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Enquiry into Australia's international research engagement: marine geoscience

In response to the Enquiry of the House of Representatives Standing Committee on Industry, Science and Innovation into Australia's international research engagement, I am writing on behalf of the Australian and New Zealand IODP Consortium (ANZIC) to comment on how the Integrated Ocean Drilling Program (IODP) and marine geoscience in general are involved in international research. My involvement is largely as Program Scientist of ANZIC, but also as a member of the Technical Advisory Group for the new Australian research vessel *Investigator*.

1. Summary

Australia is a **small but influential player** in international marine geoscience, including its role within the world's largest geoscience research program, IODP. We have natural advantages in marine geoscience because, along with our IODP partners New Zealand, we are the major players in the Southern Hemisphere. We have one of the world's largest marine jurisdictions (larger than onshore Australia) to study and manage, and marine geoscience plays a key role in both environmental and resource assessment. International research institutes are already heavily involved in cooperation with Australian groups (government agencies and universities) in the field. It should be noted that there is strong cooperation between geoscience and other disciplines such as physical oceanography and marine biology.

A **major impediment** to increased involvement is a surprising lack of researchers and only one blue water research vessel available to Australia. A new, larger and better funded blue water research vessel will replace the existing vessel in 2012 and that could be the springboard for increased national and international marine geoscience surveys and research. A coordinated program to strengthen key university departments in geoscience and marine geoscience, and attract more good students to these nationally important fields, is essential. The great increase in shipboard

scientific berths for students on the new vessel will help in this endeavour, but in the end more employment prospects in universities, government and industry are crucial.

One way to increase the **limited number of university researchers** applying for ship time would be to cover the costs of expedition logistics and immediate post-cruise science. Ideally, expedition logistics would be covered as part of the grant of ship time, as occurs in the USA for example. There is also the question of post-cruise funding for initial analyses to allow a first suite of publications to come out, which are needed to convince ARC to provide further funding to get real value out of the large government outlay on ship time. Such initial post-cruise funding is clearly needed (as is provided for Australians involved in IODP), especially if one is competing with well funded foreign collaborators.

There is uncertainty about **long-term funding for IODP**, because the present system of applying for grants from ARC is limited to five years. It takes at least five years for a successful IODP proposal to lead to an IODP expedition, and the uncertainty about long term funding can discourage potential proponents. Thus we need a more stable funding system, which could be in phase with the ten year cycle of IODP research (the next cycle starts in late 2013). It would be much more sensible to provide ten year funding direct from the Department of Science for the next ten year phase of IODP. This would correspond to the system Australia uses for other large shared infrastructure activities.

2. The nature and extent of existing international research collaborations

The sediments and rocks beneath the world's oceans contain a remarkable story of how the Earth works, and how it has worked in the past. Australian and New Zealand scientists are now involved in such studies, using the latest technology from the **Integrated Ocean Drilling Program** (IODP), which is the world's largest multinational geoscience program (www.iodp.org). The rationale for these studies includes the realization that the past is often a key to the future of the Earth.

IODP deep scientific coring uses a variety of platforms, and tests global geoscientific theories that are often developed largely on the basis of remote sensing. New technologies and concepts in geoscience are continuously being developed through IODP.

IODP's main research fields are the ***deep biosphere and ocean floor***, including microbes that live deep beneath the sea floor and that can cope with extreme conditions, and accumulations of frozen gas hydrates; ***environmental change processes and effects***, including past changes in climate and ocean currents; and ***solid earth cycles and geodynamics***, including continental breakup, large volcanic events, earthquakes and tsunamis.

The primary exploration tools are dynamically-positioned Japanese and American coring vessels; where the primary vessels are not suitable, the European Union charters other coring platforms. The available equipment can take continuous sediment or rock cores in all oceans, in most water depths and up to 5000 m below the sea bed. IODP has access to drilling platforms worth $US1 billion and an annual budget of $US200 million.

Our involvement is through ANZIC, the Australian and New Zealand IODP Consortium (www.iodp.org.au). Australia's involvement involves 14 universities, CSIRO, AIMS and ANSTO. Funding is from ARC and these groups, and amounts to $A2,180,000 p.a., which covers our activities and a $US1.4 million p.a. subscription to IODP. The funding is in place until the end of 2012. This gives us entry into IODP with its annual operating budget of around $US200 million.

Many of the same scientists, and those from Geoscience Australia for example, are involved in **other international marine geoscience** using the Australian research vessel *Southern Surveyor*, the Antarctic vessel *Southern Aurora*, and foreign vessels (from France, Germany, USA, Italy and New Zealand). Australian funding from these activities comes from government agencies, ARC and universities. There is strong cooperation between geoscience and other disciplines, such as physical and chemical oceanography and marine biology, including at sea.

3. The benefits to Australia from engaging in international research collaborations

Marine science is, by its nature, international science. To quote from Professor Kurt Lambeck, President of the Australian Academy of Sciences (National Press Club, 9 September 2009): "The importance of Australia being integrated into international science is obvious to most of us here who have worked in science. Without our overseas experience, without access to ideas and technology before they became mainstream, our own and Australia's contribution to world knowledge would be much less than what it has been. … But beyond the science community the simple fact, that to make effective use of the less than 3 percent of knowledge developed by Australia, we need timely access to much of the other 97 percent created overseas…"

We do not have the technical resources, the expertise, or the number of marine scientists to attempt to understand our vast marine jurisdiction on our own. Fortunately, our region is the best in which to address various global scientific problems, and some of them cannot be addressed elsewhere, so foreign researchers are keen to work in our region. This leads to a great deal of scientific data and samples being gathered by foreign vessels here, at very considerable cost, all of it being provided to Australian or international data bases for future use.

Australian scientists gain through shipboard and post-cruise participation in cutting edge science with foreign institutions, by building partnerships with overseas scientists, by having research proponents and co-chief scientists who can steer programs and outputs, and by early access to key samples and data. We also have the opportunity of science training for doctoral and post-doctoral students in marine science that could not be obtained in any other way. Being a member of IODP has helped us maintain our leadership in Southern Hemisphere marine geoscience research. It also means that a great number of foreign scientists are working on problems of direct relevance to Australia.

Australia became an associate member of the **Integrated Ocean Drilling Program** (IODP) in January 2008 and New Zealand has joined us in the ANZIC Consortium as a smaller member. ANZIC has access to positions on three Japanese *Chikyu* and three American *JOIDES Resolution* expeditions per year, and one alternative platform position. New Zealand is entitled to one of the *Chikyu* or *JOIDES Resolution* positions per year. ANZIC is also entitled to several voting and non-voting positions in IODP committees, which give us an overview of international marine geoscience.

There have been a number of IODP expeditions in the Pacific Ocean since mid 2009, and ANZIC has had considerable involvement.

- For example there were two Australians aboard an expedition in the Canterbury Basin east of New Zealand in late 2009, studying past climates and global sea level fluctuations for the last 40 million years. This expedition will help us better constrain what can happen in the future due to global warming and sea level rise.
- One Australian and one New Zealander are aboard an expedition to Wilkes Land (Australian Antarctic Territory) off Antarctica in early 2010, studying the onset of Antarctic glaciation about 35 million years ago, and the fluctuations in glacial history since then. Again, this expedition will help us better constrain what can happen due to climate change and sea level rise.
- In early 2010 another drilling expedition will use a much smaller ship to investigate the history of the 120 m sea level rise in the Great Barrier Reef since the last glaciation about 20,000 years ago, and the associated changes in water properties and changes in the reef as it migrated landward. This has great relevance in understanding how the Great Barrier Reef will respond to global warming and sea level rise, and a better understanding of the threat of ocean acidification to the reef.
- Other expeditions in the Pacific Ocean in which we are involved preceded and will follow the above three expeditions, in very different geoscience fields. In an IODP expedition off Japan in 2009, an Australian scientist led the study of living microorganisms that are buried to great depths below the sea bed. These organisms, from this extreme environment, include many in suspended animation for perhaps a million years. Their study gives us a better understanding of past microbial assemblages, and may lead to their medical or engineering use.

Moving from IODP coring to **marine geoscience in general**, it is clear that as Australia claims about 27 million km^2, and that more half of that is under the ocean, we need to understand it, and that understanding must be based on marine science research. For this purpose we need many more scientists and equipment than we have, and vessels and equipment with capabilities Australian research agencies do not possess.

Marine geoscience involves examining the nature of the sea bed and the processes shaping it, and the nature and resources of all that lies beneath the sea bed. The nature of the sea bed is of vital importance to the food chain that is based on it and hence to our wild fisheries and aquaculture. The sediments below the sea bed tell us about past environments, and host resources such as petroleum, metallic ore deposits of various types, and sand and gravel that are vital to our future.

Much geoscience work involves remote sensing, such as acoustic swath mapping, seismic profiling to reveal the structures (and by inference, resources) below the sea bed, and the taking of sediment cores to study climate history. It also includes taking sea bed samples on steep slopes where the ancient strata of sedimentary basins are exposed, thus giving us a better understanding of those basins and their petroleum potential.

A completely different field is the study of active and extinct volcanoes adjacent to oceanic trenches, both to better understand them and the hazards they present (earthquakes, eruptions, tsunamis), and also to study modern gold and copper deposits not only for their own worth, but also to better understand and predict ancient deposits that formed in the ocean but that are now on land. IODP coring is the ultimate tool to study many of these matters at depth below the sea floor. For example, off Japan the hazards from earthquakes are well known and devastating. There IODP will place geophysical and chemical sensors in bore holes across fault zones that generate earthquakes and tsunamis, with the aim of predicting earthquakes and thus saving untold numbers of human lives.

4. Key drivers of international research collaboration at the government, institutional and researcher levels

The key driver for international research collaboration in marine geoscience at the **government level** is to properly assess, and hence to be able to manage, our huge marine jurisdiction. This relates to living and non-living resources, environmental understanding and management, and matters such as past climatic and oceanographic changes and their implications for the future.

Drawing on a marine geoscience report (December 2009) for the new research vessel, 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

To enable this work to be done expeditiously and efficiently, and to help build better address global science questions, a great deal of international cooperation is essential.

The key drivers for international research collaboration in marine geoscience at the **institutional level** vary depending on the institution. All of them help address elements of marine geoscience research listed above. Government agencies such as Geoscience Australia tend to work further toward the applied end of the spectrum, and universities further toward the pure science end of the spectrum, but there is a great deal of cooperation between institutions and a great deal of overlap between pure and applied science. All these institutions perforce rely very heavily on international cooperation in the various areas of geoscience research, including IODP coring. All aim to produce high quality science much of which addresses key government priorities, but all realise that government priorities will change in the future and that 'greenfields' research will help define those priorities. In marine geoscience, working with foreign research institutions makes excellent research more feasible and allows its assessment against world standards.

The key drivers for international research collaboration in marine geoscience at the **individual level** are very diverse. For many marine geoscientists, especially those in government institutions or Cooperative Research Centres, their aim is to work in teams that address national or regional or local problems. Their output is measured in terms of reports, and the quality of their work is tested by publications in the international peer reviewed literature. Their personal satisfaction comes from doing good frontier research, much of it clearly in the national interest, and having it recognised as such. For others, especially those at the best universities, their aim is to carry out research into science of global importance. Their personal satisfaction comes from doing excellent research that is recognised globally and that enhances Australia's reputation on the world scene. It is a fact that Australian academics have spent personal funds at the levels of thousands of dollars to maintain marine geoscience research programs using the RV *Southern Surveyor* and its predecessor as Marine National Facility, the RV *Franklin*. It is hard to imagine any researcher in blue water marine geoscience working independently of international colleagues and their equipment.

5. The impediments faced by Australian researchers when initiating and participating in international research collaborations and practical measures for addressing these

The impediments facing Australian researchers in marine geoscience are **largely internal**, because American, German, French, New Zealand, Italian and Japanese research institutes are interested in this region and are very happy to involve local researchers with local expertise. However, their funding base is declining, so partnerships where Australia provides ship time, money or equipment are becoming more important. The new Australian vessel is of interest to foreign institutes as a platform for joint research. This would save the great costs of bringing ships into the region from the northern hemisphere and could well lead to more research (including IODP site surveys) in our region.

Many researchers in marine geoscience are geoscientists who also work on land, but there are also specialist marine geoscientists. Marine geoscientists work closely with oceanographers, biologists and marine managers. In marine geoscience, great weaknesses have been the general lack of researchers, the lack of first class marine vessels, and their limited equipment. Land-based analytical facilities have been much less of a problem.

Foreign researchers have been amazed at how little research Australia does in its huge marine jurisdiction, and that it has been carried out by one very old and **very limited blue water research vessel**. There was a time in the 1990s when Australia had a first rate geoscience vessel, *Rig Seismic*, run by the Australian Geoscience Survey Organisation; an ageing but adequate fisheries research vessel, *Southern Surveyor*, run by CSIRO; the national facility oceanographic research vessel, *Franklin*, run by CSIRO; and smaller vessels run by government agencies and universities. For much of that time, Australia was a member of the Ocean Drilling Program (ODP), and could do the necessary site surveys using *Rig Seismic*. The result was a hugely successful membership of ODP, with many major expeditions providing vital scientific information and many first-rate publications dealing with important Australian scientific questions.

Now, with a greatly increased marine jurisdiction, we have a general purpose and very old research vessel, *Southern Surveyor*, which is a national facility run by CSIRO, plus smaller vessels (some new) run by government agencies and universities. The reason for this decline in capacity is a decline in government funding. Fortunately, government had recognised the problem and is funding a modern and far more **capable research vessel** to replace Southern Surveyor, with far greater range, more scientific berths, much better equipment, and far more sea days. This vessel should come into action in 2012.

Australia has recently rejoined **ocean drilling** (IODP) and expeditions have been and will be in the Australian region until the end of 2010. In recent years we have had very **limited resources to do site surveys**, and have managed largely on the basis of past work and foreign surveys. The key to successful membership in IODP is the ability to present proposals to address global scientific problems. These proposals compete with proposals from around the world, and one average IODP expedition of two months costs $US 6 million, so the competition is fierce. Accordingly the scientific arguments need to be compelling, and the geophysical and geological data they are based on must be of the highest quality.

Without excellent site surveys, we cannot attract future IODP expeditions, and even when the new vessel comes into use, it is clear that no Australian marine research agency will have an adequate seismic profiling system to carry out the high end seismic surveys needed to back many IODP scientific proposals (they provide profiles through the strata to deep below the sea bed). We will continue to depend on foreign equipment, and getting that from the northern hemisphere is never simple. In the long run, Australia should acquire and run a first rate seismic system itself.

Another serious problem is the **lack of scientists and students** working in marine geoscience. The reasons for this have included the general run down in Australian interest in and funding for science, especially in the universities; the lack of a career path in Australia for marine geoscientists; and the lack of a blue water research vessel with enough ship time and berths to allow large numbers of students to go to sea. The provision of the new vessel is an important step forward. However, it will stretch our marine geoscience groups to the limit, and only by increasing the number of researchers and students in the field can we take full advantage of the new vessel. This requires a variety of steps involving government, institutions and individuals, including an increase in employment opportunities.

A final problem is the **lack of full funding for expedition costs** and immediate post-cruise science. The ARC cycle does not fit with the national facility cycle and ARC funds are often not forthcoming to aid successful national facility bids. Although the national facility is highly subsidised, at this moment a research group carrying out an average 20 day expedition needs to find about $50,000 to move staff and equipment to and from the vessel, and pay on-board charges. This prevents many university groups from applying for ship time. Given that applications for *Southern Surveyor* time are peer reviewed, and that 20 days on the ship costs the national facility about $700,000, this lack of funding for minor but essential costs makes little sense.

There is also the question of **post-cruise funding** for initial analyses to allow a first suite of publications to come out, which are needed to convince ARC to provide further funding to get real value out of the large outlay on ship time. Some such initial post-cruise funding is clearly needed, especially if one is competing with well funded foreign collaborators.

There is uncertainty about **long-term IODP funding** because the present system of applying for five year grants from ARC, under the LIEF scheme, causes distortions to that scheme. It takes at least five years for a successful IODP proposal to lead to an IODP expedition, and the uncertainty about long term funding can discourage potential proponents. Thus we need a more stable funding system, which could be in phase with the ten year cycles of IODP research (the next starts in late 2013).

6. Principles and strategies for supporting international research engagement

International research engagement in marine geoscience including IODP is already well developed, but improvements can be made. We should build on the additional capability to be found in the new national research vessel (from 2012) to increase the quality of our input to international research programs and thus our influence in them. Ship exchanges will become more feasible, and foreign agencies could save funds by not bringing their vessels to our region if not entirely necessary. They could bring equipment that we do not have to install on our vessel instead. Australia lacks a first rate seismic system, an essential for any country strong in marine geoscience, and present plans include only a limited system for the new vessel. In the long run, we should acquire and run such a system ourselves.

We should increase the number and level of expertise of Australian researchers involved in marine geoscience research. In part, this means better funding for geoscience and marine geoscience in our universities, hopefully thus attracting more good students to a field that is vital to the national interest. Mineral deposits onshore and petroleum resources offshore are key parts of the Australian economy. Offshore, we also need to understand the marine environment, and past changes in climate, oceanography and sea level – areas where geoscience plays a critical role.

Part of increasing the volume and quality of marine geoscience research is to reduce funding problems for universities trying to mount marine expeditions. One way to increase the limited number of university researchers applying for ship time would be to cover the costs of expedition logistics and immediate post-cruise science. Ideally, expedition logistics would be covered as part of the grant of ship time, as occurs in the USA for example. There is also the question of post-cruise funding for initial analyses to allow a first suite of publications to come out, which are needed to convince ARC to provide further funding to get real value out of the large outlay on ship time. Such initial post-cruise funding is clearly needed (as is provided for IODP), especially if one is competing with well funded foreign collaborators. A grant of up to $50,000 for a team of Australian researchers involved in an expedition would deal with this problem.

As regards IODP, the present system of applying for 5 year grants, of the order of $1.5 million p.a. from ARC under the LIEF scheme, causes distortions to that scheme, and should grants not continue in a very long term program like IODP, a great deal would be lost. It takes at least 5 years for a successful IODP proposal to lead to an IODP expedition, and the uncertainty about long term funding can discourage potential proponents. It would be much more sensible to provide funding for the next phase of IODP direct from the Department of Science, probably for a ten year term (with safeguards), from late 2013 when the next ten year phase of IODP starts. This would correspond to the system used for other large shared infrastructure activities.

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P.S. A signed paper version of this document has also been posted

Note: Other ANU scientists who are heavily involved in marine geoscience and IODP are my colleagues Professor Richard Arculus (Richard.Arculus@anu.edu.au; 02 6125 3778) and Professor Patrick De Deckker (Patrick.Dedeckker@anu.edu.au; 02 6125 2070), both of whom support the thrust of this submission. They have had some input into this document and would be happy to join me as part of a team, should you decide to interview us.