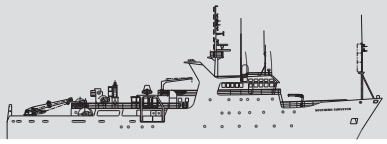


MARINE
NATIONAL FACILITY

2008 program

RV *Southern Surveyor*

**voyageplan**
**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 Investigators**

Dr David Currie (Chief Scientist) – SARDI Aquatic Sciences, GPO Box 120, Henley Beach, South Australia 5022 **Email:** currie.david@saugov.sa.gov.au

Dr John Middleton – SARDI Aquatic Sciences, GPO Box 120, Henley Beach, South Australia 5022 **Email:** middleton.john@saugov.sa.gov.au

Assoc. Prof. Bruce Ainsworth – University of Adelaide, Australian School of Petroleum, Adelaide, South Australia 5005 **Email:** bainsworth@asp.adelaide.edu.au

Dr Sasi Nayar – SARDI Aquatic Sciences, GPO Box 120, Henley Beach, South Australia 5022 **Email:** nayar.sasi@saugov.sa.gov.au

CSIRO

## 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 Is, 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 BC-KI 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 BC-KI 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 cruise but this is not essential to the canyon study proposed.

A broad-scale mapping survey using swathe, 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 swathe 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 (Appendix 1). 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

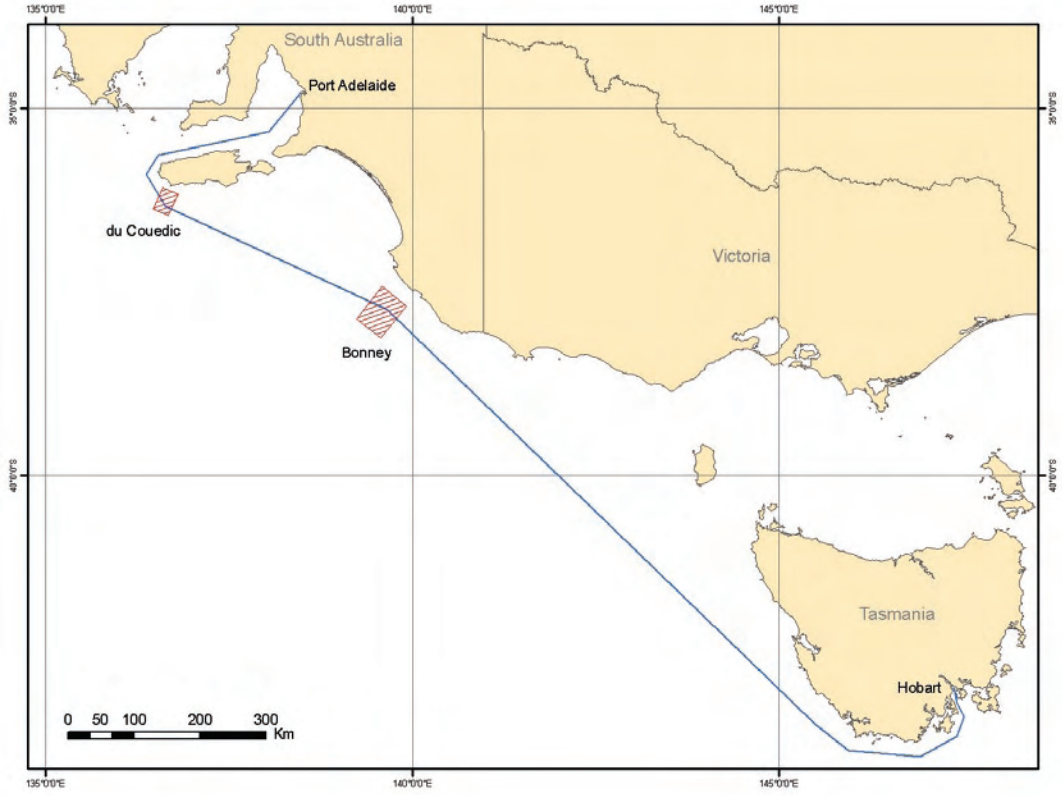



**Figure 1:** Map showing the proposed voyage track (blue line) for SS02/2008, and the locations of the two main study areas (red rectangles) off the Bonney coast and Cape du Couedic.

## Time Estimates

**Table 1:** Estimate of time for transit and surveys during SS02/2008 voyage.

| Activity | Region | Distance /Area | Time (hrs) | Total Time hrs (days) |
|---|---|---|---|---|
| Transit | Hobart – Bonney Coast | 570 nm | 52 | |
| | Bonney Coast – du Couedic | 170 nm | 16 | |
| | du Couedic – Port Adelaide | 140 nm | 13 | |
| | | | | 81 (3.4 days) |
| Swath Mapping | Bonney Coast | 6,900 $km^2$ | 150 | |
| | du Couedic | 1,000 $km^2$ | 24 | |
| | | | | 174 (7.2 days) |
| Bio/physical Sampling | Bonney Coast | | 216 (9 days) | |
| | du Couedic | | 72 (3 days) | |
| | | | | 288 (12.0 days) |
| **Total** | | | | **543 (22.6 days)** |

Poor weather conditions and equipment failures have the potential to adversely impact on the scientific outcomes of this project. A flexible sampling plan, to be revised on a daily basis, is therefore proposed. A prioritised listing of all scheduled physical, chemical and biological sampling is provided in Appendix 2. Swath mapping priorities have also been summarised in Appendix 3.

## Piggy-back Projects

**1) Project title:** Invertebrate biodiversity in deepwater canyons off South Australia

**PI** Thierry Laperousaz, South Australian Museum

**Objective:** The deepwater invertebrate fauna off southern Australia is poorly understood. This project complements core sampling to be undertaken during the voyage, and will primarily involve the preservation, curation and identification of invertebrate organisms collected during sled sampling operations.

**2) Project title:** Genetic analyses of deepwater fish.

**PI** Prof. Steve Donnellan, South Australian Museum

**Objective:** Short DNA sequences that can discriminate species are currently being determined for many marine animal species under the "Census of Marine Life" project. This piggyback project will contribute to our understanding of biodiversity, distribution and abundance of marine life in the oceans, by undertaking genetic analyses of fish collected during proposed beam-trawl sampling.

## *Southern Surveyor* Equipment

- Communications – Voice, fax and data
- Navigation – archiving of underway data including time, ship position, bathymetric depth
- Meteorological data – air temperature, humidity, wind-speed, and direction, barometric pressure and light
- Oceanographic data – underway logging of sea surface temperature and salinity
- General computing facilities and marine charting software
- Seapath Seatex 200 – for heading pitch and roll
- Simrad EK500 sounder (12, 38, 120kHz)
- Simrad EM300 multibeam swath mapper
- ADCP
- Lowered ADCP
- General purpose laboratory
- Controlled temperature laboratory (3-5°C)
- Hydrochemistry laboratory
- Fish laboratory/geoscience laboratory
- Fish sorting room
- Photographic/preservation laboratory
- Blast freezer
- Walk in freezer
- Scanmar (for monitoring altitude of underwater equipment)
- Sensors to measure: tension, winch-speed and wire out for CTD, trawl and coring winches
- Trawl winches with 5,000m of 24mm wire
- Coring winch with 7,000m of 19mm wire
- CTD/Hydro winches with 7,000m of 8mm single core conducting cable
- Hydrographic A-frame
- Stern A-frame (SWL 15 tonnes)
- 7 tonne knuckleboom crane
- Gilson winches (15 tonne, 5 tonne)
- Electronic fish measuring boards
- Smith McIntyre grabs (2)
- Small epibenthic sled
- Rock dredge (2)
- CTD (seabird SBE 911 plus)
- Additional CTD sensors (Profiling fluorometer, DO, Light)
- Rosette (24 x 10 litre Niskin bottles)
- Underway fluorometer
- Scintillation counter
- Milli-Q water supply
- On deck flowing seawater supply for phytoplankton incubators

## User Equipment

- Beam-trawl net (4m headline – Lewis/CSIRO design)
- Otter trawl (30m headline – Kavanaugh/SARDI design)
- Benthic grab (0.1m$^2$ bucket – Smith-McIntyre design)
- Sherman sled (1m width – Lewis/CSIRO design)
- Epibenthic sled (1m width - Ockelmann design)

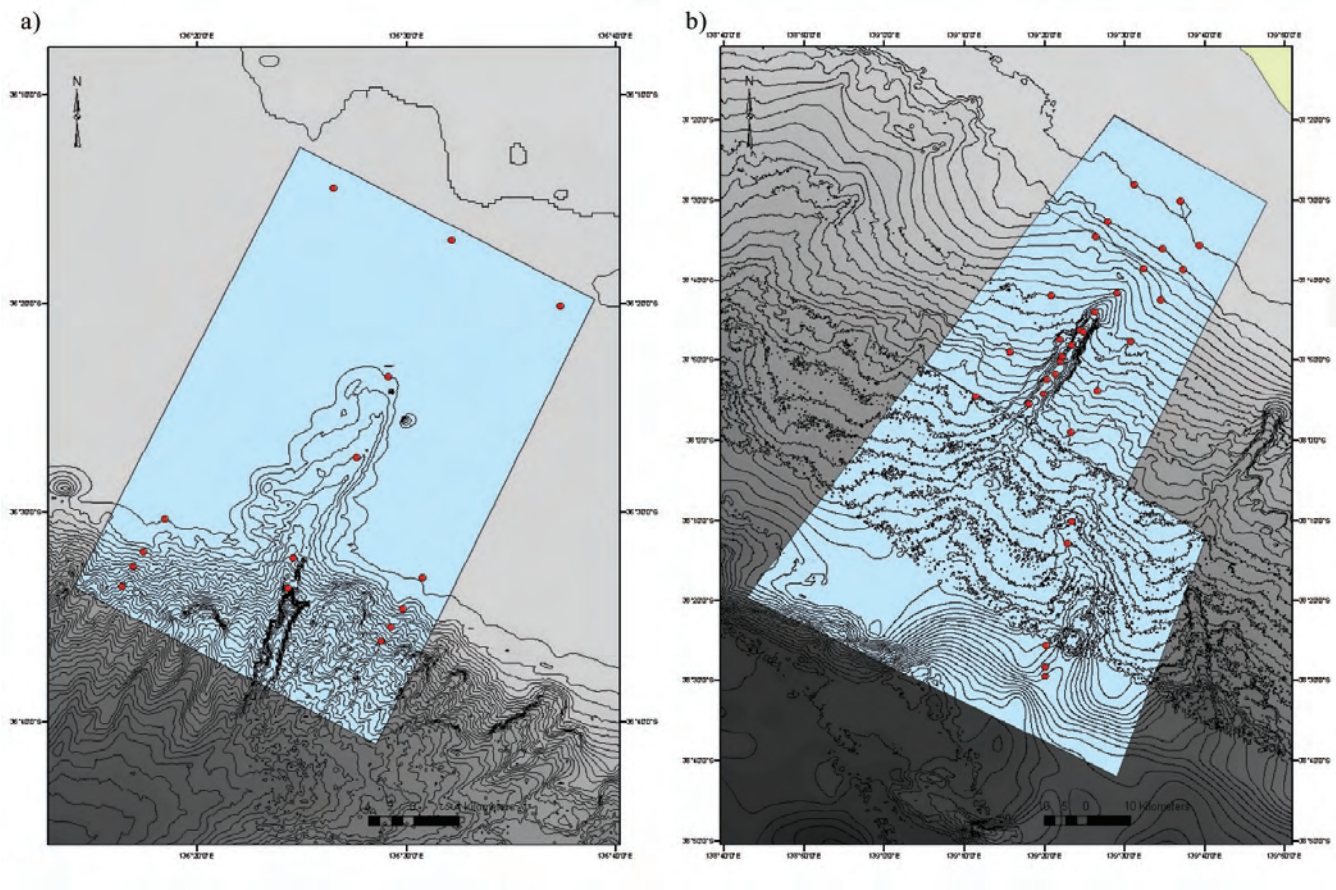
## Personnel List

| Name | Affiliation | Role |
|---|---|---|
| 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 |
| Tony Hill | PIRSA | Geologist |
| Wayne Rumball | SAM | Invertebrate Biologist |
| Ruan Gannon | SAM/UA | Fish biologist, PhD student |
| Marianne Sandstrom | UA | Geologist, PhD student |
| Anne Kennedy | FUGRO | Swath mapping support |
| Don McKenzie MSIC40524 | CMAR | MNF Voyage Manager |
| Stephen Thomas MSIC40504 | CMAR | MNF Electronics Support |
| Bob Beattie MSIC40511 | CMAR | MNF Computing Support |
| Mark Rayner MSIC40640 | 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; MNF – Marine National Facility.

This voyage plan is in accordance with the directions of the National Facility Steering Committee for the Research Vessel *Southern Surveyor*.

**Dr David Currie**
*Chief Scientist*




**Appendix 1:** Bathymetric maps of a) du Couedic canyon, and b) an unnamed canyon system off the Bonney Coast, showing target areas for swath mapping (blue polygons) and locations of prospective sampling stations (red filled circles).

**Appendix 2.** Summary table showing sampling locations (GDA94) and priorities for proposed sampling operations during SS02/2008.

| Region | Transect | Depth (m) | Station | Latitude | Longitude | Sampling Method | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | CTD | ADCP | Grab | Sled | Rock Dredge | Benthic Trawl |
| Bonney | West | 100 | BW_100 | -37.46834722 | 139.51933611 | High | High | High | High | . | High |
| Bonney | West | 200 | BW_200 | -37.54486667 | 139.46438611 | High | High | High | High | . | High |
| Bonney | West | 500 | BW_500 | -37.57616667 | 139.43952222 | High | High | High | High | . | High |
| Bonney | West | 1000 | BW_1000 | -37.69971111 | 139.34623889 | High | High | High | High | . | High |
| Bonney | West | 1500 | BW_1500 | -37.81713889 | 139.26047500 | High | High | High | High | . | High |
| Bonney | West | 2000 | BW_2000 | -37.90921389 | 139.19044722 | High | High | High | High | . | Low |
| Bonney | Centre | 100 | BC_100 | -37.50216111 | 139.61511111 | High | High | High | High | . | High |
| Bonney | Centre | 200 | BC_200 | -37.60080556 | 139.57857500 | High | High | High | High | . | High |
| Bonney | Centre | 500 | BC_500 | -37.64227778 | 139.53836667 | High | High | High | High | . | High |
| Bonney | Centre | 1000 | BC_1000 | -37.69348333 | 139.48298889 | High | High | High | High | . | High |
| Bonney | Centre | 1500 | BC_1500 | -37.73280000 | 139.43714722 | High | High | High | High | . | High |
| Bonney | Centre | 2000 | BC_2000 | -37.80190556 | 139.39012222 | High | High | High | High | . | Low |
| Bonney | East | 100 | BE_100 | -37.59430000 | 139.65561944 | High | High | High | High | . | High |
| Bonney | East | 200 | BE_200 | -37.64485000 | 139.62156667 | High | High | High | High | . | High |
| Bonney | East | 500 | BE_500 | -37.70728056 | 139.57463889 | High | High | High | High | . | High |
| Bonney | East | 1000 | BE_1000 | -37.79508611 | 139.51299722 | High | High | High | High | . | High |
| Bonney | East | 1500 | BE_1500 | -37.89615556 | 139.44244444 | High | High | High | High | . | High |
| Bonney | East | 2000 | BE_2000 | -37.98351667 | 139.38726667 | High | High | High | High | . | Low |
| du Couedic | West | 100 | DCW_100 | -36.24129922 | 136.44109855 | Low | Low | Low | Low | . | Moderate |
| du Couedic | West | 200 | DCW_200 | -36.50519841 | 136.30691346 | Low | Low | Low | Low | . | Moderate |
| du Couedic | West | 500 | DCW_500 | -36.53096537 | 136.28989666 | Low | Low | Low | Low | . | Moderate |
| du Couedic | West | 1000 | DCW_1000 | -36.54387909 | 136.28172283 | Low | Low | Low | Low | . | Moderate |
| du Couedic | West | 1500 | DCW_1500 | -36.55921511 | 136.27277201 | Low | Low | Low | Low | . | Moderate |
| du Couedic | Centre | 100 | DCC_100 | -36.28262454 | 136.53590335 | Low | Low | Low | Low | . | Moderate |
| du Couedic | Centre | 200 | DCC_200 | -36.39152921 | 136.48534144 | Low | Low | Low | Low | . | Moderate |
| du Couedic | Centre | 500 | DCC_500 | -36.45619111 | 136.46005945 | Low | Low | Low | Low | . | Moderate |
| du Couedic | Centre | 1000 | DCC_1000 | -36.53633321 | 136.40923821 | Low | Low | Low | Low | . | Moderate |
| du Couedic | Centre | 1500 | DCC_1500 | -36.56064103 | 136.40524603 | Low | Low | Low | Low | . | Moderate |
| du Couedic | East | 100 | DCE_100 | -36.33534945 | 136.62214139 | Low | Low | Low | Low | . | Moderate |
| du Couedic | East | 200 | DCE_200 | -36.55275437 | 136.51239384 | Low | Low | Low | Low | . | Moderate |
| du Couedic | East | 500 | DCE_500 | -36.57715276 | 136.49700933 | Low | Low | Low | Low | . | Moderate |
| du Couedic | East | 1000 | DCE_1000 | -36.59216901 | 136.48695536 | Low | Low | Low | Low | . | Moderate |
| du Couedic | East | 1500 | DCE_1500 | -36.60266105 | 136.47931800 | Low | Low | Low | Low | . | Moderate |
| Bonney | Centre | 2400 | PC1 | -37.92596111 | 139.30054444 | . | . | . | High | . | . |
| Bonney | Centre | 2300 | PC2 | -37.90415278 | 139.33032222 | . | . | . | . | High | . |
| Bonney | Centre | 2300 | PC3 | -37.87333611 | 139.33819167 | . | . | . | High | . | . |
| Bonney | Centre | 2244 | PC4 | -37.83709444 | 139.36693611 | . | . | . | High | . | . |
| Bonney | Centre | 2200 | PC5 | -37.86263611 | 139.35598333 | . | . | . | . | High | . |
| Bonney | Centre | 2050 | PC6 | -37.82633056 | 139.37061667 | . | . | . | . | High | . |
| Bonney | Centre | 1850 | PC7 | -37.76980278 | 139.40795000 | . | . | . | High | . | . |
| Bonney | Centre | 1800 | PC8 | -37.77395278 | 139.41366389 | . | . | . | . | High | . |
| Bonney | Deep | 4280 | PD10 | -38.47225833 | 139.33450556 | . | . | High | . | . | . |
| Bonney | Deep | 3609 | PD11 | -38.42662222 | 139.33684722 | . | . | High | . | . | . |
| Bonney | Deep | 3000 | PD12 | -38.21321944 | 139.38138611 | . | . | . | High | . | . |
| Bonney | Deep | 3000 | PD13 | -38.16991111 | 139.38865833 | . | . | . | High | . | . |
| Bonney | Deep | 4687 | PD9 | -38.49187778 | 139.33350278 | . | . | High | . | . | . |
| Bonney | Terrace | 1550 | SC2 | -37.78960278 | 139.36386111 | Low | Low | Low | Low | Low | Low |

**Appendix 3:** Bathymetric map showing unnamed canyon system off the Bonney Coast, and estimated swath mapping times for selected polygons. Note the upper canyon polygon is the highest priority, while the central polygon is the lowest priority.