?

3) Do the shelf-edge canyons focus upwelling onto the Bonney Coast, forming discrete hotspots of pelagic productivity?

4) Are the sediments and benthic community structure and diversity different beneath hotspots of pelagic productivity?

The importance of canyons in all of the questions above has been established elsewhere and in other studies. The significance of this project then is to determine the nature and role of canyons for the Bonney Coast-Kangaroo Island region and the specific paths of nutrient and sediment transport and impact of the circulation on hotpots of productivity and the benthic community. The development of a predictive skill in these areas will be of great assistance to future management, particularly as the Bonney Coast-Kangaroo Island canyons are adjacent to and are likely to influence productivity and biodiversity in two recently established Commonwealth Marine Reserves i.e. Murray and Nelson.

Voyage Objectives

Upwelling will occur within canyons that are exposed to westward slope currents and be largest where warm core (anticlockwise) eddies are found. Two canyon systems that periodically exhibit upwelling will be surveyed during the voyage. An unnamed canyon system off the Bonney Coast is our principal area of interest, and will be surveyed first, but if time permits, a second canyon system ("du Couedic" off the southwest tip of Kangaroo Island) will also be surveyed (Figure 1). The first two weeks in February is generally a period of coastal upwelling so it is also likely that such an event will be captured during the voyage but this is not essential to the canyon study proposed.

A broad-scale mapping survey using swath, acoustics and ADCP will be conducted at each target area to obtain high-resolution bathymetry, and a synoptic picture of the canyon and coastal upwelling. This broad-scale survey will be determined by the path necessary to swath the target with some extensions over the survey lines onto the shelf. Following broad-scale mapping, a series of transects along and to each side of the canyon axis will be established. Stations will be occupied along each transect to obtain a CTD-rosette sampler profile and lowered ADCP profile. Benthic grab samples will be taken at selected depth-stratified stations to determine the composition and structure of the bottom sediments and the biodiversity of the associated infauna. Dredge and trawl samples will also be taken at the same sampling stations to quantify the distribution and composition of epifaunal invertebrates and demersal fish, and to age exposed rocks on the seafloor.

Voyage Track

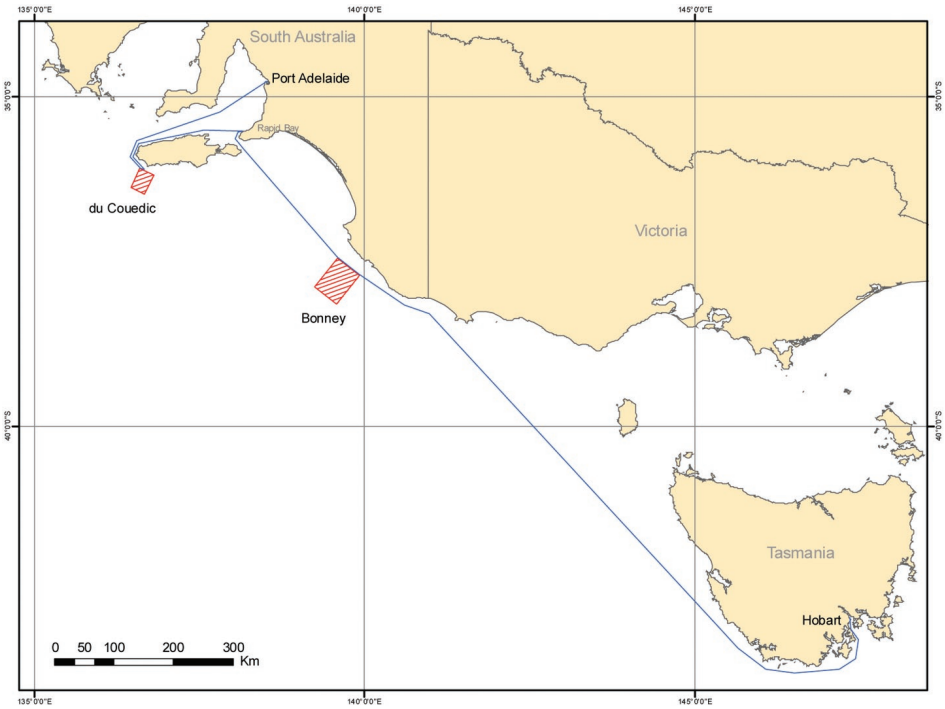

Figure 1: Map showing the voyage track (blue line) for SS02/2008, and the locations of the two main study areas (red rectangles) off the Bonney Coast and Cape du Couedic.

Results

A total of 11 days was spent surveying the target area around the Bonney canyon, while a further 7 days was spent sampling at du Couedic canyon. The remaining voyage time (3½ days) was spent in transit between Hobart and Port Adelaide. A brief summary of the data collected at each of the two canyons is given below, while a more detailed account of the daily operations is presented in the Voyage Narrative section.

Bonney Canyon

Two rectangular areas of seabed were mapped off the Bonney Coast using the EM300 multibeam sonar. The larger of the two areas (2310 km^2) straddled the main axis of the Bonney canyon and extended between the inner shelf (70 m depth) and the mid slope (2500 m depth) (Figure 2). The second smaller area (1144 km^2) was situated 40 km to the south, and covered a subsidiary branch of the main canyon near the foot of the continental slope (3000-4500 m depth). These swath data show a diffuse canyon entrance at the shelf-break (200 m depth), and a well-defined headwall on the upper slope (800 m depth). Below the headwall, the canyon is narrow (3 km wide) and deeply incised (>1 km deep) with steep sidewalls (gradient > 1:1). The floor of the canyon is terraced and bears numerous scallop-shaped scars, indicative of erosion and slumping.

A total of 61 sampling operations were undertaken at the Bonney Coast (Table 1). This included 18 CTD/lowered ADCP casts, 18 grab samples, 6 sled shots, 16 demersal trawl shots, 2 beam-trawl shots and 1 rock-dredge shot. Profiled hydrochemical, viral, bacterial and phytoplankton productivity measures were successfully processed from fifteen stations spanning the canyon (i.e. stations at 100, 200, 500, 1000, 1500 m depth on three parallel cross-slope transects; Figure 2). Samples of sediment were collected from the same fifteen stations, and have been preserved to determine their composition and infaunal biodiversity. Quantitative samples of epibenthos and fish were also collected from a subset of the same fifteen stations, and have been preserved to determine spatial patterns in biodiversity and biomass. We expect that these data will enable all survey objectives to be met.

Du Couedic Canyon

One rectangular area of seabed (1540 km^2) surrounding du Couedic canyon was mapped using the EM300 multibeam. This survey area extended approximately 15 km to either side of the main canyon axis and spanned the outer shelf and continental slope (80-4000m depth) (Figure 3). These swath data show a prominent v-shaped gouge in the outer shelf (20 km in length) characterising the upper section of the canyon. Beyond the shelf-break, the seafloor is highly folded and deeply incised, with numerous narrow channels and chutes extending across the slope. Here, below 1500 m, the canyon floor drops abruptly and forms a spectacular corrie with near-vertical headwalls (>1 km in height). The main branch of the canyon continues below this feature as a narrow (2 km wide) gorge.

A total of 65 sampling operations were undertaken at du Couedic (Table 1). This included 15 CTD/lowered ADCP casts, 33 grab samples, 8 sled shots and 9 demersal trawl shots. All CTD casts were successful, and facilitated the collection of profiled water samples

and phytoplankton productivity measures from fifteen sampling stations surrounding the canyon (i.e. stations at 100, 200, 500, 1000, 1500 m depth on three parallel cross-slope transects; Figure 3). Sediment samples were collected from all but three of the same fifteen stations, and have been preserved to determine their composition and infaunal structure. Samples of epibenthos and fish were also collected in sled and trawls shots from up to five depth strata situated along the central axis of the canyon, and have been preserved to examine spatial patterns in diversity and biomass.

Voyage Narrative

Monday 4th February. The Southern Surveyor departed Hobart at 1445 hrs and proceeded south in fine weather down the Derwent River. During the passage to South East Cape, all new crew were provided with a familiarisation tour of the vessel and introduced to the onboard safety regulations and muster stations. This was followed by a meeting with the vessel Master, at which the science plan was presented and the cabin and watch allocations established. The vessel rounded the Cape at 1900 hrs, and proceeded towards the west coast of Tasmania in light seas (3 m SW swell).

Tuesday 5th February. The Southern Surveyor spent most of the day on a north-westerly transit along the west coast of Tasmania, and by 2100 hrs the vessel was situated approximately 80 nm to the west of King Island. Moderate southerly winds (25 knots) and a following sea meant that the passage towards the Bonney Coast was relatively smooth and timely. The scientific staff used this transit period to adjust to their allocated 12-hour shifts, and to make final preparations for the forthcoming sampling programme. Safety inductions to the vessel were completed in the morning with an emergency muster and drill.

Wednesday 6th February. A water leak from the reverse osmosis plant caused an electrical short-circuit at 1030 hrs. The electrical short was successfully repaired at 1630 hrs, and the vessel was able to continue on its course towards the Bonney Coast. At 1800 hrs winds were light (15 knots) and southerly, and the SST was indicative of strong upwelling (12°C offshore from Port Macdonnell).

Thursday 7th February. Swath mapping of the inshore polygon at the Bonney canyon was begun at 0030 hrs, but progress was slower that expected (with 7 lines completed in 14 hours). In order to advance the commencement of the benthic and water column sampling, the size of the target polygon was cropped by 7 km on the western edge, and the swath survey line moved immediately adjacent to the most northerly sampling station (BW_100).

The first demersal trawl shot was undertaken at station BC_100 at 1900 hrs. Unfortunately, the trawl gear became hooked-up early in the shot, and the First Mate demonstrated exceptional skills in being able to retrieve the net intact. Only a few fish and sessile benthos were collected during this aborted shot, nevertheless the catch was of considerable interest to the SA Museum scientists who eagerly sorted and curated the material. CTD and grab samples were also undertaken at the same site (as well as BW_100 and BE_100) before the ship returned to swath map the adjacent area.

Friday 8th February. This was our most successful sampling day to date. At 1300 hrs swath mapping was halted and we began to take CTD and grab samples in sequence from three stations (BE_200, BC_200, BW_200). All of these samples were taken without complications. The grab samples ranged in size from 7-10 kg and indicated that the seafloor at the edge of the shelf was composed of coarse sand with small amounts of silt. Three demersal trawl shots were then undertaken in sequence from the same three stations (BE_200, BC_200, BW_200) between 1800 and 2300 hrs. All three 30-minute shots caught clean catches of fish (65-100 kg) with moderate diversity (10-16 species). Swathing between the 200 and 500 m contour began at midnight and was scheduled to continue until 1000 hrs the following day.

Saturday 9th February. Swath mapping of the upper canyon continued until 1000 hrs, after which we proceeded to take CTD and grab samples in sequence from three stations (BE_500, BC_500, BW_500). All went smoothly with these water and sediment collections, and there were no misfired grabs or unsuccessful Niskin bottle closures. At 1700 hrs we were on station (BW_500) to shoot away our first trawl for the evening. Not all went to plan on the first shot, with the Scanmar gear indicating that the net was closed. This shot was therefore abandoned after 15 minutes. On retrieval it was evident that the cod-end had washed over the head-rope during deployment. A second shot at BW_500 was also abandoned because the doors were over spreading. The third shot at BW_500 fished better, particularly towards the end of the 30-minute run, and the catch included 11 species of fish. The vessel then proceeded to station BC_500 and began to shoot the trawl gear away again. Unfortunately the net overspread once again and the trawling was abandoned for the evening. Swath mapping of the 500-1000 m section of the canyon was begun at 2300 hrs and was scheduled to continue until 0900 hrs the following morning.

Sunday 10th February. Swath mapping of the 500-1000 m section of the canyon was completed at 0800 hrs. We then proceeded to take CTD and grab samples in sequence from three stations (BE_1000, BC_1000, BW_1000). These samples were collected without a hitch and by 1700 hrs we were on station (BE_500) for our first trawl shot of the evening. In an effort to counteract the net over-spreading, a drogue was attached to the cod end. The attitude of the net was immediately improved with the Scanmar indicating a door-spread of 80 m and a headline height of 3.5 m. Unfortunately a door crossover occurred during this shot and no fish were collected. As a result, the trawl at BE_500 was re-shot and a small (20 kg) catch of fish (11 species) landed. One further trawl shot was completed the same evening at BC_500. This also resulted in small catch (<10 kg) of demersal fish (mostly Whiptails). At 2350 hrs the vessel headed south to continue swath mapping the mid-reach of the canyon (1000-1500 m depth).

Monday 11th February. Four swath lines were completed during the first seven hours of Monday morning, and at 0800 hrs the vessel was on station (BW_1500) for a CTD and grab sample. Two further stations (BC_1500 and BE_1500) were sampled with the same gear shortly afterwards, but a misfire of the grab at BE_1500 meant that sampling at this depth strata was not completed until 1730 hrs. At 1800 hrs we were ready to deploy the trawl net for a shot at BE_1000. The net was successfully retrieved almost two hours later after 40 minutes on the bottom at this location. This catch contained over 20 species of fish and included several

juvenile (<10 cm) Orange Roughy (*Hoplostethus atlanticus*). A second trawl for the evening at BC_1000 was postponed when it became apparent that the ground at this upper canyon location had high relief. At 2200 hrs the vessel proceeded to the upper edge of the canyon polygon to swath any unsurveyed areas between 100-200 m depth, and identify suitable trawl ground for some shallower (100 m) trawls.

Tuesday 12th February. Swath mapping of the 100-200 m depth zone was continued through the early hours of Tuesday morning. This was followed by a series of repeat CTD deployments at stations BE_200, BC_200 and BW_200 (as phytoplankton productivity measurement had not been processed during the first visit). The CTD sampling was successfully completed at 1200 hrs, and at 1400 hrs we began trawling those stations located along the 100 m depth contour (BW_100, BC_100, BE_100). This operation was not straight forward, as the region was peppered with limestone reefs standing up to 10 m proud of the seabed. The swath bathymetry collected during the previous days survey proved invaluable here in identifying trawlable ground, and as result we were successful in landing good catches of demersal fish (>70 kg) from all three survey stations without hooking the gear up. At 2200 hrs we proceeded to swath the remaining unsurveyed regions of the upper canyon (100-200 m depth).

Wednesday 13th February. The last section of the upper canyon was swath mapped during the early hours of Wednesday morning. A weak-weather front had passed through during the previous evening and brought with it 30 knot southerly winds and 3 m seas. Fortunately the weather abated during the day, and by 1300 hrs conditions were suitable for trawling at our last two 1000 m stations (BW_1000, BC_1000). The catches for both trawl shots were relatively small (<30 kg) and consisted largely of Oreos (*Allocyttus verrucosus*) and Whiptails (*Coryphaenoides serrulatusalcea*). At 1900 hrs, following completion of trawling, the vessel headed south to begin sounding a new array of swath lines located between the 2000-3000 m depth range.

Thursday 14th February. A logging problem occurred with the swath mapping system in the early hours of the morning. So the vessel was directed inshore to commence a series of depth-stratified sled shots through the central axis of the canyon. At 1200 hrs we were on station at BC_100 for our first 500 m tow, and by 2200 hrs we had successfully completed sled shots at a further 5 locations (BC_200, BC_500, BC_1000, BC_1500, BC_2000). In the late the software problem was rectified.

Friday 15th February. All of Friday was dedicated to swath mapping the high-priority polygon situated in the lower east of the canyon. Surface seawater swabs were collected at the ends of each swath line to test for the presence of any hydrocarbon slicks in the area.

Saturday 16th February. A Smith-McIntyre grab targeting possible hydrocarbon seeps in the lower canyon (station PD10) was deployed to a depth of 4125 m at 0011 hrs. As the bucket came back empty, a second grab attempt was made at station PD11 (4079 m). This grab attempt was successful and 13 kg of light-grey mud was collected. The vessel then proceeded towards the upper canyon at 2000 hrs with the intent of finalising the Bonney Coast sampling program. On route, an attempted rock-dredge tow at station PD13 proved unsuccessful. We were much more successful in the deployment of a beam-trawl, and good

catches of benthos (>20kg) were taken with this gear from stations PC3 and BC_1000. With the last beam-trawl landed at 1930 hrs we departed the Bonney Coast, and made our way towards Rapid Bay for a scheduled staff changeover.

Sunday 17th February. The vessel's work boat was lowered into the water at Rapid Bay at 0900 hrs for the planned staff transfer. This operation went smoothly with two scientists being returned to shore and one new scientist joining the voyage. After less than 30 minutes the vessel was underway for the next survey area off Cape du Couedic. At 2200 hrs the vessel arrived at the first sampling station and began to swath map the near-shore section of the du Couedic polygon (100-150 m depth).

Monday 18th February. Monday was a highly productive day for the scientists. Swath mapping of the upper canyon was continued through until 0800 hrs, after which CTD, grabs and sleds were successfully taken from each of the three sampling stations located in the 100 m depth zone (DCW_100, DCC_100, DCE_100). All sled and grabs taken contained high proportions of sponge material, and it appears from the contiguous nature of the swath imagery that the shelf bedforms near the canyon head support extensive sponge gardens. The biological sampling ended abruptly at 1900 hrs when a trawl shot hook-up at station DCW_100 resulted in a badly damaged net. At 2000 hrs we proceeded to swath map the unsurveyed regions of the upper canyon (100-150 m depth).

Tuesday 19th February. Swath mapping of the shelf, inshore from the head of the canyon, was continued through until 0800 hrs. We then proceeded to station DCC_200 for our first CTD cast of the day. This deployment went without a hitch, and was followed immediately by a grab sample. Unluckily, the jaws on the grab bucket failed to close properly after nipping a discarded long-line. A repeat grab was therefore necessary at this location. This second grab proved successful, so we proceeded to deploy the sled for a 500 m tow at the same location. However, our bad luck continued at 1020 hrs when our sled was lost on a small rocky outcrop near the head of the canyon (-36° 23.315, 136° 28.987). The crew immediately rigged up our back-up sled and we were ready to shoot-away again in less than 20 minutes. To prevent any further gear losses at this site, a repeat tow was postponed until sufficient topographic data were available to avoid any other unexpected obstacles.

At 1230 hrs the vessel proceeded to station DCW_200 and prepared to take CTD and grab samples. These deployments went ahead without incident and were closely followed by replicate CTD and grab samples on the shelf to the west of the canyon (DCW_200). The vessel then proceeded to the central axis of the canyon and began to survey the seafloor bathymetry adjacent to the central sampling locations. Due to the high topographical relief in the lower central canyon we were unable to locate suitable ground for sled tows near two of our prospective sampling stations (DCC_1500, DCC_1000). We did, however, locate some low-relief ground adjacent to two other stations (DCC_200, DCC_500) and were successful in sampling both of these prior to midnight. At 2300 hrs the vessel commenced swath mapping unsurveyed sections of the upper canyon polygon (150-200 m depth).

Wednesday 20th February. Swath mapping of the upper canyon was continued until 0700 hrs. We then proceeded to take CTD and grab samples in sequence from four stations (DCC_500, DCE_500, DCW_500, DCC_1000). Deteriorating weather conditions (30 knot southerly winds and 3 m seas) hampered this sampling, and meant that multiple grab deployments were invariably required to retrieve a sample of sediment. After completing these deployments at 1800 hrs, a sled tow was undertaken along a steep incline to the east of DCC_1000, and a small amount of sessile benthos was collected. At 2000 hrs we proceeded to swath map the lower reaches of the canyon in preparation for our scheduled trawl sampling.

Thursday 21st February. Swath mapping of the lower canyon was continued until 0700 hrs when we arrived at station at DCE_1000 to begin deploying the CTD and grab. The CTD cast was trouble-free, but after four successive grab deployments we were unable to collect any sediment samples. Grab sampling at this location was therefore terminated. CTD and grab deployments were subsequently undertaken at a further three stations during the day (DCE_1500, DCC_1500, DCW_1500), but the steep terrain at all of these sites hampered grab sampling and meant that we could only retrieve bottom sediments from station DCC_1500. Our sled-sampling program was successfully completed on Tuesday night, but not without incident. The sled became hooked-up at DCC_1500 towards the end of a 500 m tow, and would most probably have been lost, had it not been for the skill of the First Mate in manoeuvring the vessel back along the trawl line to a point at which the sled could be freed from the seafloor. After an anxious wait of about an hour, our back-up sled was returned to the vessel deck, battered and bent, but with the cod-end and catch intact. With a feeling of great relief we reverted to swath mapping the 200-500 m depth zone.

Friday 22nd February. All of Friday was occupied by sounding unsurveyed sections of the canyon. This action was necessary as poor weather conditions (35 knot SE winds and 3 m seas) meant that trawl sampling scheduled for the afternoon and evening could not be undertaken safely.

Saturday 23rd February. Weather conditions began to improve on Saturday morning, and by 1100 hrs we were able to commence fishing operations at DCE_200. Soundings, sled and grab samples taken earlier at this location indicated that the seafloor was relatively flat and composed of soft sediment with a sparse coverage of epibenthos. Accordingly, we were quite confident that the trawl could be shot and retrieved here without complications. Unluckily, we became hooked-up less than 10 minutes into the trawl shot, and spent the next hour trying to carefully prise the gear form the seabed. This cautious approach payed off and allowed the trawl net to be retrieved with only a damaged footrope. While repairs to the net were being undertaken, we returned to the station DCE_1000 and made four further attempts to obtain a sediment sample with the grab, but were unsuccessful on each occasion. By 1830 hrs the trawl net had been repaired, and at 1900 hrs we were back at station DCE_200 ready to shoot away. This time we avoided snagging the net and were able to land a small catch of Stingarees (*Urolophus paucimaculatus*) and Gurnards (*Lepidotrigla modesta*). At 2100 hrs, the vessel headed northwest to begin sounding a new array of swath lines located between the 150-250 m depth contours.

Sunday 24th February. Swath mapping of the shelf, west of the canyon, was continued through until 0700 hrs. The vessel then proceeded to station DCC_500 for the first trawl shot of the day. This shot failed to catch any fish, so a second shot was undertaken using an increased warp length. The Scanmar gear (attached to the doors and net) indicated much better bottom contact on the second shot, and when retrieved the cod-end contained 13 species of fish weighing a total of 150 kg. At 1530 hrs a trawl shot was undertaken at station DCC_1000. Unfortunately the gear appeared to fish very lightly at this deeper location and only one individual whiptail (*Lepidorhynchus denticulatus*) was landed. At 1800 hrs the vessel proceeded to station BCC_200 and began to sound the seafloor at this location in an effort to identify a suitable trawl path for the following days sampling. After half an hour on site a swath line was activated and the vessel began to map the last uncharted section of the du Couedic canyon polygon.

Monday 25th February. The final series of swath lines was completed at 0500 hrs, and at 0700 hrs the vessel was on station at DCC_200 to commence the final day's trawling. The 30-minute trawl shot at this location went according to plan, and was hauled in without incident at 0930 hrs. The vessel then proceeded to take a second trawl shot at station DCC_1000 (as the catch taken the previous day at the same station was not considered representative of the area). This time the catch was much more diverse, and contained 11 species of demersal fish. The fishing program was successfully concluded at station DCC_100 at 1700 hrs. Despite a hook-up towards the end of the shot, the catch was successfully landed, and at 1730 hrs we had begun the final transit of our voyage to Port Adelaide.

Tuesday 26th February. The vessel docked at berth No.13 in Port Adelaide at 0845 hrs, and demobilisation was completed at 1500 hrs.

Summary

This voyage was a great success in obtaining the scientific measures to effectively test hypotheses on the roles of submarine canyons in upwelling, sediment transport and productivity. Fortuitously, our sampling off the Bonney Coast and Kangaroo Island coincided with one of the strongest upwelling events recorded (Figure 4). Accordingly, we collected an exceptional data set that will be of considerable value, not only to our research team, but also to other oceanographers, biologists and geologists throughout Australia and overseas. Virtually all of our priority chemical, biological and geological samples were collected during the voyage and will, when analysed, provide new insights into the functional ecology of Australia's submarine canyons. The swath data collected during the voyage have already revealed the existence of topographic features that are unparalleled in Australia, and will undoubtedly stimulate new interest in the evolution and biology of Australia's deep-water canyon systems.

Personnel

Scientific Participants

David Currie	SARDI	Chief Scientist
Sasi Nayar	SARDI	Phytoplankton Biologist
Graham Hooper	SARDI	Fish Biologist
Mike Steer	SARDI	Fish Biologist
James Paterson	FU	Phytoplankton Biologist, PhD Student
Peter Boult	UA / PIRSA	Geologist
Wayne Rumball	SAM	Invertebrate Biologist
Ruan Gannon	SAM / UA	Fish Biologist, PhD Student
Anne Kennedy	FUGRO	Swath Mapping Support
Don McKenzie	CMAR	MNF Voyage Manager
Stephen Thomas	CMAR	MNF Electronics Support
Bob Beattie	CMAR	MNF Computing Support
Mark Rayner	CMAR	MNF Hydrochemistry Support

SARDI – South Australian Research and Development Institute; PIRSA – Primary Industries and Resources South Australia; UA – University of Adelaide; FU – Flinders University; SAM – South Australian Museum; CMAR – CSIRO Marine and Atmospheric; GA – Geoscience Australia; MNF – Marine National Facility.

Marine Crew

Ian Taylor	Master
John Boyes	First Mate
Darren Lack	Second Mate
John Morton	Chief Engineer
Dave Jonker	First Engineer
Nick Fleming	Second Engineer
Graham McDougall	Boatswain
Matt Barrett	Integrated Rating
Stuart Crapper	Integrated Rating
Tony Kennard	Integrated Rating
John Howard	Integrated Rating
John Allwood	Integrated Rating
David Persson	Integrated Rating
Peter Coleman	Able Seaman
Kevin Shanahan	Chief Steward
Dave Nichols	Chief Cook
Julie Porch	Second Cook

Acknowledgments

This survey was not a trivial exercise, and involved multiple equipment deployments in often challenging weather conditions. The work could not have been undertaken safely and efficiently without the assistance of a technically diverse and highly skilled group of mariners. In particular, the scientific party would like to thank the Captain and crew of the RV Southern Surveyor for their professional and enthusiastic support throughout the voyage. We would also like to thank the Marine National Facility staff for their outstanding efforts in keeping the instrumentation and the data streams running. Compliments are also due to the many support staff at SARDI who helped develop and mobilize the sampling equipment - we very much appreciate their contributions to a highly successful voyage.

Dr David Currie
Chief Scientist

Figure 2: Bathymetric map of the upper Bonney canyon showing the locations of 17 depth-stratified sampling sites (yellow rectangles) surveyed during SS02/2008.

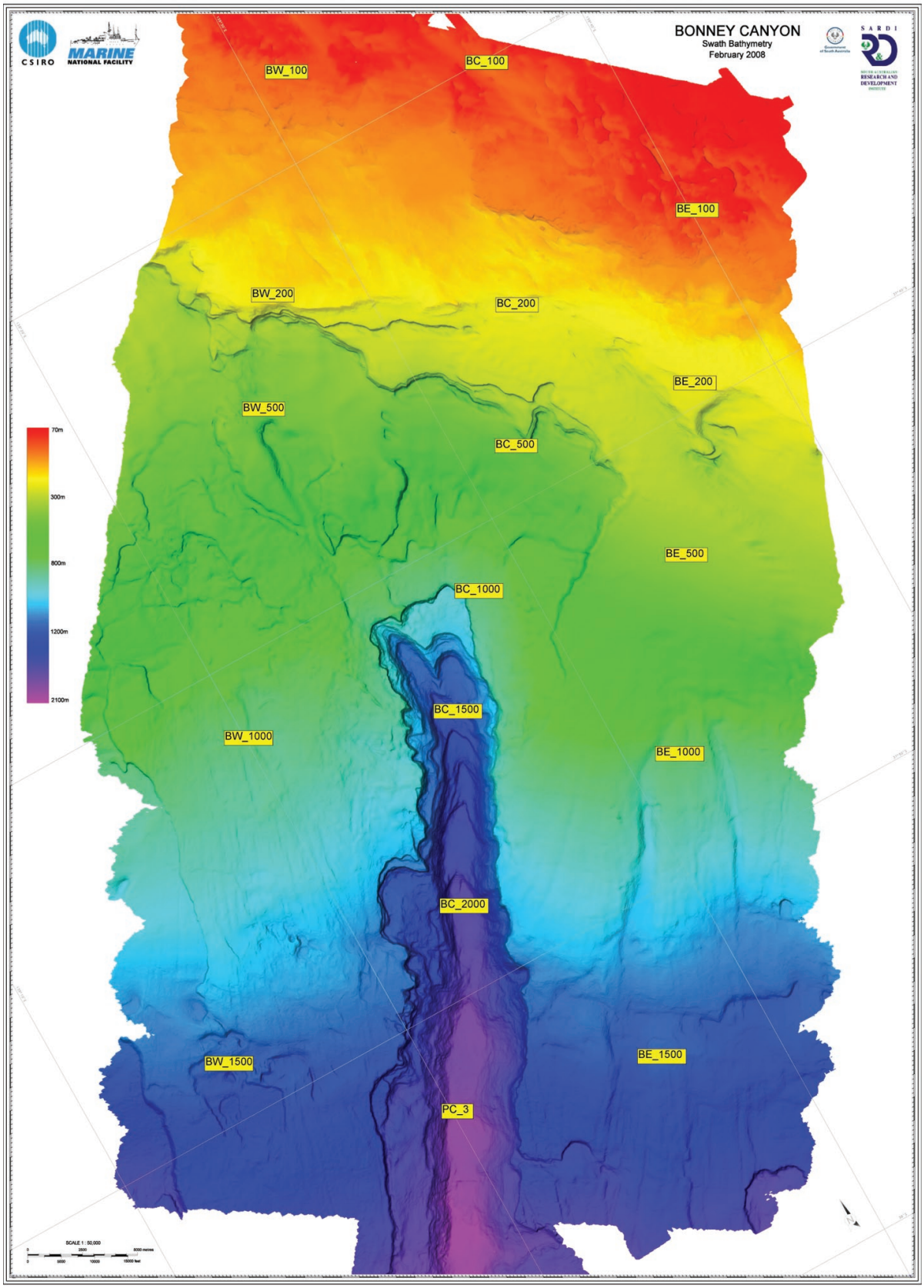

Figure 3: Bathymetric map of du Couedic canyon showing the locations of 15 depth-stratified sampling sites (yellow rectangles), and the position of an immense

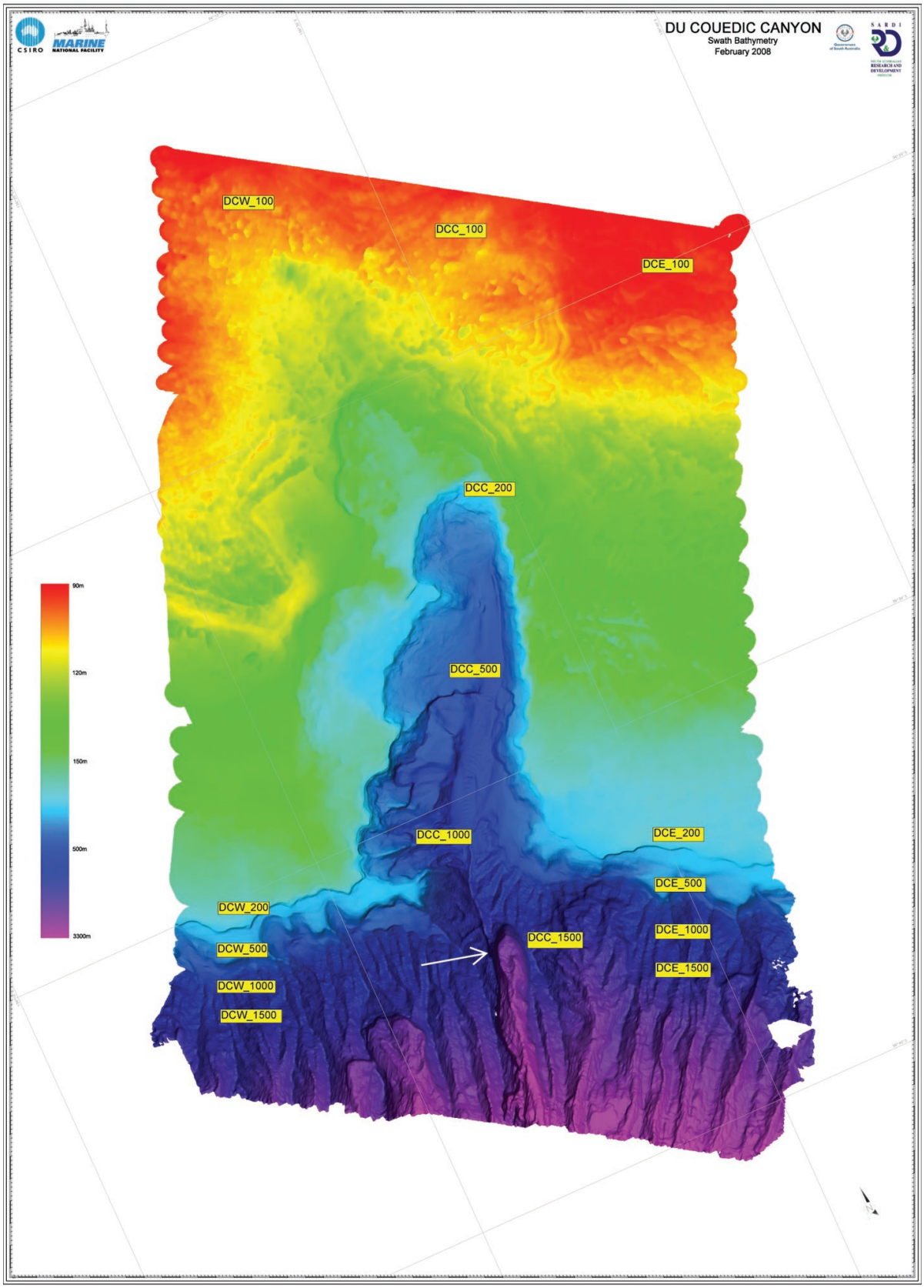

Figure 4: Sea surface temperature (SST) map recoded by NOAA satellite during voyage SS02/2008 showing an area of intense upwelling off the Bonney Coast. Image courtesy of CSIRO Marine and Atmospheric Research.

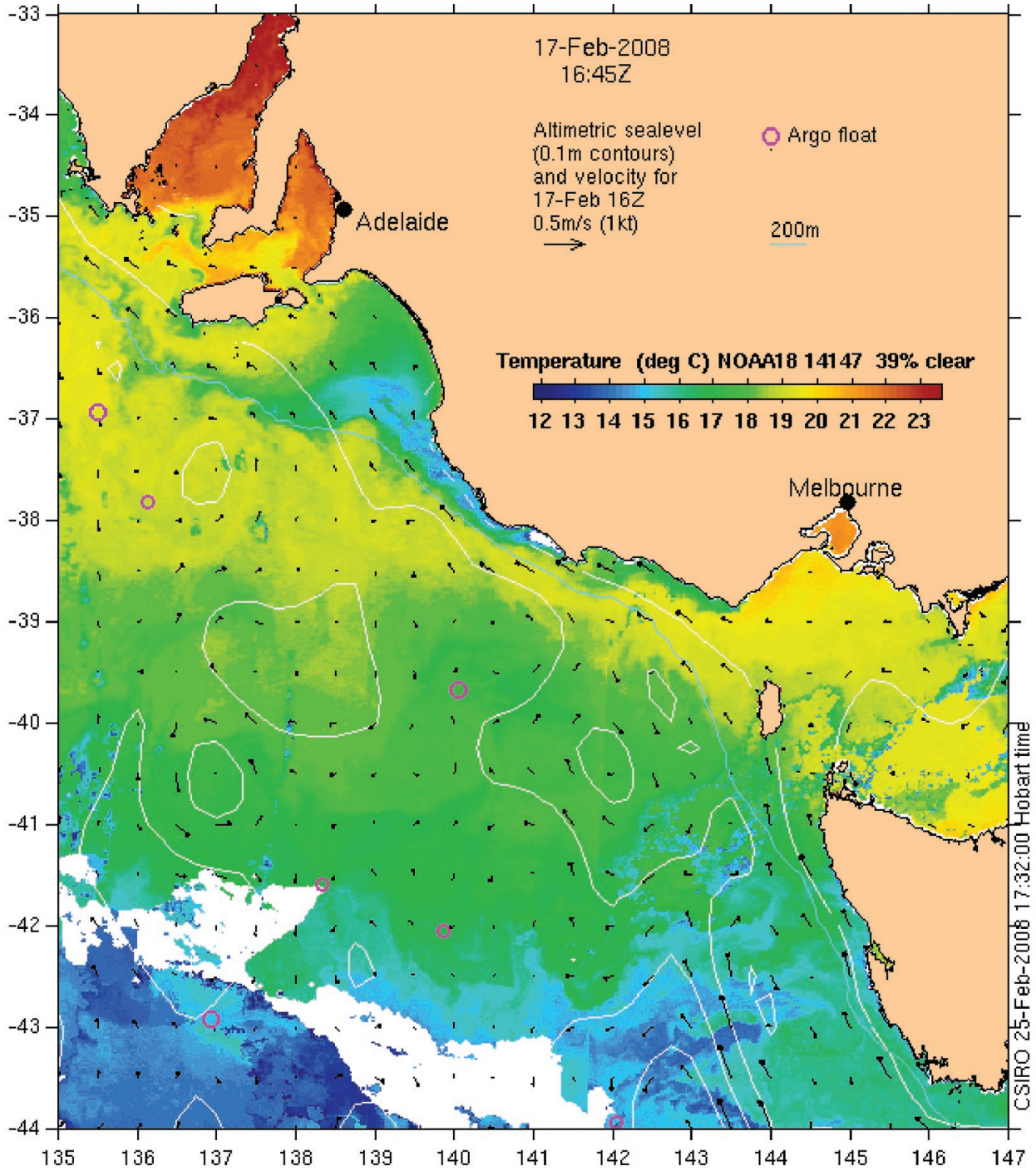

Table 1. List of sampling operations undertaken during voyage SS02/2008

#	Canyon	Site	Date	Method	Start Time	Finish Time	Start Longitude	Start Latitude	Finish Longitude	Finish Latitude	Depth (m)
1	Bonney	BC_100	07/02/08	Trawl	07.34	07.37	139 34.924	-37 28.651	139 36.737	-37 30.132	92
2	Bonney	BC_100	07/02/08	CTD	08.40	08.55	139 36.900	-37 30.156	-	-	102
3	Bonney	BC_100	07/02/08	Grab	09.06	09.12	139 36.944	-37 30.151	-	-	103
4	Bonney	BW_100	07/02/08	CTD	14.57	15.10	139 30.927	-37 28.009	-	-	102
5	Bonney	BW_100	07/02/08	Grab	15.20	15.25	139 31.291	-37 28.026	-	-	104
6	Bonney	BE_100	07/02/08	CTD	16.56	17.11	139 38.916	-37.35.313	-	-	99
7	Bonney	BE_100	07/02/08	Grab	17.20	17.24	139 39.438	-37 35.546	-	-	100
8	Bonney	BE_200	08/02/08	CTD	02.50	03.02	139 37.286	-37 38.635	-	-	182
9	Bonney	BE_200	08/02/08	Grab	03.09	03.15	139 37.156	-37 38.630	-	-	192
10	Bonney	BC_200	08/02/08	CTD	04.05	04.23	139 34.672	-37 36.054	-	-	196
11	Bonney	BC_200	08/02/08	Grab	04.30	04.37	139 34.410	-37 36.026	-	-	200
12	Bonney	BW_200	08/02/08	CTD	05.24	05.38	139 27.605	-37 32.650	-	-	160
13	Bonney	BW_200	08/02/08	Grab	05.44	05.54	139 27.419	-37 32.665	-	-	160
14	Bonney	BW_200	08/02/08	Trawl	07.21	07.51	139 27.279	-37 31.373	139 27.133	-37 32.760	155
15	Bonney	BC_200	08/02/08	Trawl	09.28	09.58	139 33.559	-37 33.685	139 34.144	-37 34.825	147
16	Bonney	BE_200	08/02/08	Trawl	11.15	11.45	139 36.719	-37 37.114	139 37.485	-37 38.414	150
17	Bonney	BE_500	08/02/08	CTD	23.01	23.42	139 34.458	-37 42.432	-	-	456
18	Bonney	BE_500	08/02/08	Grab	23.54	00.07	139 34.486	-37 42.438	-	-	456
19	Bonney	BC_500	09/02/08	CTD	00.52	01.17	139 32.309	-37 38.519	-	-	454
20	Bonney	BC_500	09/02/08	Grab	01.25	01.38	139 32.311	-37 38.523	-	-	450
21	Bonney	BW_500	09/02/08	CTD	02.29	02.59	139 26.384	-37 34.553	-	-	516
22	Bonney	BW_500	09/02/08	Grab	03.04	03.18	139 26.365	-37 34.570	-	-	520
23	Bonney	BW_500	09/02/08	Trawl	06.03	06.25	139 26.227	-37 35.023	139 26.280	-37 36.030	518
24	Bonney	BW_500	09/02/08	Trawl	08.13	08.53	139 25.799	-37 34.587	139 26.722	-37 36.010	540
25	Bonney	BC_500	09/02/08	Trawl	11.20	11.35	139 31.150	-37 37.822	139 31.752	-37 38.248	520
26	Bonney	BE_1000	09/02/08	CTD	21.53	22.23	139 30.779	-37 47.700	-	-	992
27	Bonney	BE_1000	09/02/08	Grab	22.41	23.09	139 30.771	-37 47.698	-	-	992
28	Bonney	BC_1000	10/02/08	CTD	00.01	00.45	139 28.994	-37 41.589	-	-	951
29	Bonney	BC_1000	10/02/08	Grab	00.54	01.19	139 28.983	-37 41.615	-	-	952
30	Bonney	BE_500	10/02/08	Trawl	06.13	06.47	139 35.248	-37 42.336	139 33.120	-37 41.315	419
31	Bonney	BE_500	10/02/08	Trawl	08.47	09.17	139 35.244	-37 42.347	139 33.430	-37 41.615	412
32	Bonney	BC_500	10/02/08	Trawl	10.59	11.29	139 31.047	-37 37.513	139 32.450	-37 38.386	521
33	Bonney	BW_1000	10/02/08	CTD	14.27	15.10	139 20.773	-37 41.972	-	-	1001
34	Bonney	BW_1000	10/02/08	Grab	15.20	15.51	139 20.853	-37 41.991	-	-	1003
35	Bonney	BW_1500	10/02/08	CTD	21.07	22.00	139 15.641	-37 48.990	-	-	1503
36	Bonney	BW_1500	10/02/08	Grab	22.13	23.00	139 15.643	-37 49.021	-	-	1508
37	Bonney	BC_1500	11/02/08	CTD	00.07	01.16	139 26.253	-37 43.956	-	-	1597
38	Bonney	BC_1500	11/02/08	Grab	01.29	01.58	139 26.209	-37 43.957	-	-	1593
39	Bonney	BE_1500	11/02/08	CTD	03.29	04.32	139 26.572	-37 53.770	-	-	1504
40	Bonney	BE_1500	11/02/08	Grab	04.38	05.21	139 26.574	-37 53.723	-	-	1501
41	Bonney	BE_1500	11/02/08	Grab	05.27	06.00	139 26.544	-37 53.818	-	-	1505
42	Bonney	BE_1000	11/02/08	Trawl	08.01	08.53	139 30.077	-37 46.640	139 31.080	-37 48.368	1004
43	Bonney	BE_200	11/02/08	CTD	22.19	22.37	139 37.225	-37 38.656	-	-	185
44	Bonney	BC_200	11/02/08	CTD	23.11	23.28	139 34.681	-37 36.034	-	-	190
45	Bonney	BW_200	12/02/08	CTD	00.11	00.30	139 27.860	-37 32.705	-	-	158
46	Bonney	BW_100	12/02/08	Trawl	04.31	05.05	139 32.099	-37 25.782	139 32.555	-37 27.546	92
47	Bonney	BC_100	12/02/08	Trawl	07.03	07.37	139 35.088	-37 28.590	139 36.301	-37 30.195	96
48	Bonney	BE_100	12/02/08	Trawl	09.38	10.08	139 42.113	-37 33.967	139 42.933	-37 35.608	78

#	Canyon	Site	Date	Method	Start Time	Finish Time	Start Longitude	Start Latitude	Finish Longitude	Finish Latitude	Depth (m)
49	Bonney	BW_1000	13/02/08	Trawl	03.02	03.29	139 18.670	-37 40.541	139 20.106	-37 41.969	1035
50	Bonney	BC_1000	13/02/08	Trawl	06.35	07.20	139 26.291	-37 38.820	139 27.874	-37 40.246	949
51	Bonney	BC_100	14/02/08	Sled	00.19	00.34	139 35.220	-37 28.991	139 35.490	-37 29.190	87
52	Bonney	BC_200	14/02/08	Sled	01.30	01.45	139 33.965	-37 34.211	139 34.081	-37 34.491	152
53	Bonney	BC_500	14/02/08	Sled	02.44	02.59	139 32.116	-37 38.144	139 32.442	-37 38.356	438
54	Bonney	BC_1000	14/02/08	Sled	04.30	05.00	139 27.706	-37 40.562	139 28.023	-37 40.863	969
55	Bonney	BC_1500	14/02/08	Sled	07.10	07.40	139 25.938	-37 43.279	139 26.463	-37 43.764	1523
56	Bonney	BC_2000	14/02/08	Sled	09.42	10.35	139 23.530	-37 48.220	139 23.945	-37 49.440	1917
57	Bonney	PD10	15/02/08	Grab	13.11	14.35	139 17.186	-38 29.513	-	-	4125
58	Bonney	PD11	15/02/08	Grab	15.09	16.39	139 18.884	-38 28.476	-	-	4079
59	Bonney	PD13	15/02/08	Rock Dredge	21.07	22.50	139 21.814	-38 23.783	139 18.064	-38 22.449	3392
60	Bonney	PC3	16/02/08	Beam Trawl	03.40	04.15	139 19.750	-37 52.480	139 20.600	-37 53.390	2010
61	Bonney	BC_1000	16/02/08	Beam Trawl	07.10	07.40	139 26.920	-37 40.090	139 27.788	-37 40.628	957
62	du Couedic	DCE_100	17/02/08	CTD	22.04	22.24	136 37.363	-36 20.137	-	-	107
63	du Couedic	DCC_100	17/02/08	CTD	23.08	23.22	136 32.161	-36 16.967	-	-	113
64	du Couedic	DCW_100	18/02/08	CTD	00.05	00.19	136 26.496	-36.14.460	-	-	112
65	du Couedic	DCW_100	18/02/08	Grab	00.51	00.55	136 26.456	-36 14.443	-	-	112
66	du Couedic	DCW_100	18/02/08	Grab	01.01	01.05	136 26.431	-36 14.487	-	-	120
67	du Couedic	DCC_100	18/02/08	Grab	01.47	01.51	136 32.178	-36 16.950	-	-	114
68	du Couedic	DCC_100	18/02/08	Grab	01.57	02.03	136 32.235	-36 16.977	-	-	114
69	du Couedic	DCC_100	18/02/08	Grab	02.06	02.11	136 32.248	-36 17.024	-	-	114
70	du Couedic	DCE_100	18/02/08	Grab	02.53	02.58	136 37.345	-36 20.166	-	-	106
71	du Couedic	DCE_100	18/02/08	Sled	03.37	03.54	136 36.988	-36 20.183	136 37.340	-36 20.190	101
72	du Couedic	DCC_100	18/02/08	Sled	05.02	05.17	136 31.765	-36 17.001	136 32.098	-36 16.954	109
73	du Couedic	DCW_100	18/02/08	Sled	06.06	06.21	136 26.662	-36 14.482	136 27.001	-36 14.460	108
74	du Couedic	DCW_100	18/02/08	Trawl	08.04	08.34	136 26.929	-36 14.595	136 26.235	-36 14.527	106
75	du Couedic	DCC_200	18/02/08	CTD	21.54	22.10	136 29.178	-36 23.495	-	-	186
76	du Couedic	DCC_200	18/02/08	Grab	22.20	22.26	136 29.145	-36 23.497	-	-	186
77	du Couedic	DCC_200	18/02/08	Grab	22.31	22.38	136 29.196	-36 23.500	-	-	186
78	du Couedic	DCE_200	19/02/08	CTD	01.34	01.52	136 30.800	-36 33.173	-	-	168
79	du Couedic	DCE_200	19/02/08	Grab	01.56	02.03	136 30.305	-36 33.220	-	-	169
80	du Couedic	DCW_200	19/02/08	CTD	03.35	03.56	136 18.444	-36 30.326	-	-	154
81	du Couedic	DCW_200	19/02/08	Grab	04.04	04.10	136 18.381	-36 30.305	-	-	152
82	du Couedic	DCW_200	19/02/08	Grab	04.14	04.19	136 18.361	-36 30.326	-	-	154
83	du Couedic	DCC_500	19/02/08	Sled	10.29	10.38	136 26.783	-36 27.122	136 26.685	-36 27.340	429
84	du Couedic	DCC_200	19/02/08	Sled	12.34	12.48	136 29.959	-36 24.621	136 29.946	-36 24.867	133
85	du Couedic	DCC_500	19/02/08	Grab	21.17	21.32	136 27.493	-36 27.430	-	-	500
86	du Couedic	DCC_500	19/02/08	CTD	21.40	22.10	136 27.450	-36 27.365	-	-	494
87	du Couedic	DCE_500	19/02/08	Grab	23.16	23.32	136 29.820	-36 34.636	-	-	509
88	du Couedic	DCE_500	19/02/08	Grab	23.36	23.52	136 29.855	-36 34.641	-	-	485
89	du Couedic	DCC_200	19/02/08	Sled	23.55	00.07	136 29.277	-36 23.695	136 28.985	-36 23.295	179
90	du Couedic	DCE_500	19/02/08	Grab	23.57	00.10	136 29.806	-36 34.661	-	-	498
91	du Couedic	DCE_500	20/02/08	Grab	00.17	00.33	136 29.373	-36 34.622	-	-	507
92	du Couedic	DCE_500	20/02/08	CTD	00.42	01.12	136 29.820	-36 34.656	-	-	486
93	du Couedic	DCE_500	20/02/08	Grab	01.24	01.44	136 29.890	-36 34.614	-	-	482
94	du Couedic	DCW_500	20/02/08	CTD	03.09	03.37	136 17.313	-36 31.855	-	-	442
95	du Couedic	DCW_500	20/02/08	Grab	04.01	04.15	136 17.452	-36 31.790	-	-	388
96	du Couedic	DCC_1000	20/02/08	CTD	05.03	05.52	136 24.555	-36 32.126	-	-	824
97	du Couedic	DCC_1000	20/02/08	Grab	05.58	06.19	136 24.731	-36 32.198	-	-	834

#	Canyon	Site	Date	Method	Start Time	Finish Time	Start Longitude	Start Latitude	Finish Longitude	Finish Latitude	Depth (m)
98	du Couedic	DCC_1000	20/02/08	Grab	06.33	06.57	136 24.572	-36 32.230	-	-	851
99	du Couedic	DCC_1000	20/02/08	Sled	08.30	08.43	136 26.268	-36 33.292	136 26.429	-36 33.533	907
100	du Couedic	DCE_1000	20/02/08	CTD	21.46	22.34	136 29.213	-36 35.546	-	-	1009
101	du Couedic	DCE_1000	20/02/08	Grab	22.40	23.10	136 29.222	-36 35.538	-	-	980
102	du Couedic	DCE_1000	20/02/08	Grab	23.15	23.43	136 29.240	-36 35.526	-	-	976
103	du Couedic	DCE_1000	20/02/08	Grab	23.49	00.19	136 29.406	-36 35.543	-	-	1047
104	du Couedic	DCE_1000	21/02/08	Grab	00.32	01.02	136 29.389	-36 35.487	-	-	1002
105	du Couedic	DCE_1500	21/02/08	CTD	02.04	03.03	136 28.820	-36 36.216	-	-	1450
106	du Couedic	DCE_1500	21/02/08	Grab	03.12	03.49	136 28.728	-36 36.249	-	-	1488
107	du Couedic	DCE_1500	21/02/08	Grab	03.55	04.30	136 28.755	-36.36.206	-	-	1442
108	du Couedic	DCC_1500	21/02/08	CTD	05.14	06.12	136 24.703	-36 34.834	-	-	1475
109	du Couedic	DCC_1500	21/02/08	Grab	07.23	08.03	136 25.042	-36 34.842	-	-	1483
110	du Couedic	DCC_1500	21/02/08	Sled	09.31	09.39	136 25.137	-36 34.810	136 25.085	-36 34.986	1510
111	du Couedic	DCW_1500	21/02/08	CTD	11.05	12.35	136 16.378	-36 33.563	-	-	1626
112	du Couedic	DCW_1500	21/02/08	Grab	12.40	13.13	136 16.375	-36 33.538	-	-	1614
113	du Couedic	DCW_1000	21/02/08	CTD	13.29	14.25	136 16.941	-36 32.614	-	-	904
114	du Couedic	DCW_1000	21/02/08	Grab	14.27	15.06	136 16.989	-36 32.684	-	-	954
115	du Couedic	DCE_200	23/02/08	Trawl	01.09	01.23	136 31.155	-36 33.058	136 31.168	-36 32.973	170
116	du Couedic	DCE_1000	23/02/08	Grab	02.56	03.19	136 29.768	-36 35.400	-	-	878
117	du Couedic	DCE_1000	23/02/08	Grab	03.31	03.59	136 29.517	-36 35.415	-	-	1014
118	du Couedic	DCE_1000	23/02/08	Grab	04.20	04.40	136 29.986	-36 35.258	-	-	749
119	du Couedic	DCE_1000	23/02/08	Grab	05.02	05.29	136 29.675	-36 35.701	-	-	972
120	du Couedic	DCE_200	23/02/08	Trawl	07.40	08.11	136 28.608	-36 31.995	136 30.337	-36 32.676	174
121	du Couedic	DCC_500	24/02/08	Trawl	00.49	01.33	136 27.558	-36 26.429	136 26.587	-36 28.082	540
122	du Couedic	DCC_1000	24/02/08	Trawl	04.11	04.36	136 24.614	-36 30.530	136 24.204	-36 31.480	820
123	du Couedic	DCC_500	24/02/08	Trawl	22.19	22.43	136 27.300	-36 26.998	136 26.788	-36 27.928	546
124	du Couedic	DCC_1000	25/02/08	Trawl	01.52	02.13	136 24.802	-36 29.955	136 24.225	-36 30.914	770
125	du Couedic	DCC_100	25/02/08	Trawl	05.18	05.33	136 32.488	-36 17.499	136 33.043	-36 17.760	109
126	du Couedic	DCC_200	25/02/08	Trawl	22.37	23.06	136 28.267	-36 22.156	136 27.191	-36 23.271	160