MARINE NATIONAL FACILITY FUTURE RESEARCH VESSEL

REPORT FROM MARINE GEOLOGY & GEOPHYSICS CONSULTATIVE GROUP

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[Most of these authors headed the five sub-committees which report in the Appendices below; the main report is based on the sub-committee reports. Altogether 45 geoscientists have been involved in this activity, which started with a meeting in Canberra involving 28 scientists on 4 September 2009.]

Equipment Summary

It should be noted at the outset that having a full suite of operable ship's equipment implies that the Future Research Vessel should have a large team providing technical support on shore and at sea. The Marine Geology & Geophysics Consultative Group agrees that absolutely essential major geoscience equipment for the vessel's inventory includes:

- Full-ocean depth (0-7,000 m) multibeam mapping capability*
- Multi-frequency echosounders*
- Sub-bottom profiler*
- Seismic system: compressors built in*
- Gravity meter*
- Magnetometer
- Dredge winch: 8000 m cable, capable of 10 tonne pull at sea bed*
- Coring winch: 8000 m cable, maximum pull 30 tonne*
- Main corer: minimum length 6 m, maximum 30 m*
- Various box corers
- Dredges
- Grabs

* This equipment is to be built in

Necessary laboratory and core storage facilities are outlined below. Some must be built in but some should be containerized.

A variety of other equipment that should be accessible to the vessel, in one way or another, is discussed below, and in the sub-committee reports in the Appendices. It is understood that some essential equipment may not be fundable initially, but such equipment should have priority in the future.

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Appendices: Sub-Committee Reports

1. Summary

1.1. The importance of marine geoscience

Marine geoscience research must be a high priority for Australia because:

- It underpins the definition of Australia's maritime jurisdiction, including the recent definition of the Extended Continental Shelf under UNCLOS and access to the associated resources
- Australia's marine jurisdiction is a vast area where basic, and often global, processes of plate tectonics, climate change and geohazards can be studied among many others
- It supports the largest Australian offshore industry – oil and gas exploration – through the better understanding of offshore sedimentary basins
- It supports the sustainable management of Australia's marine jurisdiction through the prediction of marine biodiversity and establishment of a national representative system of marine protected areas
- It provides much of the basic information on the shape and physical nature of the sea floor – vitally important for many research and applied science activities
- It provides information on past climate change and sea levels on many scales – vital to understanding the parameters that will constrain future such changes
- It helps put our onshore mineral deposits into their regional and genetic context, and provides direct information on offshore mineral deposits in our region

1.2. Geoscience needs of the Future Research Vessel

Given that the Future Research Vessel (FRV) size, type, capabilities and role have been established already, we cannot expect major changes in those areas. However, it is very important that the vessel is large enough and stable enough, and has an adequate range, to work efficiently in the Southern Ocean. This means having the range to work for a considerable length of time off Heard Island or the Antarctic margin. Politically the Antarctic margin is important to Australia, and we need to be able to carry out first rate scientific programs there.

Our emphasis has been on equipment, and especially on equipment we regard as essential for a world class research vessel. We believe that much of the equipment that we need will overlap with the needs of scientists in other fields, and especially the biologists. Major questions concern what equipment should be part of the vessel's resources, and what can be obtained from elsewhere; what needs to be built in, what can be containerised, and what can be brought aboard from time to time; and what capabilities does the vessel need to deploy large equipment from elsewhere provided for one-off expeditions?

We strongly support all the geoscience equipment already listed in the original Statement of Requirements (SOR). Beyond that we argue strongly in favour of major pieces of geoscience-specific equipment that gather data that are valuable to resource assessment and science and are standard for international geoscience research vessels:

- a built-in gravity meter to be used continuously, and
- a towed magnetometer system to be employed as often as practicable.

Another piece of equipment that would be very valuable in the Australian context is a ROV capable of diving to 2500 m, with sampling, measuring and drilling capabilities. Both geologists and biologists would have great interest in such an ROV. If such a system does not become part of the MNF equipment, funding should be sought for another institution to support it, in the national interest.

2. Background

A preliminary meeting was held at Geoscience Australia on 4 September 2009 to discuss the process and also the general requirements for the new vessel as regards geoscience priorities. About 20 people physically attended that meeting and another seven were present by telephone link. A report on that meeting is appended. After that meeting five sub-committees were set up to report on the needs of specific geoscience areas. Those reports are attached and contain the names of all those who worked on the various documents.

We started our considerations on the basis of the initial Science Outfit annex in the original Statement of Requirements for the Future Research Vessel as submitted to Government:

- Full-ocean depth multibeam mapping capability (e.g., 15-250 m, 30 kHz, 12 kHz)
- Multi-frequency echosounders
- Sub-bottom profiler
- Seismic system to be determined
- Dredge winch: 8000 m cable, capable of 10 t pull at sea bed
- Coring winch: 8000 m cable, maximum pull 30 t
- Corer: minimum 6 m, maximum 30 m
- Dredges as presently available
- Grabs

However, we did not confine ourselves to these pieces of equipment (see Section 4).

3. Science arguments in various categories

3.1. Deep crustal studies

Studies of the Earth's lithosphere under Australia's oceans provide insights into the extent of the continental shelf, the distribution of resources, plate tectonic movements and Earth evolution, and the assessment of earthquake and tsunami hazard. Geophysical data are essential for constraining models of the structure and composition of the crust and upper mantle, and much of our knowledge of oceanic areas today comes from gravity and magnetic measurements. Global seismic studies are informative for overall structure at long-wavelength resolution, but they do not have the capability to provide detailed information such as would be required for resource, earthquake and tsunami hazard assessment. As such, extensive complementary high-resolution datasets of marine gravity, magnetic and seismic measurements are essential and fundamental to our understanding of geology, geophysical structure and hazard assessment of the oceans surrounding Australia. They are also valuable for the assessment of the petroleum potential of poorly known sedimentary basins. For these reasons, Australia's new Marine National Facility vessel should be equipped to allow permanent recording of gravity and magnetic data and have the ability to deploy ocean-bottom seismometers and magnetometers.

3.2. Sedimentary basin studies

The rocks of Australia's sedimentary basins, and the resources of oil and gas that they contain, have for the last 40 years been a cornerstone of Australia's economic prosperity. In the future Australia will continue to exploit these resources and seek also to sequester carbon dioxide within the pore space contained in these rocks. Scientifically, at the macro scale they preserve a record of the tectonic development of the Australian continent and its margins, and in their shallow sediments they store a record of the world's climate. Where they are exposed at the seafloor they impact directly with the living environment. Understanding the sedimentary basin rocks of offshore Australia; their composition, structure and physical properties, has important implications for Australia's future prosperity and the management of the environment. Studying the offshore sedimentary basins requires a suite of tools, the foremost being a high-speed seismic reflection system (thus not competing with commercial operators seeking petroleum), but also includes potential field (gravity and magnetic data), multibeam sonar data and the ability to sample the seabed directly. Acquisition of seismic data for sedimentary basin studies is indispensable as it has the unique ability to image the structure of the geology below the seabed. In addition to its capability to image sub-surface sedimentary sequences, seismic data can also provide information about the velocity of sound in the rock, which can be used to infer its physical properties. Beyond areas of active resource development the remainder of Australia's jurisdiction has generally only received very broad seismic reflection coverage. The result of the combination of commercial and high-speed seismic reflection is that the big picture of the sedimentary basins is known, but there is a large amount of blank space between the lines where data resolution and data are now needed. Such seismic data, in the form of site surveys, are a pre-requisite for proposals to bring the coring vessels of the Integrated Ocean Drilling Program, of which Australia is a member, to our region.

3.3. Seabed mapping and characterisation

The most accurate representation of the morphology and depth of Australia's seabed is fundamental for a broad range of geological, oceanographic, and biological research studies. Multibeam sonar systems are now standard equipment for any marine research vessel. The capability to map all of Australia's Marine Jurisdiction in three dimensions using multibeam sonar systems is now a requirement. This is because the data are revealing seabed features in unprecedented detail and have direct application to geoscience, ecological, oceanographic and palaeo-environmental studies, which can be attested to by the literally hundreds of multidisciplinary marine studies and publications that have appeared over the past 10 years. Seabed mapping and the characterisation of seabed habitats has been *the* cornerstone for the prediction and preservation of Australia's (and other country's) marine biodiversity. Over the past 8 years, these data have been directly applied to the establishment of a national system of marine protected areas by the Australian Government, thus fulfilling Australia's obligations under the Conventional of Biological Diversity. Other applications of multibeam data in Australia include: oil spill modelling, rapid battle-space assessment for defence, coastal inundation and tsunami modelling, offshore mineral exploration and assessment, and site surveys for infrastructure development (pipelines, communication cables, etc). Given that Australia has recently proclaimed an additional 2.5 million km^2 of seabed under UNCLOS for resource exploitation and management, most of which is in the deeper parts of the margin, there is now an international obligation for the Australian Government to undertake activities in these areas to demonstrate that it is managing the living and non-living seabed resources sustainably. Additionally, the backscatter (i.e., seabed hardness) data provided by multibeam and side-scan sonar systems are very useful to help determine sediment substrate boundaries, which can then be used as a proxy for benthic fauna distributions.

Furthermore, modern multibeam systems now provide imagery of water column phenomena, such as hydrocarbon seeps and fish aggregations, thereby maximising the utility of these seabed mapping systems to also include pelagic research. Therefore, multibeam swath mapping systems are considered an essential requirement for the future MNF. We stress, however, that application of the multibeam sonar systems on the MNF is in no way intended to replicate the RAN Hydrographic Office in mapping the seabed for safe navigation. Of course, all multibeam data collected by the MNF will be made available to the RAN for such purposes.

Another essential piece of ship's equipment is a full ocean depth sub-bottom profiler to provide information on the nature of the seabed and what lies immediately below it. Data from the sub-bottom profiler is crucial to explore the linkages between seabed features (denoted by the multibeam and sampling gear) and deep sub-surface features (denoted by the seismic reflection and potential field data) providing high-resolution data on the shallow sub-surface sediments. It is of great importance to ensure that the FRV tender document includes performance criteria that address interference between sonars, and interference to the sonars from other sound sources aboard.

Characterising the seabed also requires physical data from samples collected by dredges, corers, grabs and video imagery and still photographs.

3.4. Palaeoceanographic and related studies

Climate change is of especial interest to Australia, and geoscience can provide a longer term perspective in this area. There is a large palaeoceanographic and palaeoclimatological constituency in Australia, and many others are interested in micropaleontology, sedimentology, geochemistry and microbiology. There will continue to be a need for the soft-sediment sampling methods traditionally used, such as piston and gravity coring. This coring capability is essential for palaeoceanography and palaeoclimatology but also for sedimentology for geohazard risk assessment (sampling of slumps) and geotechnical surveys (e.g. cable and pipeline routing), as well as for microbiological studies of subsurface microbial ecosystems in pore waters. In addition there is a need for a suite of surface-sediment sampling capabilities (box core, grab, multicorer) and this mode of sampling is needed for benthic biology studies, microbiology, geochemistry (e.g. pore-water profiles for sediment-water geochemical exchanges) and ground-truthing for acoustic seabed characterization of both surface acoustic properties (e.g. backscatter) and subsurface echo character. The requirement of recovering and deploying a long piston core (30 m is needed) alongside the ship requires unimpeded access with a minimum of columns along one side of the ship at trawl deck level.

Of particular importance are such studies along the Antarctic margin, partly to ensure that we maintain a substantial science presence there, but mainly to help with the management of living resources, and in understanding how climate change has and is affecting the ice margin and its living organisms.

3.5. Studies of older outcrops and submarine volcanoes

Studies of basement, sedimentary and volcanic rocks, and other submarine features, are of national importance in terms of understanding the processes and conditions that led to the formation of the Australian margin and region, and the resources they contain. Such studies provide valuable knowledge that can be applied in predictive studies of margin evolution and resource locations, both in an international and national context. They are of great importance in assessing the petroleum potential of little known frontier areas.

Knowledge of basement rocks around Australia constrain tectonic evolution, including rifting associated with offshore sedimentary basins. Knowledge about the rocks that form the offshore sedimentary basins helps constrain the geological history and resources (particularly petroleum) which they contain. An understanding of the structure, evolutionary history and composition of the seafloor of the Southern Ocean and Southwest Pacific Ocean relates directly to offshore mineral resources. The current tectonic environment in the Southwest Pacific is the likely analogue for the tectonic settings during formation of rock sequences found on land in the Southeast Australia. An understanding of the development and architecture of active arc volcanos, the oceanic crust, oceanic plateaus and submerged continental crust is important to global geoscience understanding. This is also relevant to understanding and predicting geohazards such as explosive volcanic eruptions and tsunami generation in response to volcanic activity, and earthquake-generated marine slides. An understanding of the alteration of igneous rocks of the oceanic crust by seawater and hydrothermal fluids is important in understanding older ore deposits on mainland Australia.

3.6. Offshore mineral resources

A better understanding of Australia's offshore mineral resources is clearly of national importance for future prosperity in the face of declining onshore reserves. For example, our offshore petroleum resources are by far the most valuable offshore resource. The activities above – especially those described under deep crustal studies, sedimentary basin studies, and studies of older outcrops – all bear directly on the assessment of petroleum resources in frontier basins. Manganese nodules and crusts, bear copper, nickel and cobalt, and are huge long-term resources in the Australian region; seabed mapping and sampling (dredging, coring, grab sampling and camera stations) are essential in better assessing these resources. Hydrothermal gold and copper deposits, both at spreading centres and in island-arc porphyry copper deposits, are of considerable significance to Australian mineral exploration companies in the Southwest Pacific region. Offshore phosphate deposits may be present in relatively shallow water (cf. New Zealand's Chatham Rise) and have long-term economic potential. Establishing the distribution and reserves of offshore deposits of construction materials (e.g., sand, gravel and shells) will also be important for the future development of many industries.

3.7. Geological hazards

Geological hazards can cause large losses of life and infrastructure and their study is important. Tsunamis and earthquakes are natural hazards for which an understanding of our offshore realm is needed. Tsunamis are of particular concern. For those that are generated far from Australia, from earthquakes and seafloor displacement in places like Indonesia, South America, the Southwest Pacific volcanic arcs and subduction zones, and New Zealand, we require accurate delineation of the inshore areas to help models of tsunami impact, for better risk assessment and disaster planning. There is also the potential danger of sudden submarine slides on the steeper margins of Australia, which could trigger local tsunamis if they are large enough. Large slides have occurred in the past off eastern Australia and, if triggered by an earthquake, might generate local tsunamis with almost no warning. Seabed mapping and an understanding of earthquake hazards are important to this field of study.

4. Equipment requirements

These requirements are drawn from the included sub-committee reports, but the details of their ranking (essential, highly desirable, access required) have been agreed by the members of this Consultative Group as listed above. We do not go into great detail here but much of that detail is in the sub-committee reports. These items need to be incorporated in the revised Statement of Requirements (SOR) and differ slightly from the original SOR, after consultation with the marine geoscience community.

4.1. Essential equipment

4.1.1. Winches, wires etc.

- A winch capable of dredging with a 10 tonne pull at the sea bed, in a water depth of 5000 m. The wire length to do this efficiently would be 8,000 m rather than the 7,000 m of the SOR. The maximum speed of such a winch is important in that fast operation saves valuable time.
- A coring winch capable of pulling a 5 tonne piston corer out of 30 m of sediment in 5,000 m of water. The pullout force alone could exceed 5 tonnes.
- Other winches capable of handling grabs, towed vehicles, and vibrocorers. An electronic cable would be necessary for some purposes.

- A-frames for above purposes (e.g. long piston corer and relatively short gravity corer) plus deployment of large ROVs

4.1.2 Built-in equipment

- Multibeam sonars: full ocean depth at high resolution
- Multi-frequency echosounders
- Sub-bottom profiler
- Two compressors for seismic system (total capacity 800 scf/m)
- Coring system for 6 m gravity corer, and up to 30 m piston corer
- Gravity meter*
- Range of acquisition and processing instruments for geophysical equipment
- Range of handling, processing and storage facilities for cores and dredges
- General-purpose wet and dry laboratories with adequate geoscience sample processing capability
- Cold store (4°C) for cores
- Some laboratory capability for geochemical and geobiological analyses

* Major item not in SOR but standard in international geoscience vessels

4.1.3. Deployable equipment

- Multipurpose seismic profiling system capable of high-resolution surveys in shallow to moderate water depths, and of moderately deep penetration (<4 km) surveys in moderate to deep water. Winch, airguns, seismic cable to 2400 m.
- Magnetometer and magnetometer winch*
- Dredges
- Subsurface sampling equipment: multicorer, small box corer to sample water-sediment interface, large box corer (Kasten corer) to provide undisturbed sediments, vibrocorer for sand and gravel.
- CTD
- Towed bodies: sidescan sonar, video and still camera

* Major item not in SOR but standard in international geoscience vessels

4.2. Highly desirable equipment

- ROV capable of diving to 2500 m, with sampling equipment – arms and drill

4.3. Equipment to which access is needed

- AUVs
- Deep-tow equipment (e.g., side scan sonar/video system) to 6,000 m water depth
- Large ROVs (specifically excluded in SOR)

4.4. Containerised equipment

- Geobiological laboratory (ultra clean)
- Geochemical laboratory (very clean)
- Other specialised laboratories

Ship capabilities and priorities relative to geoscience

	Gravity Meter / magnet-ometer	OBS/OBM deploy/ recover capability	Seismic Reflection system	Sub-bottom profiler	Full-ocean depth multibeam sonars	Deep-towed body capability	Deep-tow working-class ROV	Long/short coring capability	Surface sampling capability	Deep dredging	Wax coring
Deep Crustal Studies[1]	Essential	Essential	V. useful	Not applicable	V. useful	Useful	Useful	Not applicable	Not applicable	V. useful	Useful
Sedimentary Basins[2]	V. useful	V. useful	Essential	V. useful	Essential	Useful	Useful	V. useful	V. useful	Essential	Useful
Seabed Mapping[3]	Useful	Not applicable	Useful	V. useful	Essential	V. useful	V. useful	Essential	Essential	V. useful	Not applicable
Palaeo-studies[4]	Not applicable	Not applicable	Useful	Essential	Essential	V. useful	V. useful	Essential	Essential	Not applicable	Not applicable
Outcrops[5]	Essential	Not applicable	Essential	Essential	Essential	V. useful	Essential	Not applicable	Useful	Essential	Essential
Hazards[6]	Not applicable	Not applicable	Not applicable	V. useful	Essential	Useful	V. useful	Essential	Essential	Not applicable	Not applicable
Minerals[7]	V. useful	Not applicable	V. useful	Useful	V. useful	Useful	V. useful	Essential	Essential	V. useful	V. useful

Major applications:

1. Geodesy, geology, high-resolution national dataset applications/studies
2. Margin evolution, petroleum prospectivity, geotechnical studies
3. Geomorphology, sedimentary and ecosystem processes, habitat and biodiversity prediction studies
4. Sequence stratigraphy, palaeo- climatology and oceanography, environmental reconstructions, nutrient/microbial processes, site survey applications/studies
5. Margin evolution and geochemical, tectonic history studies
6. Margin evolution, coastal vulnerability, environmental reconstructions studies
7. Resource assessment studies: petroleum and other minerals

Definitions:

- Essential = necessary data to deliver program and/or answer science question
- V. useful = data provide significant contribution to deliver program and/or answer science question
- Useful = data are complementary to program and/or science question
- Not applicable = not necessary

5. Repositories for geophysical and geological data

- A long-term and sustainable central national repository for all geophysical data is needed to ensure appropriate archival and access to data collected on national facility surveys. Geoscience Australia fills this role at present. The ship's scientific crew should be responsible for submitting data to the repository.
- A long-term and sustainable central national repository for all geological samples, and especially cores, is also required to ensure appropriate archival and access to samples collected on national facility surveys. Geoscience Australia stores considerable quantities of such material at present, but its cool storage area for cores is almost full.

6. Ship time costs, post-cruise science

- Ship time should be allocated on the basis of peer review, taking account of scientific merit, national needs, and experience of proponents
- Ship time and onboard costs, such as victualling charges, should be minimal or nil to encourage research proposals from science teams without access to large pools of funds. We support the model used for the Australian Synchrotron, whereby the facility covers all costs including travel to the facility. For the MNF, freight and loading costs also could be covered for science teams with limited funding. The test for providing these ancillary funds would be whether a project is approved, but the amount of funding would be determined on a case-by-case basis. In any case, MNF should provide advice to chief scientists on what costs it will cover, so that they can plan accordingly.
- Post-cruise analysis costs should not necessarily need MNF funding, if some other form of national funding is provided to allow scientists to take full advantage of these data, acquired at great cost. A model for this arrangement is the Australian involvement in IODP, where some post-cruise costs for researchers are covered. This should be a simple procedure, with reasonable funding being made available in a coordinated manner, even if not directly from MNF.

7. Balance between pure science and institutional science

This is an area of considerable concern to some of the geoscience community, who worry that government research agencies may be allocated extended periods of time on the national facility vessel for 'national interest' programs. Clearly this is a matter that would need careful governance and clear rules. For the *Southern Surveyor* science committee the rules included 'national interest' and, for example, expeditions with routine repetitive oceanographic measurements on standard north-south profiles were approved. It was recognised that such studies are important to the world science community. A variety of governance and funding models are employed for research fleets around the world that address the balance between pure science and national interest science surveys and these could be adopted either in total or in part for the new Marine National Facility Vessel. These have recently been examined and discussed in detail at Geoscience Australia and to move this debate forward these views will be tabled at future meetings where such matters will be discussed.

We suggest that these views be carefully considered by the groups that allocate ship time. Once average demand is understood for high-quality 'national interest' and 'pure science' expeditions, a general balance could be established.

8. Governance

It is essential that the governance mechanisms ensure that the MNF's procedures and operations are open and are seen to be fair. Matters to consider include:

- Representation on science and management committees
- Establishment of national data and sample repositories
- The balance between 'pure' science and 'national interest' science in programming (i.e., balance between national facility science, systematic long-term national interest science, and special purpose national interest science surveys)**
- How to deal with multi-year programs, such as site surveys for IODP drilling*
- How to cover costs for university researchers such as travel, freight and initial post-cruise science, because of the timing miss-match between MNF ship time and ARC grants.

** see 7 above.
* It is possible that by making an arrangement with IODP to provide MNF ship time for site surveys, we could not only get more IODP research drilling in our region, but also use that ship time as an in-kind contribution to our IODP membership thus increasing our rights within IODP.

Appendix A

Marine National Facility Vessel

Sub-Committee Report: Deep-Crustal Studies

Michael Morse (chair), Ron Hackney, Alexey Goncharov (Geoscience Australia); Dietmar Mueller (University of Sydney); Nick Rawlinson, Sara Pozgay (Australian National University); Graham Heinson University of Adelaide); Will Featherstone, Jon Kirby (Curtin University of Technology)

1) Scientific Arguments

Studies of the Earth's lithosphere under Australia's oceans provide insight into the extent of the continental shelf, the distribution of resources, plate tectonics and Earth evolution and the assessment of earthquake and tsunami hazard. Geophysical data are essential for constraining models of the structure and composition of the crust and upper mantle and much of our knowledge of oceanic areas today comes from gravity and magnetic measurements. Global seismic studies are informative for overall structure at long-wavelength resolution, but they do not have the capability to provide detailed information such as would be required for resource, earthquake and tsunami hazard assessment. As such, extensive complementary high-resolution datasets of marine gravity, magnetic and seismic measurements are essential and fundamental to our understanding of geology, geophysical structure and hazard assessment of the oceans surrounding Australia. For these reasons, Australia's new Marine National Facility vessel should be equipped to allow permanent recording of gravity and magnetic data and have the ability to deploy ocean-bottom seismometers and magnetometers.

Gravity data are an essential part of defining the geoid and provide information on crustal density distribution. The density contrast between sediments and continental-shelf basement allows the use of gravity data to constrain the thickness of the potentially petroleum-bearing sediments. Similarly, the density contrast between the crust and mantle constrains models of crustal structure, crustal evolution and heat flow. Whilst the gravity signature of the world's ocean areas is obtainable from satellite-altimetry measurements of sea-surface height, these data are not of sufficient resolution for many applications (e.g. assessment of resources and earthquake/tsunami hazard). In addition, the accuracy of satellite-derived data is severely limited within 50–100 km of the coastline. As such, ship-based measurements of the gravity field are a fundamental dataset that should be obtained at every opportunity.

Magnetic data provide information on the degree of magnetisation of rocks, which can be used to constrain the depth to magnetic basement below sedimentary basins (i.e. sediment thickness) and the volcanic content of those basins (which affects resource potential). Magnetic data also indicate the orientation of the Earth's magnetic field at the time when rocks were formed. Field reversals during the formation of tectonic plates give rise to the seafloor magnetic lineations that provide fundamental constraints on plate movement. Understanding plate motions is critical to assessments of resource accumulation, earthquake hazard and past sea level and climate. Only ship-based magnetic measurements have a resolution that is sufficient to map seafloor magnetic lineations.

A new ship with permanently installed and operated gravity and magnetic instruments will continually alleviate the current limitations imposed by present-day irregular and sparse data coverage, including difficulties associated with correcting for mis-ties at ship-track cross-overs. In addition, gravity and magnetic data used in conjunction with seismic images derived from ocean-bottom seismometers provide a powerful tool for comprehensive understanding of any region.

Many such cross-disciplinary studies have been carried out on land and any future geophysical ocean vessel should be fully equipped for such collaborative studies.

2) Essential Equipment

To meet the scientific tasks outlined above, the new MNF vessel should be equipped with an in-built gravity meter and a pair of magnetometers towed behind the ship. These instruments would be a permanent part of the ship's instrumentation, thereby allowing the acquisition of data for the entire duration of every cruise. This would allow the expansion and enhancement of a fundamental marine geoscience dataset on a continuous basis within Australia's marine jurisdiction. The ship should also have the ability to deploy ocean-bottom instruments (seismometers, hydrophones and magnetometers) during smaller-scale surveys of specific areas.

Marine gravity meter
Modern marine gravity meters are compact and self-contained, thereby requiring little maintenance whilst at sea. The gravity meter needs to be installed as close as possible to the ship's centre of gravity and linked to GPS navigation systems for accurate positioning and timing. Manufacturers of suitable instruments include: Elektropribor (CHEKAN-AM), Scintrex (Micro-g LaCoste Air Sea II), ZLS Corporation (Dynamic Gravity Meter) and Bodenseewerke (KSS31).

Land gravity meter
The ship should also have a dedicated land gravity meter for measuring ties to land reference stations.

Pair of magnetometers
Appropriate magnetic data would be derived from a system comprising dual scalar magnetometers measuring total magnetic intensity. The sensors would be towed in parallel on either side of the ship, at least four ship lengths behind the ship (to avoid disturbances induced by the metallic ship and its electronics). Modern magnetic acquisition systems with dual magnetometers towed in parallel allow across-line gradients to be measured. This leads to improved gridding of anomaly data and improved ability to detect offline anomalies. This is particularly beneficial for marine surveys where ship-tracks are typically widely spaced.

Ability to deploy ocean-bottom geophysical equipment
Whilst ocean-bottom seismometers (OBS), hydrophones and magnetometers would not be a permanent part of the MNF vessel's instrumentation, the ability to store such equipment onboard and to deploy it is essential. Deployment would be possible using the A-frame that is already planned for the vessel. Onboard storage requirements for 30 OBSs and associated equipment would include at least 25m^2 below the crane, 50m^2 on deck and space for a container on the deck (not on top of another container). A forklift would be required to shift the OBSs and if no forklift were available on the ship, then the OBSs would need to be removed from the container in port and stored on the deck. Lab requirements include 10m^2 of dry lab workspace, access to 220V/50Hz power supply and a means to run a GPS cable outside. During deployment, the OBS/OBMs would be tracked in the water using the transducer system planned for the ship.

3) Highly desirable equipment/capability

In the future, specialised geophysical surveys are likely to be conducted using Unmanned Aerial Vehicles and Autonomous Underwater Vehicles. Therefore, the capability to launch and recover these types of platforms is highly desirable.

4) Equipment required but not on the vessel

Deep-crustal studies require constraints on seismic velocities and crustal thickness. This is achieved using seismic refraction and passive seismic surveys in which seismic wave travel-times are recorded by ocean-bottom seismometers and hydrophones. Magnetic measurements made during targeted surveys over limited areas require reference magnetometers to allow diurnal magnetic variations to be corrected for. In remote areas, these reference instruments would need to be deployed on the sea floor. These instruments would be sourced externally to the MNF from international organisations that rent such equipment or from the academic community (e.g. the University of Adelaide operates a number of OBMs and the Australian National University is actively seeking to acquire a pool of about 20 broadband OBSs).

5) What must be built, what can be containerised

The gravity meter requires a permanent housing as close as possible to the ship's centre of gravity. Magnetometers would need to be stored on board ready for deployment as soon as the vessel is under way.

6) Equipment responsibilities

As it is envisaged that the gravity meter and magnetometers will operate whenever the ship is at sea, they would be operated by ship technicians. The technicians would be trained in minor maintenance and in making gravity measurements to tie to land-based reference stations. Periodic major maintenance and repair would need to be carried out by instrument manufacturers and funded from MNF operating funds.

7) Repository responsibilities

Measured gravity and magnetic data from the permanently-installed instrumentation would be provided to Geoscience Australia who would process and archive the data and make it available to users. If the ship were so equipped, measured gravity and magnetic data could be transferred to Geoscience Australia in real-time.

Appendix B

Marine National Facility Future Research Vessel

Sub-Committee Report: Sedimentary Basin Studies

Sub-Committee: Mark Alcock (GA); Chairman; Bruce Goleby, Dave Holdway, Irina Borissova and Chris Nicholson (GA); Neville Exon (ANU)

1. Summary

The rocks of Australia's sedimentary basins and the oil and gas that they contain have been one of the cornerstones of Australia's economic prosperity for the last 40 years. In the future the nation will continue to exploit these resources and seek also to sequester carbon dioxide within the pore space contained in these rocks. At the near surface they host gravels and mineral sands that are also considered to be economically important. At the macro scale, they preserve a record of the tectonic development of the Australian continent and its margins and in their shallow sediments they store a record of the World's recent climate. Where they are exposed at the seafloor they impact directly with the living environment. Understanding the sedimentary rocks of Australia, their composition, structure and physical properties, has important implications for Australia's future prosperity and the management of the environment.

Studying the sedimentary basins of Australia requires a suite of tools, the foremost being seismic, but also including potential fields (gravity and magnetic data), multibeam data and the ability to sample the seabed directly.

The acquisition of seismic data for sedimentary basin studies is indispensible, as it has the unique ability to image the structure of the geology below the seabed. It is for this reason that it is the primary technique used by the oil and gas industry for resource exploration. In addition to its capability to image the geology of the sedimentary sequence, seismic data can also deliver information about the velocity of the rock, indicating the properties of the rock.

Although the seismic system proposed here may be used to solve questions relevant to petroleum exploration, the seismic system is not intended to, nor has it the capacity to, act as a substitute for a commercial seismic exploration system. The seismic system proposed is the most capable seismic system that can be deployed on a general purpose research vessel with the size and crew levels proposed. The system is expected to operate in one of four modes of operation using common equipment.

a. High speed seismic reflection acquisition, where a short (450m-600m) streamer and two GI guns are deployed as an adjunct to multibeam operations.

b. High resolution seismic reflection acquisition particularly suited to site survey work, where a streamer of up to 2400m but more normally less than 1200m is deployed at shallow depth (2-3m). In this mode either GI or water guns may be deployed, depending on the vertical resolution sought.

c. The last mode of operation most closely approaches conventional seismic reflection acquisition, a streamer of initially 1200m, but with the capacity to be extended up to the reel by the hire or purchase of additional sections will be operated with a source of moderate power.

d. As an air gun source for wide angle surveys or seismic refraction/OBS – land station work.

Potential field data is also considered essential for sedimentary basin investigation as it gives important information regarding the bulk composition of the sedimentary sequences and information about the geology at depth greater than that possible for seismic data. For instance potential field data may be used to distinguish between volcanic and sedimentary sequences which may appear similar on seismic data. With the vessel configuration proposed and likely program, potential field data is considered as essential as it can be acquired continuously at very low cost during multibeam bathymetry campaigns. The character of multibeam surveys, where the vessel mows the grass, is particularly suited to the acquisition and interpretation of potential field data. The specifics of the provision of potential field and multibeam systems are covered in other sub-committee reports.

2. Science arguments

From the outset it needs to be stated that this proposal does not seek to replicate the capacity of a commercial seismic exploration vessel.

The rocks of Australia's sedimentary basins and the oil and gas that they contain have been one of the cornerstones of Australia's economic prosperity for the last 40 years. In the future the nation will continue to exploit these resources and seek also to sequester carbon dioxide within the pore space contained in these rocks. At the near surface, they host gravels and mineral sands that are also considered to be economically important. At the macro scale, they preserve a record of the tectonic development of the Australian continent and its margins and in their shallow sediments they store a record of the World's recent climate. Where they are exposed at the seafloor they impact directly with the living environment. Understanding the sedimentary rocks of Australia, their composition, structure and physical properties, has important implications for Australia's future prosperity and the management of the environment.

Although there has been significant seismic exploration in the Australian jurisdiction over the last 40 years, this has focused on the areas of known high prospectively in the Bass Strait and North West Shelf of Australia area. The spatial extents of these heavily explored areas only constitute a small portion of the Australian jurisdiction (figure 1). Beyond the areas under active development the remainder of the jurisdiction has generally received a very broad reconnaissance level coverage of deep seismic. The result of the combination of commercial and deep seismic data is that the big picture of the sedimentary basins is known (the bones) but there is a large amount of blank space between the lines where the penetration of deep seismic systems is less critical than improving the vertical resolution and aerial density of seismic data coverage.

It is therefore envisaged that the seismic system will be used to address the following problems:

- Infill the existing deep seismic framework with high speed seismic data collected as part of the multibeam program
- High resolution site surveys for proposed International Ocean Drilling Program or stratigraphic drilling sites, with a penetration of up to 4 km.
- High resolution seismic studies of Cenozoic to Quaternary sequences of the continental shelf
- High resolution seismic acquisition over possible mass movement locations
- High resolution seismic acquisition in support of palaeoclimate studies
- An energy source for alternative reflection surveys or OBS surveys

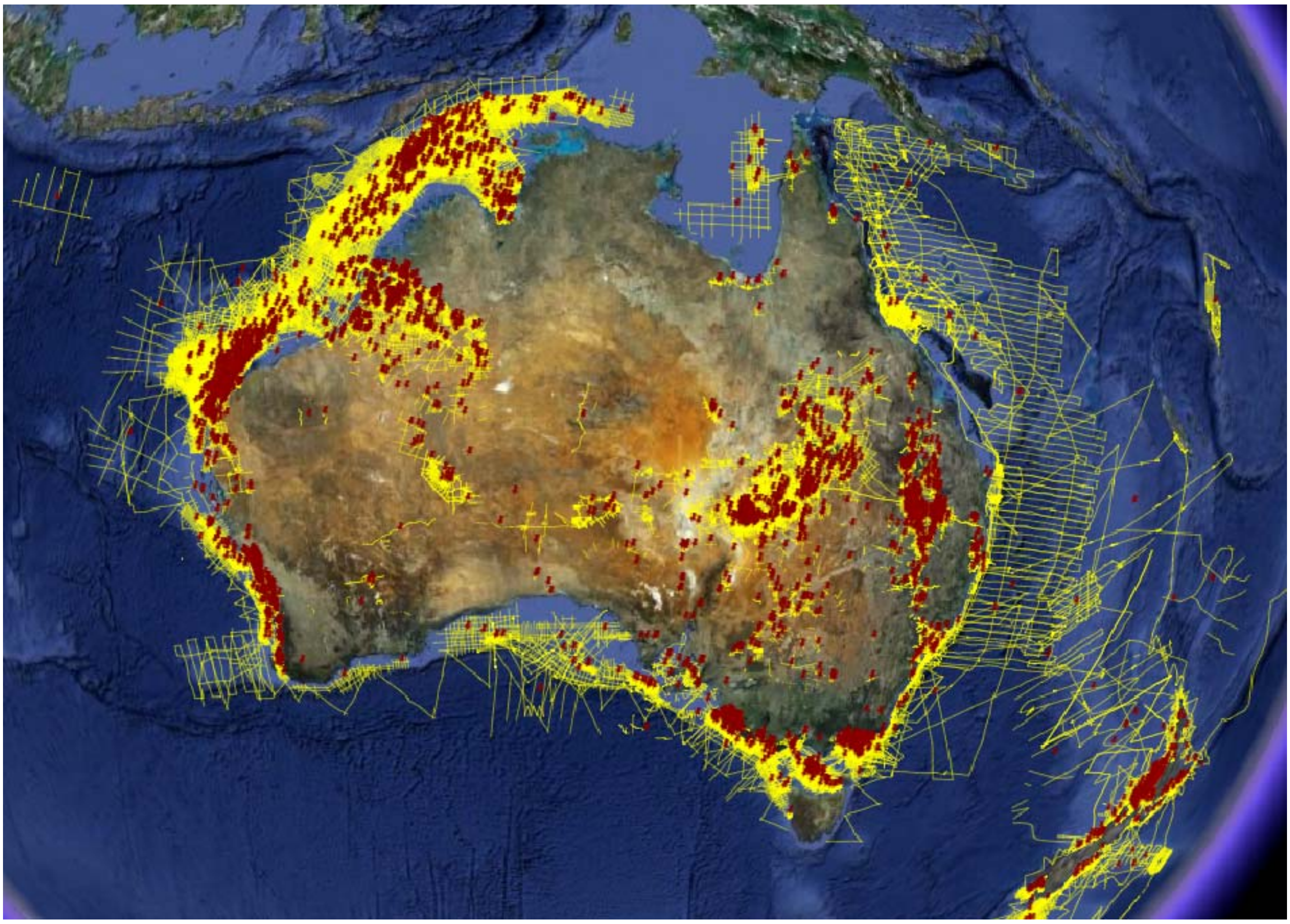

Figure 1. Currently available seismic data in the Australian Region. The figure includes data lodged with the Australian Government under the Offshore Petroleum and Greenhouse Gas Sequestration Act 2006 and data collected for research purposes. Data collected in the New Zealand Jurisdiction are not held by Australia.

3. Essential equipment, including shipboard laboratory equipment

The list of seismic equipment below is for a minimum configuration, for some components such as winches, upgrading capacity may have a minimal cost implication and should be considered to add flexibility to the system.

- Seismic Compressors (2x400 scfm, electric, 2000 psi built into vessel)
- Total 8 GI guns (6 in use 2 spare)
- 2x Seismic gun arrays, each capable of deploying 3 GI guns
- 2x Seismic gun arrays, each capable of deploying a single GI gun at 10kts (guns shared with above array)
- Seismic gun controller for GI gun array
- Seismic winch with capacity for 2400m of streamer
- Seismic Streamer and acquisition system (Digital, solid streamer, minimum active length 1200m plus 50% spares, minimum group length 3.125m, sample rate between .25ms and 4ms))
- Cable leveller system and controller (6 levellers and 2 spares)

- Seismic navigation system
- Seismic processing system (workstation and relevant software)
- Suitable area within the instrument room to conduct post-processing of data

- Capability to deploy and retrieve ocean bottom seismometer
- Gravimeter
- magnetometer

4. Highly desirable equipment

- 1x water gun and suitable deployment system
- Single channel seismic eel and high frequency acquisition system
- Increase capacity of winch drum to 4800m
- Increase seismic streamer length to 2400m with associated increase in cable leveller and spare compliment
- Sampling equipment (dredges and ROV)

5. Equipment to which access is needed

- Deck space for installation of more capable seismic systems such as the IFREMER multi trace seismic system
- Ocean bottom seismometers
- Sonobuoy deployment and recording system (air launcher and radio receiver)

6. What has to be built in?

- The seismic compressors and their associated fixed high pressure air lines and manifolds, acquisition system, navigation system, cable levelling controllers, relevant cabling from the instrument laboratory to the working deck should be built into the FRV.
- The guns, equipment to deploy them and their umbilicals, cable levellers, seismic winch, streamer and spares need to be purchased as part of the vessel's compliment of equipment but can be stored off of the vessel between seismic campaigns

7. Repository for geophysical data

- Geoscience Australia, which already has responsibility under the Offshore Petroleum and Greenhouse gas Sequestration Act 2006 for exploration seismic data, is recommended to be the primary data repository for all geophysical digital data.
- Lodgement of field geophysical data will be undertaken by the science crew as part of the vessel service arrangements. For surveys where survey support is not supplied by the national facility, the senior investigator will be responsible for ensuring that lodgement of all field data and reporting occurs. Field geophysical data will be lodged at the data repository before forwarding to the relevant researchers. Potential field data should be made available for immediate release or streamed in real time while seismic data should remain confidential for a defined period before being released as open file.

8. Ship time costs, post-cruise science

- Ship time should be allocated on the basis of peer review.
- Onboard costs, such as victualling charges, should be minimal or nil to encourage research proposals from science teams without access to large pools of funds.
- Post-cruise analysis costs should not need MNF funding.

Annex A: Considerations for purchase of individual components for the seismic system

1. Compressors: Experience has indicated that seismic compressors represent the largest risk to seismic operations for this reason the seismic compressors should be purchased with reliability as a primary consideration. The cost of lost ship time due to equipment failure will quickly negate any savings in the original purchase price. It is recommended for reliability and safety that the seismic compressors and their fixed high pressure infrastructure (manifolds and high pressure air lines) should be installed as part of the vessel's equipment and maintained by the ship's engineers.

The proposal suggests the installation of two compressors as the installation of a single compressor would give rise to an unacceptable risk to the survey program if it were to fail during a survey campaign. With the configuration of the vessel as a diesel electric propulsion system it would be expected that the compressors would be electrically driven.

2. Seismic Streamer:

It is recommended that a digital solid streamer of proven design commonly deployed on commercial seismic vessels be purchased. This will increase the likelihood of adequate support, repair capacity and availability of spare sections for purchase or hire if additional streamer length is desired. The section length, whether 100m or 150m, is immaterial. Group length should be 3.125m with the capacity to sum adjacent channels and therefore achieve longer group lengths. Flexibility of sample rate is critical. When operating in high resolution mode the source with a sample rate of between .25ms and 4ms. The number of active channels supported at various sample rates and strength of the streamer will dictate the maximum deployable length of the streamer.

The streamer will require the purchase of an armoured tow leader and stretch/elastic sections. The collection of high speed seismic data requires the use of an extended tow leader as the additional speed through the water poses difficulties in getting the streamer down to the target depth. A depressor system to force the front of the cable system down will also be required

3. Seismic navigation system: The correct navigation system is critical for the collection of good quality seismic data. It is normal practice to collect seismic data using specialised navigation systems that control the source and recorder timing. Seismic data is normally collected on a pre-plotted shot-point basis - that is distance along the line at pre-determined locations. This ensures that the correct geometries are maintained between the source and receiver locations along the line. The use of time based systems is considered inadequate as they allow smearing of the data due to poor alignment of data from adjacent shots. The navigation system should be such that it can output each actual shot time to a log file to the nearest millisecond.

4. Cable levellers and controller: For any streamer more than a few hundred meters in length cable levellers must be used to control its depth in the water column. Normally cable levellers will be fitted at every few hundred meters. The suggested purchase number of 6 levellers plus 2 spares assumes a leveller every 100m for high resolution seismic acquisition where fine control of the streamer depth is particularly important. Normal seismic acquisition would assume that levellers would be fitted every 200m. For high speed seismic acquisition it may be possible to control the streamer with a drogue. Consideration should be given to also purchasing streamer retrieval floats. For the short streamer deployment lengths compass equipped levellers are desirable (50% of purchased levellers) but not mandatory.

Appendix C

Marine National Facility Future Research Vessel

Sub-Committee Report: Seabed Mapping and Characterisation

Andrew Heap, chairman, Cameron Buchanan, Phil O'Brien and David Holdway (GA); Rob Beaman (JCU); Neville Exon (ANU); Peter Hill (consultant); Iain Parnum, Kim Klaka and Andrew Woods (Curtin); Cedric Griffiths (CSIRO); Ron Boyd (Newcastle)

1. Summary

Seabed mapping and characterisation is a key element of any study of the seafloor and what lies immediately below it, geologically or biologically. Knowledge of the seabed shape and character also affects our understanding of the nature of currents and waves above the seabed. Seabed mapping and characterisation is therefore important in providing the fundamental spatial data required for many diverse marine research programs, including biodiversity studies.

The value of these advanced seabed mapping tools was recognised in the Science Outfit annex in the Statement of Requirements (SOR) for the Future Research Vessel (FRV) of October 2007, which indicated that there should be three swath mapping systems fitted to the vessel: (1) 300 kHz 2-150 m depth range, (2) 100 kHz (3-1000 m), and (3) 12 kHz (20-11,000 m). The mid and deep water system could be a combined dual-frequency system (e.g., 12/24 kHz). The range of depths and frequencies covered by these swath mapping systems would mean that the FRV has the ability to survey the full range of ocean depths within Australia's marine jurisdiction in the highest resolution, and thus fulfill not only the Minister's requirements but also those of the scientific community.

Various combinations of equipment can be devised to meet the general needs spelled out in the SOR. As both shape and character are needed for seabed characterisation studies, the additional backscatter (seabed hardness) data generated by these swath mapping systems are also extremely valuable. In addition, a towed side-scan sonar would be needed for many seabed research studies. Another essential piece of ship's equipment is a full ocean depth sub-bottom profiler. The FRV tender document should include performance criteria that address interference between sonars, and interference to the sonars from other sound sources aboard.

2. Science arguments

Multibeam sonar systems are now standard equipment for any marine research vessel. The capability to map Australia's Marine Jurisdiction to the full extent in three-dimensions using multibeam sonar systems is now a requirement. This is because the data are revealing seabed features in unprecedented detail and have direct application to geoscience, ecological, oceanographic and palaeo-environmental studies, which can be attested to by the literally hundreds of multidisciplinary marine studies and publications that have appeared over the past 10 years.

Seabed mapping and the characterisation of seabed habitats using multibeam sonar systems has been providing *the* cornerstone data basis for the prediction and preservation of Australia's marine biodiversity. Over the past 8 years, these data have been directly applied to the establishment of a national system of marine protected areas by the Australian Government, thus fulfilling Australia's obligations under the Conventional on Biological Diversity. Notwithstanding this, other applications of multibeam data in Australia include: oil spill modelling, rapid battle-space assessment for defence, coastal inundation and tsunami modelling, offshore mineral exploration and assessment, and site surveys for infrastructure development (e.g., pipelines, communication cables, etc.)

Given that Australia has recently proclaimed an additional 2.5 million km^2 of seabed under UNCLOS for resource exploitation and management, all of which is in the remote, deeper parts of the margin, there is now an international obligation for the Australian Government to undertake activities in these areas to demonstrate that it is managing the living and non-living seabed resources sustainably.

Backscatter data provided by multibeam sonar systems are very useful for determining seabed substrate boundaries, which have in turn been used as a proxy for broad-scale benthic fauna distributions. Further, modern multibeam systems now provide imagery of water column phenomena, such as hydrocarbon seepage and fish aggregations, thereby maximising the utility of these seabed mapping systems to also include pelagic research. Therefore, multibeam sonar systems are considered an essential requirement for the FRV.

Another essential piece of the FRV equipment is a full ocean depth sub-bottom profiler to provide information on the nature of the seabed and what lies immediately below it. Data from the sub-bottom profiler is needed to explore the linkages between seabed features (denoted by the multibeam and sampling gear) and deep sub-surface features (denoted by the seismic reflection and potential field data) by providing high-resolution data of the shallow sub-surface sediments.

Given the current coverage of multibeam data for Australia's margin (Appendix A), it is clear that there is a need for further data acquisition on the geomorphic shelf, but the FRV is not the vessel for such work. Its capabilities are best utilised in moderate to deep water (i.e., >200 m water depth), where much more coverage can be acquired in areas which are relatively poorly known. However, the FRV should be equipped with a shallow-water multibeam system for targeted research in specific areas on the geomorphic shelf, when necessary. Such a capability would also mean that the highest resolution data can be collected for all water depths in the Australian Marine Jurisdiction covering the coast to the deep ocean floor.

We stress that application of the multibeam sonar systems on the FRV is in no way intended to replicate the RAN Hydrographic Office in routine mapping the seabed for safe navigation. The Australian Hydrographic Service is responsible for methodical mapping and this is incredibly time-consuming in shallow water. Detailed mapping of specific scientific targets can be done from smaller vessels using a variety of equipment. In line with current arrangements, all multibeam data collected by the FRV will be made available to the RAN for such purposes.

Over the life of the new vessel an important scientific role will be to map the **change** of seabed properties. If this is to be achieved then the ability to accurately and precisely re-occupy sampling sites is essential. Consideration for an ability to re-sample locations at periods from months, years to decades should be a basic requirement. To this end we suggest an ability to re-occupy a seabed site to an accuracy within 1% of water depth and a precision of 0.5% of water depth.

It is of great importance to ensure that the FRV tender document includes performance criteria that address interference between sonars, and interference to the sonars from other sound sources aboard.

3. Essential equipment, including shipboard laboratory equipment
The highest possible resolution is needed for the various depth ranges.

- Deep-water multibeam system (12 kHz; 20-11,000 m)
- Mid-water multibeam system (100 kHz; 3-1000 m)
- Shallow-water multibeam system (300 kHz; 2-150 m)

- The deep- and mid-water systems could be a combined dual frequency sonar (e.g., 12/24 kHz)
- Narrow-beam, full ocean depth sub-bottom profiler
- All necessary marine acoustic acquisition and post-processing software
- Suitable space to conduct post-processing of data
- Deploy XBT or similar devices to determine water column sound velocities
- Capability to deploy a range of side-scan sonars, including very large, deep-tow systems
- Accurate seabed positioning equipment (requiring hull-space for SBL positioning) to enable repeat re-occupation of a seabed sampling site to and accuracy of 1% of water depth (i.e. 20 m at 2000 m water depth) and a precision of 0.5% of water depth.

4. Highly desirable equipment
- Side-scan sonar capable of being deep towed to 1500 m depth (e.g. 100 kHz)
- Cameras and videos for ground-truthing swath and side-scan sonar maps

5. Equipment to which access is needed
- A variety of large deep towed sonars (e.g., Southampton University's TOBI system) and their ancillary equipment
- ROVs and AUVs for ground-truthing swath and side-scan sonar maps

6. What has to be built in?
- The multibeam systems and their acquisition and post-processing software equipment should be built into the FRV
- Sidescan sonar systems, ROVs and AUVs would be brought on and off the vessel, together with their control equipment

7. Repository for geophysical data
- If possible, Geoscience Australia should be the primary data repository for all geophysical data (and physical samples). It is the intention that the data and samples will be accessible and made freely available for research purposes.

8. Ship time costs, post-cruise science
- Ship time should be allocated on the basis of peer review.
- Ship time and onboard costs, such as victualling charges, should be minimal or nil to encourage research proposals from science teams without access to large pools of funds.
- Post-cruise analysis costs should not need MNF funding, but some other form of national funding is needed to allow scientists to take full advantage of these data, acquired at great cost.

Annex A: Analysis of swath-mapping needs for Australia's Marine Jurisdiction

Table 1. Break down of Australia's Marine Jurisdiction and the current multibeam coverage

	Area (mill km²)	**% of total AMJ**	**Multi-beam area (mill km²)**	**Multi-beam % AMJ**
Max. AMJ	14.47			
Water depth range:				
0-200 m	2.28	15.77	0.09	0.62
200-3000 m	4.56	31.54	0.82	5.67
>3000 m	7.62	52.70	1.23	8.48
Total multibeam			**2.15**	**14.77**
Water depth range:				
0-200	2.28	15.77		
200-500	0.52	3.60		
500-1000	0.63	4.36		
1000-2000	1.52	10.51		
2000-3000	1.89	13.07		
3000-4000	2.58	17.84		
4000-5000	3.42	23.65		
5000-6000	1.61	11.13		
>6000	0.02	0.14		
>200	12.18	84.23		

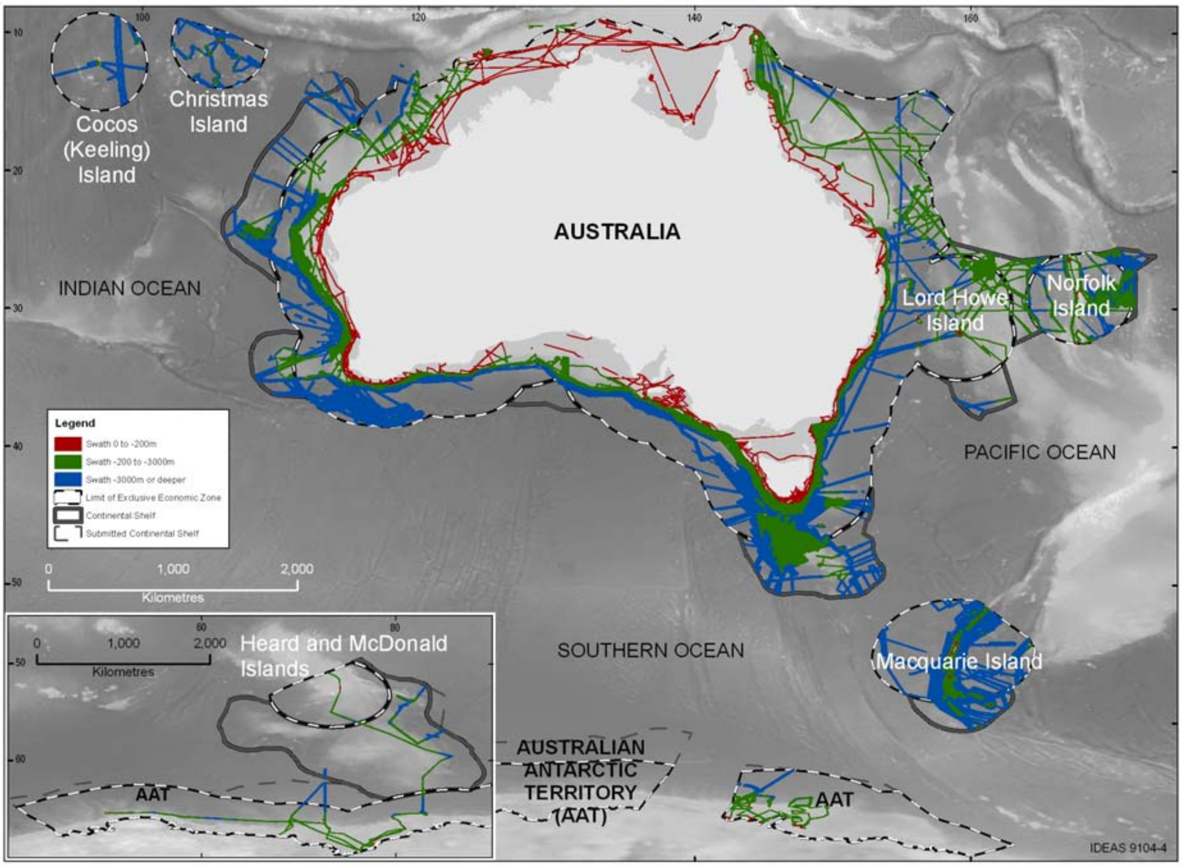

Figure1. Currently available multibeam sonar coverage for Australia's marine jurisdiction. Red: <200 m water depth; Green: 200-3000 m water depth; Blue: >3000 m water depth.

Summary of analysis of available multibeam data for Australia's margin:

1. 52.7% of the AMJ lies in water depths greater than 3000 m.
2. The largest 1000 m water depth range is 4000-5000 m makes up 23.7% of the AMJ.
3. 84.2 % of the AMJ lies beyond the geomorphic shelf (>200 m).
4. 61.9% of the AMJ beyond the geomorphic shelf (>200 m) lies in water depths greater than 3000 m.
5. 14.8% of the AMJ is covered by multibeam bathymetry – 0.6% in less than 200 m water depth; 5.7% in 200-3000 m water depth; and 8.5% in greater than 3000 m water depth.
6. 2.3% of the AMJ is covered by multibeam bathymetry acquired by the *RV Southern Surveyor* – 0.5% in less than 200 m water depth; 1.4% in 200-3000 m water depth; and 0.4% in greater than 3000 m water depth. This reflects the water depth capabilities of the EM 300 multibeam bathymetry system on the *RV Southern Surveyor* that operates most effectively in the 200-3000 m water depth range.
7. 15.2% of the multibeam coverage in the AMJ was acquired by the *RV Southern Surveyor* since 2004 – that is 5.5 years. The vast majority of the coverage has been acquired by foreign vessels, the largest areas by dedicated contract or collaborative surveys using the French vessels *l'Atalante* and *Marion Dufresne*, the German vessel *Sonne*, and the American vessel *Melville*.

Conclusions:

- More than half of the AMJ lies in greater than 3000 m water depth, and nearly two thirds of the area beyond the geomorphic continental shelf lies in greater than 3000 m water depth.
- To be able to map, and conduct marine geoscience and benthic habitat studies throughout the full AMJ in the most efficient manner using a single national facility vessel, a dual mid to deep range multibeam system is necessary. This needs to be taken into account when deciding on the size of the vessel and its hull design, as such systems require substantial hull real estate.
- From the above figures, it is clear that there is a need for detailed swath-mapping of the continental shelf, but the FRV is not the vessel for such work. Its capabilities are best used in moderate to deep water, where much more coverage can be acquired in areas which are relatively poorly known. The Australian Hydrographic Service (AHS) is responsible for methodical mapping, and this is incredibly time-consuming in shallow water. The geomorphic shelf is best mapped using high-resolution shallow water systems such as those on the survey vessels of the AHS, and other high-resolution systems available in various Australian institutions. Ideally, the FRV should be equipped with such a system for targeted research in specific areas.

Annex B: Potential ship equipment and capability to deliver to seabed mapping and characterisation research

Proposed: Full ocean-depth multibeam sonar system comprising: 1) a shelf to upper slope system, and 2) a (dual frequency) upper slope to abyssal plain system.

Example systems:
French research vessel *Pourquoi pas?*
Reson 7111 100 kHz (3-1000 m, 150°, 1.5° x 2°)
Reson 7150 12/24 kHz (50-6000 m, 150°, 1° x 1°)

French research vessel Simrad EM 710 97-100 kHz (5-1500 m, 150°, 0.5° x 1°)
Simrad EM 122 12 kHz (20-11,000 m, 150°, 1° x 2°)

Proposed: Deep-tow, dual frequency side scan sonar with 6,000 m depth rating and access to coaxial or fibre optic cable and winch system.

Example system:
Edgetech 2400 DSS system – 75 & 410 kHz.

Proposed: Sub-bottom profiler, narrow-beam and integrated with 12 kHz multibeam system. Full ocean depth capability and at least 100 m sub-bottom penetration in soft sediment.

Example system:
Kongsberg SBP 120 or parametric Topas PS18 (as on *Southern Surveyor*).

Proposed: Deep-tow underwater video camera with high-resolution stills capability. Deep, working class ROV with capability to 6000 m.

Comment
While we know that technology is developing rapidly in this field – and including equipment names will be ultimately required – we intend to further discuss the problems and resolution that we want the systems to address in more detail, as later advice to the Technical Working Group.

For example, what do we need to address for future seabed studies related to:
a) climate change effects on seabed morphology,
b) possible future CCS leakage monitoring,
c) documenting benthic habitat changes over time,
d) assessments of marine mineral resources, and
e) quantifying temporal variation of seabed properties in general.

Appendix D

Marine National Facility Future Research Vessel

Sub-Committee Report: Palaeoceanographic and related studies

Will Howard, chairman (Tasmania); Jock Keene (Sydney); Greg Skilbeck (UTS); Mike Ellwood, Patrick De Deckker and Brad Opdyke (ANU); Joanna Parr and Martin Young (CSIRO), John Moreau (Melbourne); Leanne Armand (Macquarie); Pat Quilty (Tasmania); Lindsay Collins (Curtin); Ray de Graaf (GA)

1. Science and technical case

There is a large palaeoceanographic and palaeoclimatological constituency in Australia, and many others are interested in micropalaeontology, sedimentology, geochemistry, and microbiology. Studies of the climatic and geochemical variability recorded in archives like marine sediments, corals, and other marine sequences are the *only* means of capturing the variability of the marine components of the climate system and the carbon cycle beyond the very limited historical observational record. These archives are central to the science underpinning national research priority, particularly for An Environmentally Sustainable Australia[1]. There will continue to be a widespread need for soft-sediment sampling methods traditionally used, such as piston- and gravity coring. This coring capability is essential for palaeoceanography and palaeoclimatology but also for sedimentology for geohazard risk assessment (sampling of slumps) and geotechnical surveys (e.g. cable and pipeline routing), as well as for microbiological studies of subsurface microbial ecosystems in pore waters. In addition, there is a need for a suite of surface-sediment sampling capability (box core, grab, multicorer) and this mode of sampling is needed for benthic biology studies, microbiology, geochemistry (e.g. pore-water profiles for sediment-water geochemical exchanges) and ground-truthing for acoustic seabed characterization of both surface acoustic properties (e.g. backscatter) and subsurface echo character.

The requirement of recovering and deploying a long piston core alongside the ship also requires unimpeded access with a minimum of columns along one side of the ship at trawl deck level. Small winches forward and/or HIABs forward allow corers to be rotated into horizontal position safely. See http://www.whoi.edu/page.do?pid=19095 for a technical description of the WHOI system (the Australian system would not, however, be a 50-meter system, but components of the design could be incorporated).

The importance of capturing the sediment/water interface and pore water for understanding geochemical fluxes (e.g. CO_2 fluxes associated respiration of organic detritus) and microbial ecosystems was stressed – Indeed, much of the particulate/seston material produced in the overlying water column dissolves at the water/sediment interface, thus obtaining cores with an intact interface is paramount to determine benthic exchange kinetics. Obtaining undistributed cores is only possible with a giant box core and/or multicorer. Complementary to these cores would be a Smith-McIntyre grab. This field overlaps with oceanography, geochemistry and marine biology. There may be a need for a powered coring system like “PROD” and/or vibrocoring system (need power and/or video or other data through cable).

Increasingly, key palaeoclimate archives are not downcore sequences in unlithified sediments but

[1] See: http://www.innovation.gov.au/Section/AboutDIISR/FactSheets/Pages/NationalResearchPrioritiesFactSheet.aspx

biotic growth sequences in living (or formerly living) organisms such as corals (deep and shallow) or biotic archives such as rhodoliths. For this type of sampling, capabilities such as video-equipped ROVs with sampling arms and/or drills are essential. This type of sampling and imaging capability is vital for benthic ecology and acoustic seabed characterisation, as well as geochemistry. Deep-water large ROV capability would allow more effective and accurate sampling and observation surveys. ROV capability would also require fibre optic cable and winches with the required pulling power.

See:
http://www.ropos.com/index.php?option=com_content&view=article&id=17&Itemid=19 has the specifications for ROPOS, a deepwater research ROV.
http://www.ifremer.fr/fleet/systemes_sm/engins/victor.htm for specifications of the IFREMER ROV Victor 6500

In addition to sampling capabilities, this type of science, needs other facilities such as sample storage and curation (expanded repository facilities may be required), on-board analysis (i.e. accommodation for instrumentation such as core photography, multi-sensor core loggers, x-ray, open-core visible-spectrum reflectance, and others whole-core and split-core analyses). Similarly sediment sampling requires bench space for laying out samples/cores etc with access to fresh water and, in some cases, ultra-pure water. Auxiliary capabilities include compressed air, nitrogen and gas bottles (for GC-MS) – a need shared with chemical oceanography.

Microbiology, a growing theme in marine geosciences, also has specific needs as well as a generic capabilities shared with oceanography and geochemistry (see section 4). Microbiological studies need to be done under extremely clean conditions.

2. Essential coring and surface sampling equipment

See http://www.boscorf.org/education.html for specifications of a range of sediment sampling equipment.
Long piston corers, capacity up to 30 m to give several hundred thousand years of history
Short gravity corers (up to 6m), which can be deployed rapidly and repeatedly for survey cores
Box corers, to give undisturbed samples from 30 cm to 10 m long
Multicorers : see http://www.oktopus-mari-tech.de/bpn-e.html for specifications of one type of multicorer
Grab samplers (e.g. Smith-McIntyre) for bulk surface sediments

3. Equipment to which access is needed
A variety of ROVs with sampling arms and drills for precise sampling of deepwater coral buildups, individual deepsea corals, rhodoliths etc.
Vibrocorers for coring sands and gravels

4. General built-in facilities
Wet and dry laboratories
Cool room at 4°C for cores and sediment samples
General storage for drums of dredged rocks
Aquaria to keep organisms alive, with filtered sea water supply

5. Needs for microbiological sampling

Some of this sampling equipment may be built into laboratory containers, and studies will include gas safety monitoring and deep biosphere work. Much of the equipment will be of use to chemical oceanographers and geochemists

-80°C and -20°C freezer space
GC-FID instrumentation
Chromatographic analysis instrumentation (IC, ICP-MS) - as much and as good as can be purchased and can fit into the hull
Anaerobic cultivation and incubation equipment
Multiple built-in gas lines for N2, CO2, He, Ar
Laminar flow and biological safety bench hoods
Molecular biology hood
Incubator racks
Sample storage racks
Autoclaves
Sinks
Open bench space for setting up experiments/office work
Space for ovens
Water connections for mQ water
Stable benches for high precision balances
Reagent cabinets

See http://iodp.tamu.edu/labs/ship/Fdeck_microbiology.html
for the specifications of the microbiology lab aboard the drillship *JOIDES Resolution.*

6. Repository for samples
If possible, there should be the primary national data repository for all for cores. Geoscience Australia has provided a facility for some cores in the past.

7. Ship time costs, post-cruise science
Ship time should be allocated on the basis of peer review.
Ship time and onboard costs, such as victualling charges, should be minimal or nil to encourage research proposals from science teams.
Some other form of national funding is needed to allow scientists to take full advantage of these data, acquired at great cost.
Berths are needed to perform/run university training schemes as sea, such as “University of the Sea” programs.

Appendix E

Marine National Facility Future Research Vessel

Sub-Committee Report: Studies of older outcrops and submarine volcanoes: other winches and dredging

Leonid Danyushevsky, chairman (Tasmania), Richard Arculus (ANU), Chris Yeats and Shannon Johns (CSIRO), Ray de Graaf (GA), David Murphy (QUT), Carl Spandler (Queensland), Neville Exon (ANU).

1. Science arguments

Studies of basement, sedimentary and volcanic rocks, and other submarine features, are of national importance in terms of understanding the processes and conditions that led to the formation of the Australian margin and region, and the resources they contain. Such studies provide valuable knowledge that can be applied in predictive studies of margin evolution and resource locations, both in an international and national context. Knowledge about the rocks that form the offshore sedimentary basins helps constrain the geological history, and is critically important in assessing the petroleum potential of frontier basins. These rocks can be dredged in many locations, and such work is a relatively cheap alternative to drilling in the early assessment stage.

Knowledge of basement rocks around Australia constrains tectonic evolution, including rifting associated with offshore sedimentary basins. Knowledge about the rocks that form the offshore sedimentary basins helps constrain the geological history and resources (particularly petroleum) which they contain. An understanding of the structure, evolutionary history and composition of the seafloor of the Southern Ocean and Southwest Pacific Ocean relates directly to offshore mineral resources. The current tectonic environment in the Southwest Pacific is the likely analogue for the tectonic settings during formation of rock sequences found on land in the Southeast Australia. An understanding of the development and architecture of active arc volcanos, the oceanic crust, oceanic plateaus and submerged continental crust is important to global geoscience understanding. This is also relevant to understanding and predicting geohazards such as explosive volcanic eruptions and tsunami generation in response to volcanic activity, and earthquake-generated marine slides. An understanding of the alteration of igneous rocks of the oceanic crust by seawater and hydrothermal fluids is important in understanding older ore deposits on mainland Australia.

2. Essential equipment, including shipboard laboratory equipment

- Two state-of-the-art winches suitable for dredging to depths of at least 6,000m (8,000 m of cable, capable of 10 t pull at sea bed, 30 t max total load). It is highly desirable to have a capability of dredging to 8,000m (10,000 m of cable) to cover the full range of water depths in the region.
- Wax coring capability for sampling fresh volcanic glass from active spreading centres (a side winch with at least 6,000 m of cable capable of sampling to 5,500 m). The same winch as for sediment coring /water sampling can be used.
- A minimum of four full dredge assemblies on board. Similar design to the current dredges.
- Grab sampler equipped with camera and lights. Similar design to the current grab.
- Full ocean depth multibeam sonars, including a 12 KHz instrument for deep water
- Gravity meter and magnetometer and equipment on board required for their deployment.
- One coring winch for sediment/sticky wax coring and for towed equipment.

- Two (one large blade, one small blade) rock saws
- Fully equipped thin section preparation facilities (polishers, grinding laps, balances, hot plates, etc.)
- Microscope lab with binocular microscope and full petrographic (reflected and transmitted light) microscope with dual head and digital camera.
- Back/side deck space appropriate for the temporary installation of a large winch and A-frame for ROV or AUV operations.
- Sufficient overall deck space for launching and recovering project specific ROVs, AUVs, coring devices, and rock drills.
- Fresh and salt water supply on back deck for washing off equipment and back deck.
- USBLs
- CTD System:
    - rosette
    - large sample bottles
    - USBL
    - Seabird CTD
    - Eh sensor
    - optical backscattering (ΔNTU) sensors
- Appropriate enclosed, air conditioned lab space adjacent to back deck for processing and logging rock samples, which contains:
    - trough drainage for washing samples,
    - good lighting,
    - good sediment traps on sinks, or having sinks feed directly into troughs,
    - large floor-based sediment traps/drains which will not get clogged up with sample material
    - multiple work benches, and
    - space for a rock saw.
- Appropriate lab space for filtering water samples, which contains:
    - large bench space,
    - air conditioning,
    - high-quality air filtration system to screen out dust contaminants,
    - Milli-Q water system for production of ultrapure water for filtration of hydrothermal plume particulates

3. Highly desirable equipment for the vessel, with prioritisation

Items listed in order of prioritisation

- ROV capable of working to 3,500 m
- Subbottom profiler capable of working on slopes
- Some type of chemical analysis equipment (XRF, ICP AES or MS or both)
- Wet chemistry lab to prepare samples for chemical analysis
- XRD

4. Equipment that is needed but cannot be put on this ship

All items essential for dredging, coring and grabbing can be put on the ship

5. What has to be built in and what can be containerised

All winches should be built it. Dredges, corers and grabs do not have to be on board all the time (containerised?)
Rock saws and microscopes should be built in.
Analytical equipment and wet chemistry lab can be containerised, but should be a part of the MNF facilities, rather than a responsibility of the researchers

6. Responsibilities for equipment

With regards to rock sample collection (dredging, coring, grabbing), the responsibility should lie with the MNF, with appropriately trained MNF technical staff responsible for using these technologies available to assist researchers during voyages that use them.

7. Responsibilities for repositories of geophysical data and geological samples

Geoscience Australia should be responsible for archiving and storing all geological samples once researchers are finished with their samples. Alternatively, a half of all material collected is stored by GA for future use, with the second half remaining a responsibility of researchers.

8. Governance: ship time allocation, ship costs, post-cruise science funding

- Granting ship time should cover all costs associated with running the voyage. The current system requires researchers to pay MNF ~ $21,000 for a 25 day voyage plus cover the costs of getting the research party to and from the ship and getting samples of the ship. All these costs should be included in the grant of ship time.
- Post cruise science funding is essential to fully profit from the collected samples. Granting ship time should also involve providing financial means for post-cruise science.

Appendix F

AUSTRALIA'S NEW VESSEL: REPORT FROM PRELIMINARY MEETING AT GEOSCIENCE AUSTRALIA

Friday 4 September 2009, 1030-1530
Scrivener Room, Geoscience Australia, Canberra

Explanation
Andrew Heap (Geoscience Australia) chaired a preliminary meeting at Geoscience Australia to discuss the process regarding the new vessel, which aims to provide input on the geoscience priorities in science, and the design of vessel and equipment. Neville Exon (ANU) was the co-chair. The main aim of the meeting was to agree on the process that is being developed. During the meeting general matters were discussed, including an early overview of science and equipment ideas. This was not a meeting where details were widely discussed; that is a matter for the subcommittees of the Marine Geology and Geophysics Consultative Group. A working lunch was provided by Geoscience Australia, so that informal discussion could continue. The results of some questions from the audience are set out under the presentations below. A summary of major equipment needs ascertained at this meeting is set out in Section 11.

Physically Present
Clinton Foster (until lunch), Andrew Heap, Mark Alcock, Michael Morse, Phil O'Brien, Ron Hackney, Irina Borissova, Chris Nicholson, Jack Pittar, Ray de Graaf, Cameron Buchanan (Geoscience Australia); Fred Stein, Ray Binns (CSIRO); Will Howard (U Tasmania); Neville Exon, Brad Opdyke, Michael Ellwood and Patrick De Deckker (ANU); Greg Skilbeck (UTS); Rob Beaman (JCU); Peter Hill (consultant).

Present by telephone link
Leonid Danyushevsky (U Tasmania); Chris Yeats, Joanna Parr, Shannon Johns, Cedric Griffiths (CSIRO); Lindsay Collins and Ian Parnum (Curtin University).

1) Introduction and Welcome: Dr Clinton Foster, Chief of Marine & Petroleum Division, Geoscience Australia

Dr Foster welcomed all those attending the meeting and emphasised that the new vessel arrangements showed that the marine science world had come together in declaring the need for the vessel, and noted the importance to all marine geoscientists of getting the geoscience characteristics/equipment of the new vessel right. He pointed to the ASPI "Sea Change" and the OPSAG "Marine Nation" documents as supporting the need for the new vessel. He commended the geoscience planning arrangements, with universities, Geoscience Australia and CSIRO the main players.

2) Overview of the New Vessel Process: Captain Fred Stein, New Vessel Management, CSIRO

Captain Stein introduced the new vessel process to the audience (presentation available on CSIRO Marine National Facility website):

- Minister Carr had said that the "best marine science" was what the vessel program would pursue
- $150M for vessel + some operating costs (not clear what proportion)

- To be owned and operated by CSIRO
- *S. Surveyor* to operate through June 2012
- New vessel to be available thereafter for science but 2012-2013 to be a commissioning year
- Not a fisheries vessel, but with fisheries research capability
- Diesel electric propulsion means great speed flexibility
- 300 days/year
- Ship capable of going to ice-edge (ice strengthened)
- Long range limited by victualling
- 30-45 scientific party in mix of single and double cabins
- Collaboration is necessary, piggybacking more possible than for *S. Surveyor*.
- Helideck will allow science crew changes
- Integrated IT system
- Will use commercial off-shelf tech. where possible
- High modularity
- Acoustically quiet
- Support for "routine" underway measurements.
- DP-2 capable for dynamic positioning – high priority for geoscience

3) Geoscience Australia's science views: Andrew Heap, Geoscience Australia (presentation available on CSIRO Marine National Facility website)

Geoscience Australia had prepared a document setting out their marine requirements. He drew from this is making the following points. The main drivers for GA are:

- Energy security: petroleum and petroleum infrastructure surveys
- Law of the Sea: collection of data to support additional claims, science of our marine jurisdiction
- Resource assessment: living and non-living resources; long term resources including offshore minerals, alternative energy and carbon capture and storage
- Geological hazards: seabed stability and data for tsunami modelling

Dr Heap presented an excellent table setting out GA's drivers on one axis and the priority for various pieces of equipment elsewhere (see presentation). It was agreed that a similar table should be prepared for the requirements of the general marine community, and that was done toward the end of the meeting (see appendix).

He noted that:

- Publicly-funded data should be publicly available (OSDM)
- Government agencies have a role in:
    - Processing
    - Archiving
    - Distribution
- GA will supply its equipment and some support

Greg Skilbeck asked whether geological samples could be archived at Geoscience Australia as part of the National Facility arrangements, along with geophysical data, because that would ensure that samples were properly stored and curated in the long term. It was agreed that this is an important question for the future.

4) Comments on geoscience needs: Neville Exon, Australian National University (presentation available on CSIRO Marine National Facility website)

Dr Exon started with a brief presentation setting out the intended process. He highlighted what equipment of especial interest was agreed in the initial **Science Outfit** annex in the **Statement of Requirements** for the Future Research Vessel as submitted to Government:

- Three swath-mappers: 15-250 m, 30 kHz, 12 kHz
- Multidirectional sonars: 90kHz, 20-30 kHz
- Multi-frequency echosounders
- Sub-bottom profiler
- Seismic system to be determined
- Dredge winch: 7000 m cable, capable of 10 t pull at sea bed
- Coring winch: 7000 m cable, maximum pull 30 t
- Corer: minimum 6 m, maximum 30 m
- Dredges as presently available
- Grabs

Major items not yet agreed are:

- Camera tows, videos
- Gravity meter
- Magnetometer
- Note that an ROV is outside scope of documents, but ship design will enable mobilization of ROV to 5000 m +

Ray Binns noted the great importance of ROVs and AUVs to future marine science. There is almost certainly strong support for this view beyond the geoscience group, because searching for and accurately locating specific sample types is so important. There was considerable discussion of these matters here and elsewhere, and there was strong support for the concept. Binns provided documentation on two previous bids for an Australian ROV, and Fred Stein agreed to put them up on the new vessel web page.

Fred Stein made the general point that being able to handle such equipment on the new vessel is a high priority, even if the equipment itself came through outside collaboration. As regards AUVs, he pointed out that AUVs are part of the remit of IMOS, and that cases should be made to them.

More discussion about ROVs targeted the question of their substantial cost, their high running costs and the need for a team of permanent staff to run them. It seems that ROVs may well be outside the scope of what can be regarded as part of the equipment of the new ship, but the relevant sub-committee will consider the issue further. It may be that cooperating with foreign agencies or contractors with the necessary equipment, once we have a suitably equipped vessel, may be the way forward, unless an Australian research institution buys and hosts an ROV. ROVs capable of diving to 2500 m would meet the needs of many researchers.

5) Working lunch (informal discussions)

6) Broad discussion of science and equipment needs: Chaired by Andrew Heap and led by subcommittee chairs as below:

Deep crustal studies: potential field (gravity and magnetics)	Michael Morse
Sedimentary basin studies: high-speed seismic system	Mark Alcock
Seabed mapping and characterisation: multibeam, side scan sonar, sub-bottom profiler	Andrew Heap

Palaeoceanographic studies: coring, coring winch and cable, deep-sea camera/ROV system	Will Howard
Studies of older outcrops and submarine volcanoes: other winches and dredging	Leonid Danyushevsky (by phone)

7) Deep crustal studies: potential field (gravity and magnetics). Chairman, Michael Morse, Geoscience Australia

Morse pointed to the great importance of shipboard potential field data to both deep crustal studies and basin studies. He noted that the resolution of satellite gravity data was too low to deal with many questions. He indicated that both a gravity meter and a magnetometer system might well be run on all methodical geophysical surveys at cruising speed, almost on a 'set and forget' basis, and ideally 'port-to-port' on all expeditions. He suggested that a magnetometer might be used with other deep-towed packages to obtain high resolution data. Mark Alcock and Fred Stein discussed the question of streaming data direct to shore for quality control and processing, and it was agreed this should be possible. Leonid Danyushevsky said that a deep towed magnetometer would help seabed studies of volcanic areas.

It was noted that shipboard gravity readings can help in developing better Geoid models – something with widespread importance. As regards the gravity meter it would be important to check how UNOLS and other fleets handle this capability. It was noted that Ocean Bottom Seismometers and Ocean Bottom Magnetometers would be important for some studies, but could probably be supplied from outside the national facility equipment.

8) Sedimentary basin studies: multipurpose high-resolution seismic system. Mark Alcock, Geoscience Australia

It is a given that sedimentary basin studies are important to many geoscientists, having both academic and applied importance. Mark Alcock made a strong case for a multipurpose seismic reflection system capable of being configured to provide all manner of data, ranging from very high-resolution in shallow water, to relatively deep penetration (3-4s) in favourable deeper water environments. The system could be extended over time. It would fill gaps in existing industry-standard data, and could be used for site surveys, such as those need for IODP drill sites. IODP site surveys need at least 3s of seismic penetration. Basic characteristics would include:

- Built-in electrical compressors for high reliability, serviced by ship's crew
- Digital acquisition system
- A combination of several airguns suitable for various purposes was needed, probably GI guns, with a total capacity of ~600 cubic inches. Arrays would need to be simple to make deployment easy
- Up to 2400 m of seismic cable. What are envisaged are 50 m oil-filled sections that can be repaired on board.

Discussions emphasised the importance of a built-in sub-bottom profiler to provide higher resolution but shallower penetration for coring location, and for surveys of slumps and other features. Other equipment, such as sparkers and boomers could be brought aboard from elsewhere as needed.

9) Seabed mapping and characterisation: multibeam, side scan sonar, sub-bottom profiler. Andrew Heap, Geoscience Australia

Dr Heap made the general points that seabed mapping was important for providing the background data for new areas of science, including biodiversity studies, and there was widespread support from biologists for this tool. He noted that the technique was needed in all water depths, as set out in the earlier planning (see section 4). Both seabed shape and character was needed, so back-scatter from a swath-mapper was valuable, but a towed side-scan sonar would be needed for many studies

Discussion moved on to practical considerations, such as whether a shallow system should be built in (generally agreed), and whether a gondola could be used off Antarctica (Fred Stein suggested that it could). It was agreed that access to sidescan sonars was important, and that they should generally be towed below the thermocline, and it was noted that it in some cases they needed to be towed near the seabed. Ray De Graaf pointed out that an armoured co-axial cable would be needed for this and other towing purposes.

10) Palaeoceanographic studies: coring, coring winch and cable, deep-sea camera/ROV system. Will Howard, University of Tasmania.

It was generally agreed that palaeoclimate and carbon cycle history are high priorities for government climate policy, and marine archives including cores are necessary for capturing this science. Piston coring is necessary for studies of geohazards (slumping) and geotechnical studies.
We should aim at a combination of long to medium length piston coring, and shorter and rapider gravity coring, from adjacent locations on the side of the vessel. A maximum core length of 30 m should be sought. Specifications are needed on low-stretch wire to avoid pre-tripping and double hits with a piston corer. We need to look at existing systems e.g. WHOI system. Vertical clearance may also be an issue, so the minimum height of A-frames needs to be considered. Greg Skilbeck asked if we can support re-entry into core holes? This might need acoustic beacons for precise positioning of gear.

The importance of capturing the sediment/water interface and pore water for understanding geochemical fluxes (e.g. iron) and microbial ecosystems was stressed. This field overlaps with geochemistry and biology. We need box cores (including a giant box core) and a multicorer, as well as grab samplers like the Smith-McIntyre grab. There may be a need for a powered coring system like "PROD" and/or vibrocoring system (need power and/or video or other data through cable). Surface samples are also needed to ground-truth acoustic characterisation (Rob Beaman).

A submersible drill would be useful (e.g. for submerged corals – Jody Webster), and sampling by ROV is needed for palaeoclimate archives like deep corals (e.g. Ron Thresher of CMAR, Stewart Fallon of ANU). Rob Beaman stressed the importance of an accurate control system for ROV/AUV, and that this should have full coverage of the sea bed (e.g. installed in a drop keel). Ray Binns re-emphasized the need to have access to a large ROV, and possible ownership of a smaller ROV.

11) Studies of older outcrops and submarine volcanoes: other winches and dredging. Leonid Danyushevsky (University of Tasmania).

Leonid Danyushevsky led this discussion by telephone from Tasmania, which was not easy. He wanted to know if dredging to any depth in the Australian marine jurisdiction was in scope. Fred Stein replied that 6000 m was the maximum envisaged. Two trawl winches will probably be available for dredging. Leonid asked if we could dredge off the side, but the view was that we would be dredging off the stern. As regards dredging of normal sedimentary or igneous targets, traditional dredging will continue to play a major role.

Accuracy is very important for dredging of modern volcanics, and also for wax coring from the hydrowinch. There was general agreement that access to an ROV with a manipulator arm would also be valuable for volcanic studies.

11) Ship capabilities and priorities relative to Science Driver/Program. Prepared at meeting from people's comments by Andrew Heap

	Gravity Meter Magnet-ometer	OBS/OBM deploy/ recover capability	Seismic system	Sub-bottom profiler	Full-ocean depth multibeam sonars	Deep-towed body capability	Deep-tow working-class ROV	Long/short coring capability	Surface sampling capability	Deep dredging	Wax coring
Deep Crustal Studies[1]											
Sedimentary Basins[2]											
Seabed Mapping[3]											
Palaeo-studies[4]											
Older Outcrops[5]											
Defence											
Hazards											
Minerals											

Major applications:

6. Geodesy, geology, high-resolution national dataset applications/studies
7. Margin evolution, petroleum prospectivity, geotechnical studies
8. Geomorphology, sedimentary and ecosystem processes, habitat and biodiversity prediction studies
9. Sequence stratigraphy, palaeo-climatology, environmental reconstruction, nutrient/microbial processes, site survey applications/studies
10. Margin evolution and geochemical, tectonic history studies

Definitions:

Essential = necessary data to deliver program and/or answer science question

V. useful = data provide significant contribution to deliver program and/or answer science question

Useful = data are complementary to program and/or science question

Not applicable = not necessary

Winches/wires:

Ability to sample (i.e., dredge/core) to 6,000 m water depth
Ability to operate deep-tow equipment (e.g., side scan sonar/video system) to 6,000 m water depth

Additional:

Cone penetrometer for geotechnical studies?

12) Summing up and next steps: Neville Exon (ANU)

The next step is for the Sub-Committee chairs to work with their group to prepare a brief report. This should follow the following format as far as possible:

1) Science arguments for geoscience fields, with some prioritisation
2) Essential equipment, including shipboard laboratory equipment
3) Highly desirable equipment for the vessel, with prioritisation
4) Equipment that is needed but cannot be put on this ship
5) What has to be built in and what can be containerised
6) Responsibilities for equipment
7) Responsibilities for repositories of geophysical data and geological samples
8) Governance: ship time allocation, ship costs, post-cruise science funding

This is the proposed format that will be used by the Marine Geology & Geophysics Consultative Group (Exon, Heap, Consultative Group co-chairs; Howard, Alcock, Morse, Danyushevsky, sub-committee chairs) in preparing a Report for the New Facility Technical Working Group. This Working Group (includes Exon and Heap) meets in Hobart on 2 October, to put together a combined Science Equipment Report for all disciplines, which will be the basis for a Request for Proposals to build and equip the ship, which should go out on 17 October.

Clearly, this is a very short timeframe, and if you could get your **sub-committee reports to Andrew and me by 23 September**, that would be much appreciated. They need not be very long, and the emphasis will be on capability rather than specific equipment. However, notes on specific equipment would be much appreciated and would be put in an appendix. The above table, with any modifications, will be in our report. As Andrew is away until 24 September, I will help draw together a report from the seabed mapping subcommittee.

Report prepared by Neville Exon, based on the formal presentations and his, Will Howard's and Andrew Heap's notes: 10 September 2009