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A brief history of scientific ocean drilling from the Australian and New Zealand points of view

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A full review of Australia's involvement in ocean drilling since its onset in 1968 through the Deep Sea Drilling Project (DSDP) to the 1985–2003 Ocean Drilling Program (ODP), plus the initial part of the 2003–2013 Integrated Ocean Drilling Program (IODP) was provided by Neville Exon's 2010 paper: Scientific drilling beneath the oceans solves earthly problems, published in the *Australian Journal of Maritime and Ocean Affairs* 2(2), 37–47. Much of this short summary is drawn from that paper.

A broader, briefer review was provided by Deborah K. Smith, Neville Exon, Fernando J.A.S. Barriga and Yoshiyuki Tatsumi, 2010: Forty years of successful international collaboration in scientific ocean drilling, published in *Eos*: *Transactions American Geophysical Union* 91(43), 393–404 (doi.org/10.1029/2010EO430001).

Early days: The Deep Sea Drilling Project

Between 1968 and 1983, the DSDP began the study of the deep ocean's sediments and rocks using the *Glomar Challenger*. DSDP was funded by the US National Science Foundation but welcomed foreign scientists, including Australians and New Zealanders, to its drilling campaigns.

This ship started to build a story about what was happening and had happened in the 70 per cent of the Earth's crust that lies beneath the oceans. Its major achievements included:

- Drilling and dating the oceanic basalts that form on the sea floor as continents drift apart and are later covered in sediment, thus contributing greatly to the concept of plate tectonics.
- Proving that the oceanic rocks existing at present have all formed in the last 200 million years, and showing that such rocks are continuously poured out at mid-oceanic ridges and destroyed at oceanic trenches. Continental rocks, by contrast, can be billions of years old. Many of these 'continental rocks' are, in fact, ancient sedimentary and volcanic rocks that formed in the ocean but have been accreted to the continents.
- Providing a detailed history of the climate and oceanographic changes that have affected the world's oceans in the last 200 million years.

Figure 3.1. *Glomar Challenger* at sea
Source: *JOIDES Resolution* Science Operator, Texas A&M University

This was the first-generation exploration phase of ocean drilling, with holes being drilled in most parts of the world's oceans to test existing ideas and also to see what was actually there. All holes were spot-cored rather than continuously cored.

DSDP drilled eight legs in the Australasian region in two phases. In the first phase, the first regional expedition was Leg 21 in 1973, with Gordon Packham of the University of Sydney aboard, and the last was Leg 33 in 1976. Both these legs happened to be in the Southwest Pacific, but others were elsewhere in the region. This exploratory phase set the scene for the problem-solving expeditions that came later, including the final DSDP expedition in our region in 1986, which was the oceanographic Leg 90 in the Southwest Pacific under the International Phase of Ocean Drilling (IPOD), a predecessor to ODP.

A great deal was learned about the volcanic ridges and the intervening sedimentary basins that characterise the sea floor in our region, and about its plate tectonic history. For example, it was shown that other Gondwanan continents broke away from Australia, starting about 160 million years ago, with Australia moving north from Antarctica in the last 90 million years.

Early maturity: The Ocean Drilling Program

In 1985, a larger and more capable drilling vessel, the *JOIDES Resolution*, replaced the *Glomar Challenger* in the new Ocean Drilling Program (ODP), and continuous coring becoming normal. This was a phase of ocean drilling that aimed to solve global scientific problems, unlike the DSDP's curiosity-driven exploration. Many scientific questions of global significance were addressed, and the understanding of our geological framework increased greatly.

This phase of ocean drilling was still largely funded by the US, but considerable funds were also provided by other countries, especially European countries and Japan. Although scientists from member countries took up most positions on vessels, scientists from countries that were not members, especially where drilling was taking place, also participated. Australia joined ODP in 1988 in a consortium with Canada, Korea and Taiwan, and Australian scientists were heavily involved both before Australia joined and afterwards. New Zealand never joined ODP, but its scientists were often involved; for example, on the oceanographic Leg 181 to the Campbell Plateau and Chatham Rise region.

Figure 3.2. *JOIDES Resolution* travelling through the Panama Canal in ODP days

Source: *JOIDES Resolution* Science Operator, Texas A&M University

There were 17 two-month ODP expeditions in the Australasian region, starting with Leg 119 in Prydz Bay, south of the Kerguelen Plateau, in 1988, and ending with Leg 194 on the Marion Plateau off eastern Queensland in 2001. Australian and New Zealand scientists were heavily involved in writing proposals, and seven Australians became co-chief scientists on expeditions. By the time ODP ended in 2003, 71 Australian scientists had participated in expeditions, and seven Australian scientists had acted in the key position of co-chief scientist. At the end of ODP, Elaine Baker and Jock Kenne of the Australian ODP Office in Sydney published an excellent review of Australian achievements in ODP entitled *Full Fathom Five: 15 Years of Australian Involvement in the Ocean Drilling Program*.

The Australian geoscience research vessel *Rig Seismic* was instrumental in conducting some of the detailed site surveys that were essential for successful ODP proposals. When *Rig Seismic* was disposed of in 1998, Australia unfortunately no longer had the world-class seismic profiling capability needed for most site survey work. Fortunately, a new world-class Australian Marine National Facility, the *Investigator*, came into operation in 2014 and it has been gathering data for future IODP proposals.

Maturity: The Integrated Ocean Drilling Program

From 2003 to the present day, we have had two phases of IODP, Integrated Ocean Drilling Program (IODP(1)) and International Ocean Discovery Program (IODP(2)), with a major rebuild and refit of *JOIDES Resolution* early in the cycle, which greatly increased its laboratory capabilities and improved its living quarters, among other things. In addition, the deep drilling capability of the Japanese drill ship *Chikyu* and specialist platforms provided by the Europeans have greatly widened the scope of research activities. The European-chartered drilling vessels were invaluable for occasional expeditions when neither of the other two vessels was suitable. This meant that drilling in the Arctic Ocean and in the Great Barrier Reef, for example, was now possible.

When ODP ended there was no easy mechanism for Australia to join IODP, but Helen Bostock of ANU was commissioned and funded (from money carried forward from Australia's ODP consortium) to find a way forward. When a major IODP workshop was held in Hobart, with international and national participants, there was clearly great interest from Australian research institutions, and our efforts redoubled after that. In January 2005, a proposal for Australia to join IODP, as part of an Asian consortium with South Korea and potentially India and Taiwan, was put forward to the National Collaborative Research Infrastructure Strategy (NCRIS), under the guideline to 'provide access to infrastructure'. After some changes during the assessment process, the IODP proposal was included in the Integrated Marine Observing Strategy (IMOS) capability in February 2006. Unfortunately, it was distinctly different from other proposals within the IMOS capability and was excluded from final IMOS funding.

Figure 3.3. *JOIDES Resolution* leaving Honolulu in 2008, soon after its refit
Source: *JOIDES Resolution* Science Operator, Texas A&M University

Later in 2006, an Australian IODP steering group decided that we should work toward an IODP Australian Research Council (ARC) bid, and Neville Exon was commissioned and funded to steer a bid to be submitted in early 2007, for funding to commence in January 2008. Several meetings of scientists representing a number of Australian institutions were held, and a Canberra-based geoscience group undertook to lead this project. There were many important players, but Richard Arculus, Patrick De Deckker and Neville Exon, all of ANU, formed a core group. The group convinced the ANU Deputy Vice Chancellor of Research, Professor Lawrence Cram, to provide $100,000 per year from central funds if the bid succeeded. Things then moved fast, with 18 Australian institutions joining the ARC bid, and New Zealand agreeing to join a consortium if we succeeded. Richard Arculus became the lead chief investigator on the bid with another 20 chief investigators from universities or principal investigators from government research agencies also signing.

In late 2007, we were informed that the ARC/LIEF bid had succeeded and, with the funds from ARC and the Australian partners, Australia was able to join IODP as an Associate Member. New Zealand then joined

to make the Australian and New Zealand IODP Consortium (ANZIC). Australia and New Zealand joined IODP in 2008 and have been very active members since. ANZIC has had three co-chief scientists thus far, and will have had another six by the time *JOIDES Resolution* leaves our region in 2018. Altogether, 35 ANZIC scientists and one science communicator have been part of various expedition science parties up to the end of 2013, and many more since. Details of our involvement are set out in Chapter 5.

Thus far there have been three phases of IODP drilling in the Australasian region. The initial phase consisted of five expeditions that started with Expedition 317 in the Canterbury Basin, east of New Zealand, in late 2009, and ended with Expedition 330 to the Louisville Seamount Trail, northeast of New Zealand, in early 2011. The next phase of 'regional' drilling, 10 expeditions in the Indian Ocean, was triggered by the Indian Ocean IODP Workshop in Goa in 2011. There were five expeditions in the area between India and Australia, starting with Expedition 353 studying the Indian Monsoon in late 2014, and ending with Expedition 362 studying the Sumatra seismogenic zone in late 2016. This was immediately followed by the Western Pacific Warm Pool Expedition 363, which was stimulated by the Indian Ocean Workshop.

In 2012, the Southwest Pacific IODP workshop was held in Sydney, and it too stimulated a whole series of proposals, nearly all with New Zealand leadership, with six expeditions to be drilled in 2017 and 2018 in the third phase of regional drilling. These will start with Expedition 371 to the Lord Howe Rise in mid-2017 and end with Expedition 376 to the Brothers Volcano in mid-2018.

The Australasian IODP Regional Workshop, held in Sydney in June 2017, is expected to help initiate another round of IODP drilling in this region in the early 2020s.

This text is taken from *Exploring the Earth under the Sea: Australian and New Zealand achievements in the first phase of IODP Scientific Ocean Drilling*, edited by Neville Exon, published 2017 by ANU Press, The Australian National University, Canberra, Australia.