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Major IODP planning workshops

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Planning workshops for proposed future IODP drilling are critically important in generating ideas that can lead to successful drilling proposals that can address global scientific questions. Among other things, they bring together a critical mass of scientists to be able to carry out informed discussions, and often to form the core of proponents of future proposals. Four workshops of special interest to Australia and New Zealand are discussed below.

Such workshops can be global in scope, such as the IODP New Ventures in Exploring Scientific Targets (INVEST) workshop in 2009, which addressed the whole question of the way ahead for scientific ocean drilling, and led to the preparation of the carefully thought through, and hugely influential, IODP Science Plan for 2013–2023. Another global workshop was the Chikyu+10 workshop in 2013, designed to help plan IODP scientific ocean drilling over the next decade using the unique deep-drilling riser capacity of the *Chikyu*. Implementation of the workshop's plans has been hampered by funding limitations.

The next level of IODP workshops is those covering a large region, bringing together a varied group of scientists interested both in that region and in developing proposals for future IODP drilling. Such workshops were the Indian Ocean IODP Workshop in 2011 and the Southwest Pacific IODP

Workshop in 2012. Both generated a great deal of interest and helped lead to numerous successful IODP proposals, which were drilled from 2014 to 2016 and will be drilled in 2017 and 2018.

Finally, there are more detailed planning workshops dealing with a particular topic or even with a single proposal, but none are discussed below.

INVEST meeting, Bremen, September 2009

In September 2009, a very large (584 participants) scientific meeting was held in Bremen, Germany, to begin designing the next 10-year phase of IODP to start in late 2013. Several Australians played key roles at this meeting and afterwards. Australians attending were Brian Kennett, Richard Arculus, Stephen Gallagher, Jody Webster, Chris Yeats, Helen McGregor and Elizabeth Abbey. The INVEST meeting report is available from usoceandiscovery.org/past-workshops-old/iodp-new-ventures-in-exploring-scientific-targets-invest.

Preceding the meeting, the Science Committee of ANZIC had produced a white paper entitled *IODP INVEST: Beyond 2013, Australasian White Paper*, authored by Stephen Gallagher of the University of Melbourne and others (usoceandiscovery.org/wp-content/uploads/2016/05/INVEST_Report.pdf). Its initial statement was the following:

In order for international collaborative ocean drilling to continue as a major research effort post-2013, it is necessary for the scientific community to demonstrate the societal relevance and impact of their work on a global scale. Increasingly, national earth science funding around the globe is focusing on research that directly influences society, most notably in the areas of climate change and hazard mitigation. Australia and New Zealand are unique among the members of IODP in that they are the only countries in the Southern Hemisphere. They direct scientific access to, and have direct national interest in, a vast region that extends from the Equator to Antarctica. This region incorporates the climatologically vital Southern Ocean and the active tectonic margins of the Southwest Pacific and Indian Oceans, major global sources of tsunami activity. Furthermore, the Australian and New Zealand earth science community includes world leaders in their fields who possess unique knowledge and expertise critical to any global scientific investigation. Bearing this in mind, we believe that our two countries can make a major contribution to the INVEST planning process and the ocean drilling research effort moving forward.

An ANZIC report on the meeting was written by Stephen Gallagher, Chris Yeats, Chris Hollis, Jody Webster and Helen McGregor, but was never published. In summary they wrote:

Over 570 scientists from around the world attended a series of workshops hosted by MARUM at Bremen, 23–25 September 2009. The organising committee allocated each delegate to 2 to 3 working group (WG) sessions over 3 days, which were facilitated by a WG leader and scribe. Outcomes of each workshop were communicated to all delegates in several joint sessions and as a series of reports to the organising committee. It is clear that there are many unanswered questions that need to be addressed by the IODP beyond 2013. However, it will be an onerous task to distil all the contributions into a science plan that is sufficiently different from the Initial Science Plan to convince the various funding bodies to continue to fund IODP beyond 2013.

Helen McGregor made some general observations:

As outlined below numerous exciting hypotheses were put forward under each theme for the IODP post-2013 period. Several of the Working Group summaries advocated new, though similar approaches to conducting IODP science, and testing their respective hypotheses.

The common approaches included in her observations were:

Transects. For example, shelf to basin transects would link terrestrial and marine climate variability, and/or evaluate the timing of marine and terrestrial biological response to changing climates. Latitudinal transects were suggested to investigate tropical ocean–atmosphere dynamics, and pole–equator climate and sea-level variability, and to improve spatial coverage across key periods e.g. Palaeocene-Eocene Thermal Maximum (PETM) and Oceanic Anoxic Events (OAEs) (climate and ocean acidification questions). Other suggestions included ridge to passive/active margins transects to understand the evolution of ocean crust through time, and transects across subduction zones.

Recovery. Many groups called for continuous records, which would allow them to better test their hypotheses. One example was improved recovery through past warm periods. Higher recovery also would help to better investigate subduction zones and volcanic arcs processes.

High-resolution. Obviously the drill core resolution required is dependent on the question being asked but higher-resolution records were requested for studying past variability in interannual climate modes such as ENSO, shoreline dynamics in response to sea-level changes, higher resolution ‘windows’ across periods such as the PETM, and the evolution of sea-floor

biota. Higher-resolution records were also requested for investigating past ecosystem responses to critical events in Earth's history, and the behaviour of the geodynamo.

Observatories. The use of real-time observatories was proposed to better constrain biogeochemical cycles. In situ measurement and monitoring of seismic activity were proposed to understand the triggers of earthquakes, submarine landslides and tsunamis. Better linkage of ocean climate records with instrumental data was also proposed.

Data–model comparisons. This was clearly advocated within the Climate Change theme. Input from the modelling community would improve understanding of volcanic geohazards and ocean acidification.

Richard Arculus of The Australian National University (ANU) was a member of the post-INVEST New Science Plan Writing Committee consisting of 14 scientists, as was New Zealander Peter Barrett of Victoria University, Wellington, showing the scientific regard in which ANZIC is held, with no other Associate Member country represented on this committee. The workshop and the writing committee were the genesis of the exciting IODP Science Plan for 2013–2023, *Illuminating Earth's Past, Present, and Future*, available from www.iodp.org/about-iodp/iodp-science-plan-2013-2023.

Chikyu+10 Workshop, Tokyo, April 2013

A three-day Chikyu+10 Workshop was held in Tokyo to help plan IODP scientific ocean drilling over the next decade using the unique deep-drilling riser capacity of the *Chikyu*. It was chaired by Mike Coffin from the University of Tasmania and 397 participants attended from 21 countries, including 15 Australians and New Zealanders, who were largely funded by ANZIC. The workshop had five themes that reflected IODP's new Science Plan: dynamic fault behaviour, continent formation, deep life, ocean crust and Earth's mantle, and sediment secrets. Full workshop proceedings are available from www.jamstec.go.jp/chikyu+10/docs/C+10_report_textbody.pdf.

It was apparent that *Chikyu's* riser capacity would be fully utilised until 2017 in completing the earthquake-related Nankai Trough subduction zone NanTroSEIZE program, with the plan being to drill 5,000 m below the sea floor. At that time, the choices for a succeeding IODP deep-drilling program, with a broader geographical spread, included drilling:

- the CRISP subduction zone program off Central America
- the Izu-Bonin Arc south of Japan
- the Hikurangi margin subduction zone east of New Zealand (IODP Proposal 781B)
- a Mohole program to reach the Earth's mantle, perhaps off Hawaii.

Much detailed work is going into these potential programs. *Chikyu* is also seeking commercial work, and would consider doing IODP non-riser drilling if this made logistical sense.

More recently, IODP Full Proposal 871(CPP) has been submitted, entitled 'First deep stratigraphic record for the Cretaceous eastern Gondwana margin: Tectonics, palaeoclimate and deep life on the Lord Howe Rise high-latitude continental ribbon'. It would use *Chikyu* under a joint agreement between Geoscience Australia and JAMSTEC. The main aim of the expedition would be to better understand the geological history of this part of the former Australian margin, but the cores would also be critical to understanding its petroleum potential. Things have progressed to the extent that drilling might occur this decade.

Indian Ocean IODP Workshop in Goa, India, October 2011

This workshop was initiated and planned by ANZIC and IODP-India, on the understanding that *JOIDES Resolution* could be encouraged to visit the Indian Ocean in 2014 for the first time in a decade. It was hosted by the National Centre for Antarctic and Ocean Research (NCAOR), with Dhananjai Pandey as coordinator. The workshop aimed to improve existing proposals, build new proposals and familiarise our Indian colleagues with IODP, which India had joined not long beforehand. Neville Exon, Stephen Gallagher, Mike Coffin and Richard Arculus played leading roles, and there were another eight ANZIC participants. This was a very high profile event in India, and about 40 foreigners and 70 Indian scientists attended the workshop.



Figure 9.1. Dignitaries at the opening ceremony, with Dhananjai Pandey (co-convenor from NCAOR) at the lectern and Neville Exon (co-convenor from ANZIC) beside him

Source: Indian National Centre for Antarctic and Ocean Research



Figure 9.2. Participants in the Goa workshop

Source: Indian National Centre for Antarctic and Ocean Research

The workshop themes were:

- **Cenozoic oceanography, climate change, gateways and reef development.** This covered both very broad questions related to the Indian Ocean, and narrower ones such as the causes and effects of the Indonesian Throughflow Current, sea-level rise and fall, and the origin of late Pleistocene reefs.
- **The history of the monsoons.** This covered tectonics, uplift, weathering and erosion, sediment deposition, and climate and oceanography, and dealt with all Indian Ocean areas affected by monsoons.
- **Tectonics and volcanism.** There are many questions related to the tectonism of the Indian Ocean, such as plate tectonics, the evolution of the oceanic crust including mid-ocean ridge formation and the formation of large igneous provinces, continental rifting and related deposition, subduction, and arc volcanism and earthquakes.
- **The deep biosphere.** Pioneering studies of the extremophiles of the deep biosphere in sediments and basalts have largely been concentrated in the Atlantic and Pacific Oceans. Given the different nature of the oceanography and inputs of organic matter into the Indian Ocean, the deep biota could be rather different there.

Many papers were presented and a full summary of the workshop, entitled ‘Detailed Report on International Workshop on Scientific Drilling in the Indian Ocean, Goa, India, October 17–18, 2011’, is available from usoceandiscovery.org/wp-content/uploads/2016/05/Workshop_Report_India.pdf. There was much discussion of existing and future proposals, and ANZIC involvement in a variety of proposals was expected. The aim was to have proposals submitted for the 2012 meetings of the IODP Proposal Evaluation Panel, with the hope that they would be drilled by *JOIDES Resolution* in 2014, or later by alternative platforms. The existing Northwest Shelf sea level proposal, in the Dampier Basin, was discussed and was to be simplified to cover the last 5 million years, including a strong component dealing with the Indonesian Throughflow Current. Other proposals already in the mix in our region included drilling on the Naturaliste Plateau (Cretaceous black shales), Kerguelen Plateau (Cretaceous Large Igneous Province) and Great Australian Bight (biogenic gas-rich Quaternary sediments). The pirate threat in the Arabian Sea meant that there was a shortage of feasible highly ranked proposals in the Indian Ocean, so there was a great need for excellent new proposals outside the Arabian Sea.

This workshop was an important step toward more IODP drilling in the Indian Ocean, and increasing international cooperation for that and other geoscientific purposes. It has borne fruit with the first ocean drilling in the Indian Ocean for many years. Remarkably, eight Indian Ocean IODP expeditions were later approved for 2015 and 2016 and drilled (see Chapter 10, Figure 10.1).

The workshop has been covered in a short *Eos* article (Vol. 93, No. 7, 14 February 2012), in the full report cited above, and was later in a report in *Scientific Drilling* No. 14 (September 2012, pp. 60–67; usoceandiscovery.org/wp-content/uploads/2016/05/Workshop_India_SD_Report.pdf).

Southwest Pacific IODP Workshop in Sydney, October 2012



Figure 9.3. Co-convenor Stephen Gallagher addressing the workshop
Source: Neville Exon

With a diverse group of 80 scientists from around the world, this workshop was held at the University of Sydney, in order to review the latest research in the region, briefly outline possible future IODP expeditions and set

up working groups to develop compelling new drilling proposals in the global science context. As the *JOIDES Resolution* was expected to be in the region fairly soon, the workshop participants agreed on the urgent need to build strong science proposals. The workshop was hosted by ANZIC and the University of Sydney, with additional funding from IODP-Management International, the US Science Support Program and Japan Drilling Earth Science Consortium. It covered all fields of geoscience, and drilling targets that extended from the Equator to Antarctica. The four science themes of the new IODP Science Plan were addressed. An additional resource-oriented theme considered possible co-investment opportunities involving IODP vessels.

Various new full and add-on proposals were identified, with the aim of submitting most by the proposal deadline in April 2013:

- **Climate and Ocean Change:** marine Palaeogene proposals, namely Lord Howe Rise and Campbell Plateau, and a Wilkes Land continental shelf Neogene proposal.
- **Deep Biosphere:** biosphere in organic-rich Gulf of Papua sediments, and several ancillary proposals.
- **Earth Connections:** formation of the Greater Ontong Java large igneous province, initiation of subduction and origin of sedimentary basins in the Lord Howe Rise region, and structure and dynamics of mantle flow in the northern Australian-Antarctic Discordance.
- **Earth in Motion:** the active Brothers Volcano system in the Kermadec Arc, active volcanic systems in the Manus Basin, the nature of the Tuaheni Landslides off northeast New Zealand, and near-trench-axis comparative drilling around the Pacific Ocean.
- **Marine Resources:** the nature and resource potential of gas hydrates off northeast New Zealand, and deep stratigraphic drilling on the Lord Howe Rise related to both petroleum potential and research.

Many of the proposals were broad and multidisciplinary in nature, hence optimising the scientific knowledge that can be produced by the use of IODP infrastructure. This was particularly the case for the proposals related to active volcanic systems in the Brothers Volcano and Manus Basin; the Cretaceous-Palaeocene palaeoenvironment, tectonic history, and petroleum potential of the Lord Howe Rise region; and slow-slip subduction, fluid flow, landslides and gas hydrate potential of the Hikurangi subduction margin.

Many drilling ideas were put forward for consideration, many of them were later submitted as proposals, and most of the proposals are now approved (see Chapter 10, Figure 10.1). Several lead proponents, who are now co-chief scientists, have remarked that without the workshop they never would have written proposals.

The workshop results were published in detail on the IODP website in early 2013 (usoceandiscovery.org/wp-content/uploads/2016/05/Workshop_SWPacific_Report.pdf), and later in *Scientific Drilling* No. 17 (April 2014, pp. 45–50).

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