2005 RV *Southern Surveyor* program

MARINE
NATIONAL FACILITY

voyageplan

SS08/2005

GA Survey 293: Marine National Facility Research charter by Geoscience Australia and Department of Environment and Heritage.

Characterising benthic habitats and sedimentary processes of southwest Australian margin, including developing an understanding of the petroleum potential of the East Mentelle Basin.

Itinerary

Monday 26 September, 2005: GA staff arrive at vessel in Fremantle
Tuesday 27 Septmember, 2005: Mobilise vessel, GA staff accommodated onboard
Depart: Fremantle 1000hrs, Wednesday 28th September 2005
Arrive: Fremantle 1000hrs, Thursday 20th October 2005. Demobilise vessel

Principal Investigator

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CSIRO

Scientific Objectives

The scientific objectives of this survey (GA Survey 293) are to:

1. develop an understanding of deep-water sedimentary processes and benthic biota and habitats in "blind" submarine canyons on the southwest Australian margin;
2. document the geological and biological transitions between shelf, slope and offshore platform seabed environments; and
3. investigate the stratigraphy and geology of the Mentelle Basin and assess its implications for petroleum potential.

The main survey objectives are to address existing knowledge gaps regarding deep-water temperate benthic marine habitats on the outer shelf, slope and offshore platform environments on the southwest Australian margin. A further objective of the survey is to assess the petroleum potential of the Mentelle Basin.

Background

Of particular significance to deep-sea habitats are studies of submarine canyons which are known to contain unique geological environments and support a diverse range of biological communities that are comparatively well documented in the literature. Previous studies of submarine canyons in Australia have revealed that they are sites of considerable geological (and biological) diversity (e.g., Von Dor Borch, 1967; Exon *et al.* 2005; Hill *et al.*, 2005). Geological evidence indicates that submarine canyons on the southern margin formed principally from subaqueous erosion by sediment gravity flows and slumps after the break up of Australia from India and Antarctica (Connolly & von der Borch, 1967; Exon *et al.*, 2005).

Submarine canyons are geomorphically complex features that contain a variety of substrates, including steep-sides that can expose lithified strata and provide hard-ground habitats for benthic organisms. The head of the large, well-developed submarine canyons may intrude landwards across the shelf, and can even join major river systems. The Perth Canyon is the largest and most well-developed submarine canyon on the southwest margin of Australia (Fig. 1). Existing high-resolution bathymetry data shows that it cuts the shelf and has incised the margin up to 2,000 m in places. Submarine canyons such as the Perth Canyon intercept organic-rich material transported on the inner shelf (cf., Puig *et al.*, 2003). This material is supplied to the head of the canyon and transported downslope where it provides nourishment for a diverse and abundant macrofauna (Vetter and Dayton, 1999; Gage, 2004;). Deeply-incised submarine canyons are also biological "hotspots" because they act as conduits for upwelling of cooler nutrient-rich water from the deep ocean (Hooker *et al.*, 1999). As such, the Perth Canyon, on the southwest Australian margin, contains a relatively high amount of terrigenous sediment, has evidence of active sedimentary processes including erosion, and supports diverse and abundant benthic biota.

Relatively less is known about submarine canyons that are wholly confined to the continental slope. Existing bathymetry data indicates that, south of the Perth Canyon, the southwest Australian margin is extensively cut by a series of "blind" submarine canyons on the continental slope (Fig. 1). Blind submarine canyons do not intercept littoral sediments and organic matter on the inner shelf. The blind submarine canyons are thus likely to contain relatively less terrigenous sediment, less direct evidence of active sedimentary processes, and presumably less diverse and abundant benthic biota.

The present survey represents a vital opportunity to sample key seabed environments and benthic biota together in two fundamentally different types of submarine canyon. For the first time, deep-sea seabed environments and associated processes and benthic biota will be compared and contrasted in a large well-developed shelf-intruding canyon (i.e., Perth Canyon) versus a blind canyon (Fig. 1).

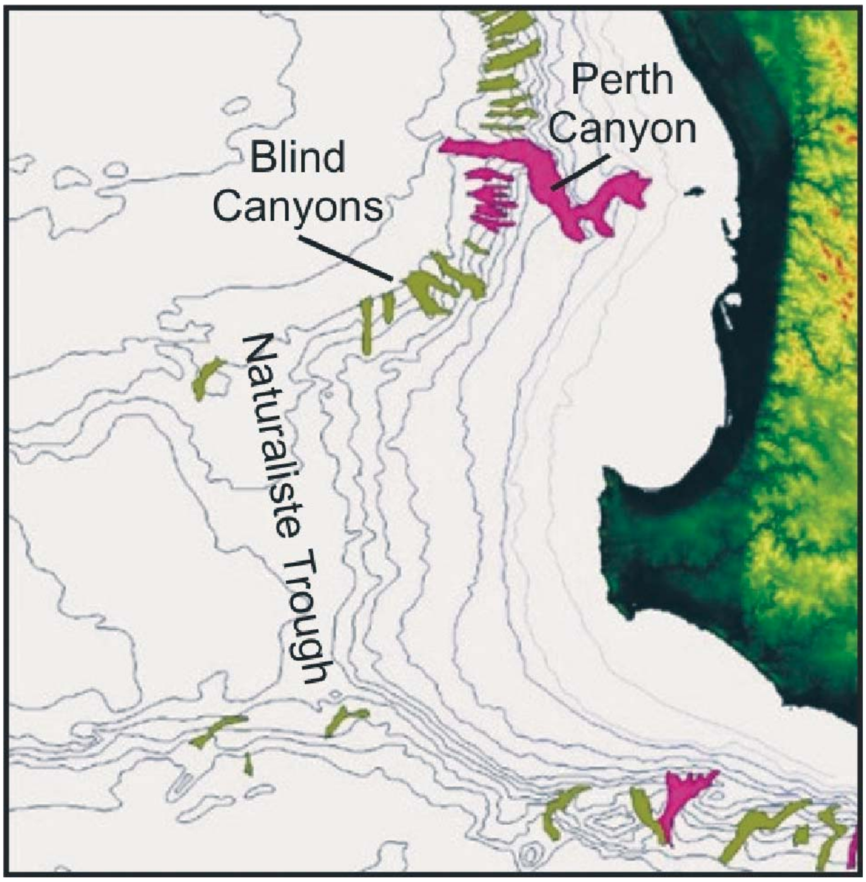


Figure 1: The location of known submarine canyons on the southwest margin of Australia. Perth Canyon is the largest and most extensive canyon on the southwest margin and cuts the shelf. The other canyons are "blind" canyons and wholly confined to the slope.

The Mentelle Basin is a frontier sedimentary basin lying beneath the Naturaliste Trough (Fig. 2). The basin has never been explored. Consequently, its stratigraphy can currently only be deduced from petroleum exploration wells in the nearby Vlaming Sub-basin and through correlations with seismic lines. Uncommercial oil has previously been found in one exploration well from the Vlaming Sub-basin which suggests an oil-prone petroleum system may be present. The second objective of the survey is to establish whether the Mentelle Basin contains a similar succession of rocks as the Vlaming Sub-basin and thus assess its petroleum potential. This will be achieved by sampling the basin strata that may outcrop in the Perth Canyon and other "blind" submarine canyons which presumably have incised into the rocks that make up the Mentelle and Vlaming basins.

The seabed in the Naturaliste Trough is relatively deep and flat (Fig. 1). Sediments and associated benthic marine habitats on the relatively flat regions of the Naturaliste Trough will also be a target for the survey in comparison with those of the rugged submarine canyons. Targeting this region will provide key data on seabed environments and benthic biota for a deep-water offshore marginal plateau in comparison to those associated with the shelf and upper slope environments. This region also coincides with the structural boundary between the western and eastern Mentelle Basin (Fig. 2) and could be a conduit where petroleum generated in the basin could migrate upwards into the surface sediments, with possible implications for benthic biota. Analysis of Synthetic Aperture Radar (SAR) scenes for the region indicates a potential slick on the ocean surface in the vicinity of the southern Mentelle Basin. If time permits, a sampling program will be undertaken near the slick to collect shallow seismic data and near-bed water samples and surface sediments to analysis for thermogenic hydrocarbons. This area is a low priority for the survey. Several "ring" structures have also been identified in SAR data around the main survey area, which will be investigated to determine if they are associated with gas seep sites.

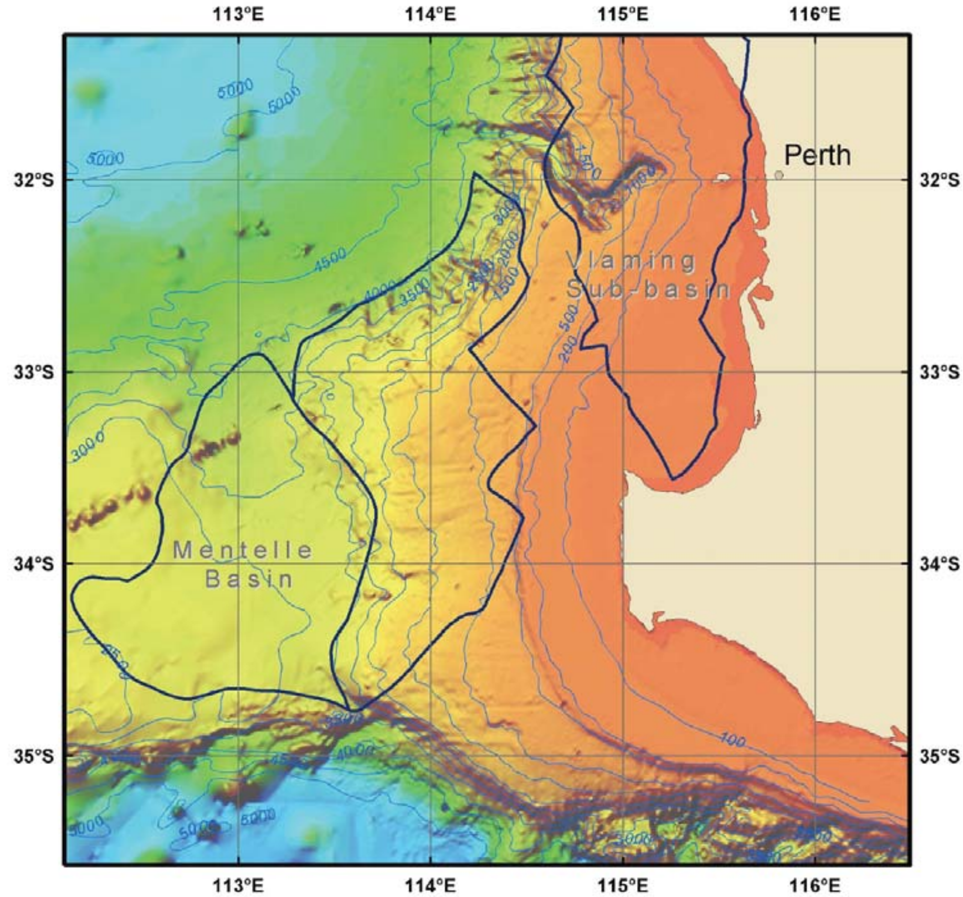


Figure 2: Map showing bathymetry of the southwest margin and boundaries of the underlying east and west Mentelle Basin and nearby Vlaming Sub-basin.

Four study areas have been identified for this study to address the scientific objectives (Fig 3). High-resolution bathymetric and backscatter data is critical for the accurate location of sample sites and mapping of benthic marine habitats. Swath-mapping, side scan sonar imagery, and sub-bottom profiles will be used together with the physical samples to help understand correlations between substrate type and benthic habitats and biota in each of the study areas.

The proposed ship tracks will ensure complete bathymetry coverage of the "blind" submarine canyons on the southwest margin. These data will be processed on-board, together with the side-scan sonar and sub-bottom profiler records to provide information on the nature of the sea floor, variation in sediment type and bathymetry. Proposed station locations for geological and biological sampling will be selected based on these processed data.

Linkages to Other Marine National Facility Surveys

SS08/2005 is one of four complementary surveys aboard the RV *Southern Surveyor* this year studying the geology and biology of the southwest margin. The other surveys are being run by CSIRO – Marine and Atmospheric Research and University of Tasmania.

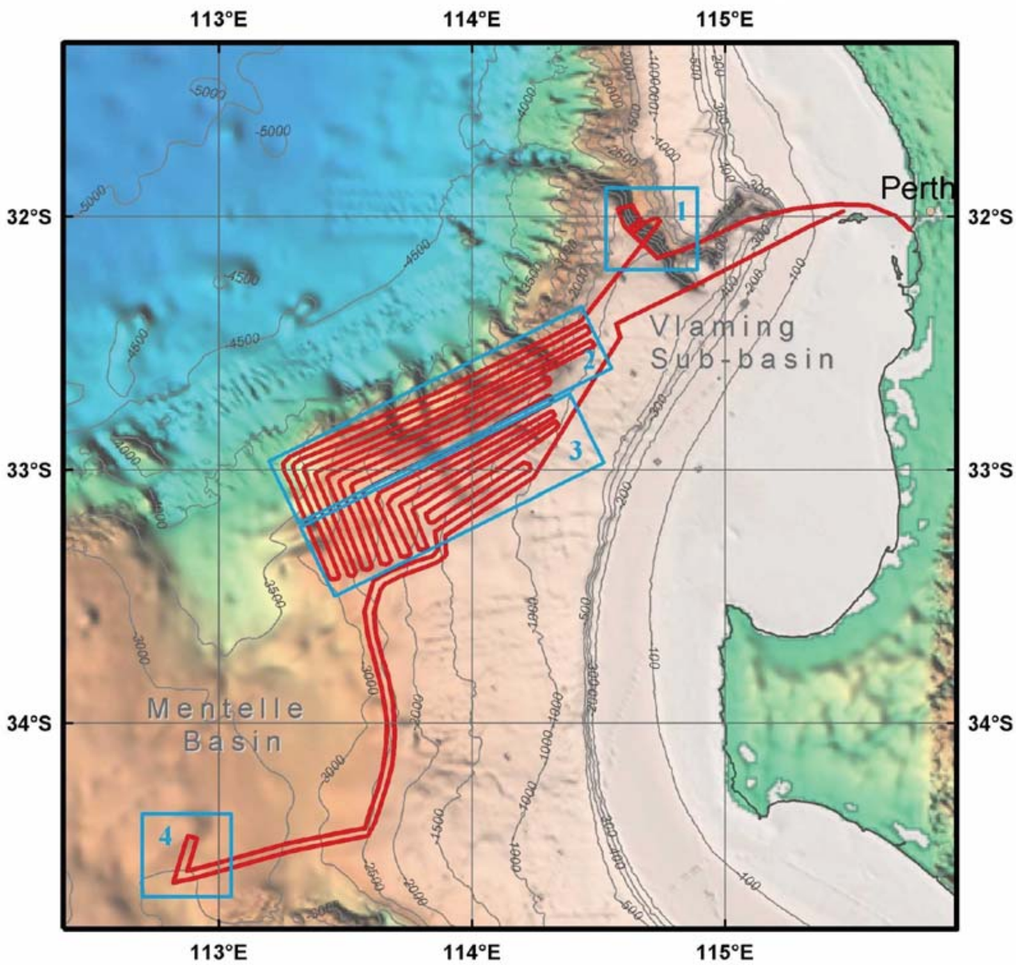


Figure 3: The location of GA Survey S293 (SS08/2005) showing proposed ship tracks and proposed study areas.

Voyage Plan

Transit to Area 1 (10-14 hours)
Deploy Geoscience Australia's ADCP mooring at 115° 26′ 44.25″E; -32° 02′ 41.66″S (Water depth = 27 m).

Area 1 (~2 days)
Swath mapping, sub-bottom profiles and deep-water (<3,500 m) dredging of the outer Perth Canyon to infill bathymetry data gaps will be completed. Approximately 4-5 stations will target specific sites to sample the basement rocks of the Vlaming Sub-basin and associated benthic habitats and biota.

Area 2 (~10 days)
The area will be extensively swath mapped with side scan sonar in and 3.5 kHz sub bottom profiles to extend existing high-resolution bathymetry and seabed information onto the upper slope and outer shelf. These data will provide details on the extent of the blind canyons. These new and existing data will be used to design the sampling program of CTD's, gravity cores, box cores, video imagery, rock dredges, and if required, benthic sleds. Approximately 10-12 stations will target specific environments and associated habitats and biota at different depths in the larger canyons (e.g., interfluves, flanks/walls, floors).

Area 3 (~7 days)
The area will be extensively swath mapped (possibly with side scan sonar to 1,000 m) and 3.5 kHz sub bottom profiles will also be collected. This information will be used to design the sampling program of CTD's, gravity cores, box cores, video imagery, rock dredges, and if required, benthic sleds. Approximately 9-10 stations will target specific environments and associated habitats and biota on the flat-lying regions of the eastern Naturaliste Plateau. Cores of the surface sediments will be collected to determine the presence of hydrocarbons.

Area 4 (~2 days)
This area is a low priority. It will only be occupied if we complete all survey objectives for Areas 1, 2 and, 3 otherwise the time will be used to complete work in the other areas. This area is the site of possible natural hydrocarbon seepage as interpreted by the presence of a large slick on the ocean surface from a SAR scene. The area will be swath mapped and 3.5 kHz sub-bottom profiles collected. The area will be sampled using the gravity corer to collect shallow sediments to analyse for hydrocarbons.

Transit From Area 3 to Feemantle (~18 hours)
Recover Geoscience Australia's ADCP mooring at 115° 26′ 44.25″E; -32° 02′ 41.66″S (Water depth = 27 m).

Transit From Area 4 to Feemantle (~24 hours) – if required
Recover Geoscience Australia's ADCP mooring at 115° 26′ 44.25″E; -32° 02′ 41.66″S (Water depth = 27 m).

Voyage Track

See Figure 3 and Time Estimates

Time Estimates

Transit from Fremantle to Area 1 (incl. deploy ADCP) ~10-14 hours
Area 1: Digital data acquisition and sampling ~2 days
Area 2: Transit from Area 1, digital data acquisition and sampling ~10 days
Area 3: Transit from Area 2, digital data acquisition and sampling ~7 days
Area 4 (if required): Transit from Area 2, digital data acquisition and sampling ~2days
Transit from Area 3 to Fremantle (incl. ADCP recovery) ~18 hours
Transit from Area 4 to Fremantle (incl. ADCP recovery) ~24 hours

Sampling Program

Digital Acquisition (~10 days)

Swath bathymetry – ~1300 line-km (entire survey)
3.5kHz sub-bottom profiles – ~1300 line-km (entire survey)
Side scan sonar – as necessary

Physical Sampling (~11 days)

Rock Dredges (max. 25x)
Gravity Cores (max. 25x)
Box Cores (as necessary)
Seabed video (max. 25x)
Benthic Sled (as necessary)
CTD's (max. 25x)

Total – 21 days

Date	Activity/Description
26/09/2005	Technical party arrive in Fremantle
27	Science party arrive in Fremantle. Mobilisation.
28	Transit to Area 1. Deploy ADCP mooring at 115° 26′ 44.25″E; -32° 02′ 41.66″S (Water depth = 27 m).
29	Begin sediment acquisition program; CTD, gravity/box core, camera, dredge, sled at select sites.
30	Continue physical sample acquisition.
1/10/2005	Transit to Area 2. Begin digital acquisition with swath mapper, 3.5 kHz SBP and side scan sonar.
2	Continue digital data acquisition.
3	Continue.
4	Continue.
5	Continue.
6	Begin sediment acquisition program; CTD, gravity/box core, camera, dredge, sled at select sites.
7	Continue physical sample acquisition.
8	Continue
9	Continue
10	Continue
11	Continue
12	Transit to Area 3. Begin digital acquisition with swath mapper, 3.5 kHz SBP and side scan sonar.
13	Continue digital data acquisition.
14	Continue
15	Begin sediment acquisition program; CTD, gravity/box core, camera, dredge, sled at select sites.
16	Continue physical sample acquisition
17	Continue
18 19 20	Transit to Area 4 (if necessary). Begin digital acquisition with swath mapper, 3.5 kHz SBP and side scan sonar. Sediment acquisition program; CTD, gravity/box core, camera, dredge, sled at select sites. Transit to Fremantle. Recover ADCP mooring. Arrive 08:00. Begin demobilisation.
21	Science & technical depart Fremantle.

***Southern Surveyor* Equipment / Space**

- Simrad swath-mapper with sound velocity profiler
- TOPAS 3.5 kHz sub-bottom profiler
- 12 & 200 kHz echo-sounder
- CTD (including Transmissometer)
- Trawl winch for dredges/benthic sleds
- Smith-Macintyre grab (2)
- Coring winch (for gravity core/box core/dredges)
- Benthic sled and spare nets
- Room for microscopes in dry lab
- Space for Swath and TOPAS processing
- Space for Side Scan Sonar & Camera processing
- Dark room for 35 mm film processing
- Space in fish laboratory for processing sediments/rocks
- Space for rock saw on deck and in fish sorting room
- Cold room for core storage (cores)

Special Requirements

- Room for sampling gear on deck (box core, dredge, camera)
- Room for consumables (core barrels, liners, etc)
- Room for Thomas (core deployment cradle)
- Room for video camera winch
- Room for large benthic sled (Sherman)
- Location to store fixing and preservation chemicals
- Sonardyne positioning system

Data sets to be collected from the National Facility's instruments

- Navigation (digital acquisition)
- Metrological data
- Echo-sounder with digital acquisition (12 & 200 kHz)
- Swath-sonar (digital) EM 300
- Sub-bottom profiles (digital) TOPAS
- ADCP
- Water temperature and thermosalinograph

User Equipment GA equipment (transported to the ship)

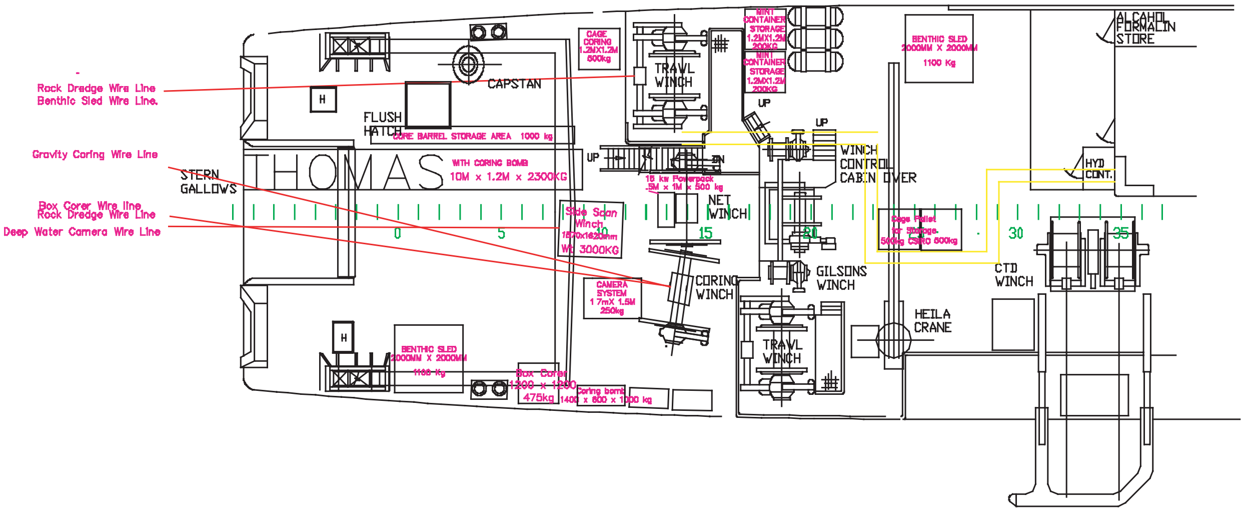
- Gravity Corer including bomb, barrels and liners
- Box corer
- Core deployment system (Thomas)
- Rock dredges and associated consumables (x3)
- Underwater camera system with winch (x2)
- Side Scan Sonar with associated hardware / softwar
- Sampling / storage equipment (bags, buckets, nalley bins, etc.)
- Microscope
- 5 mm large plastic sieve (X2)
- Rock Saw (both large and small)

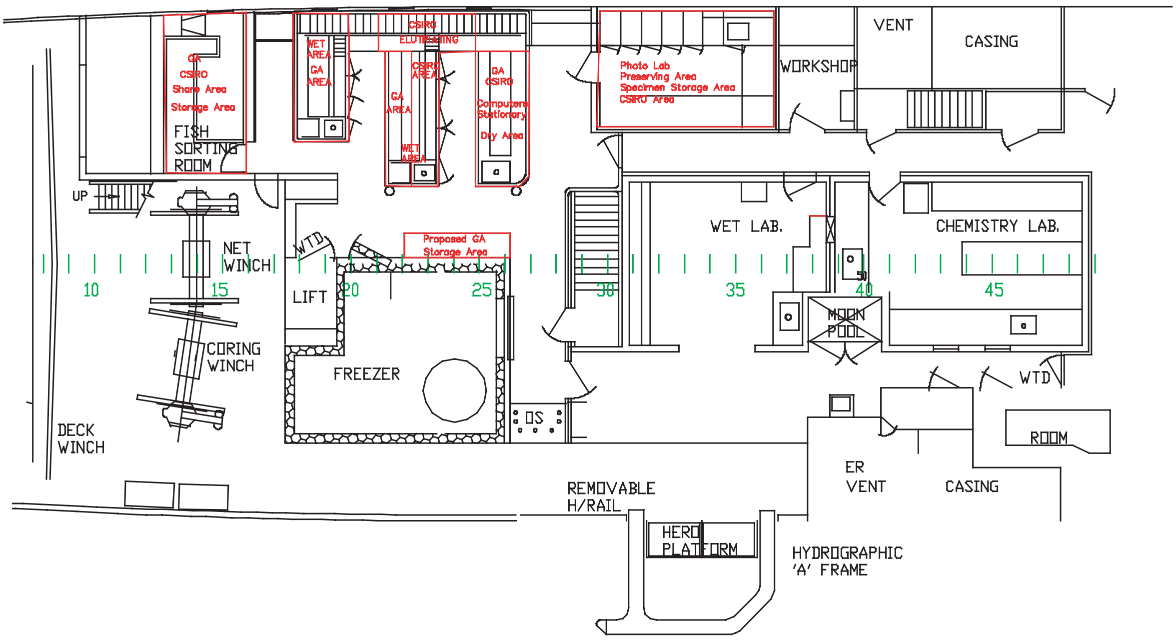
Personnel List

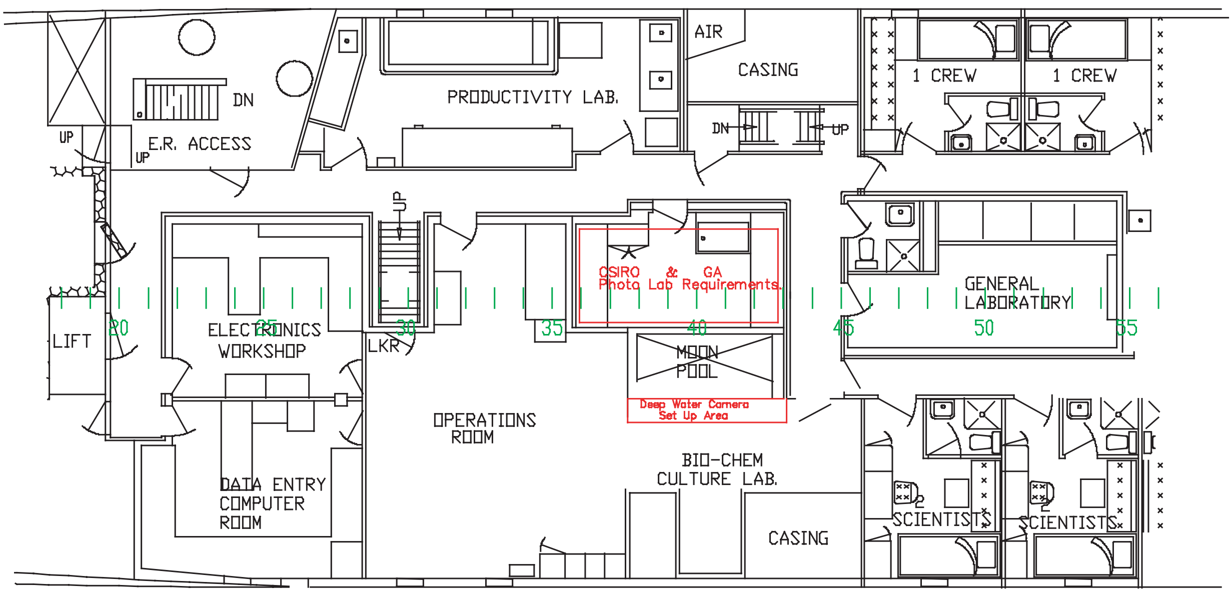
Name	Organisation	Role	Shift
Andrew Heap	GA	Chief Scientist	12:00-00:00
Jane Blevin	GA	Scientist/watch leader	00:00-12:00
Irina Borissova	GA	Scientist/GIS/Database	12:00-00:00
Emma Mathews	GA	Scientist/Database	00:00-12:00
Michele Spinoccia	GA	Swath processor	12:00-00:00
Cameron Mitchell	GA	Swath processor/GIS	00:00-12:00
Colin Tindall	GA	Geol. Technician	00:00-12:00
Franz Villagran	GA	Elect. Technician	12:00-00:00
Craig Wintle*	GA	Geol. Technician	12:00-00:00
Ian Aitkinson	GA	Elect. Technician	00:00-12:00
Petar Vujovic	GA	Geological Technician	06:00-18:00
Karen Gowlett-Holmes	CMAR	Biologist	12:00-00:00
Julian Finn	Museum of Victoria	Biologist	00:00-12:00
Drew Mills*	MNF	Voyage Manager, Electronics	
Hiski Kippo*	MNF	Computing	

* Nominated system support technicians to comply with AMSA requirements for additional berths.

Proposed Ship Layout Plans







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