Australian and New Zealand IODP Consortium

Annual Report 2015

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Compilation by Neville Exon and design by Catherine Beasley

Cover photo: *JOIDES Resolution* at sea. Photo courtesy of John Beck, IODP/TAMU

Back Cover: *JOIDES Resolution* IODP Expeditions in 2015; ECORD Expedition 357 was in the North Atlantic

Australian and New Zealand IODP Consortium

Chairman's Overview

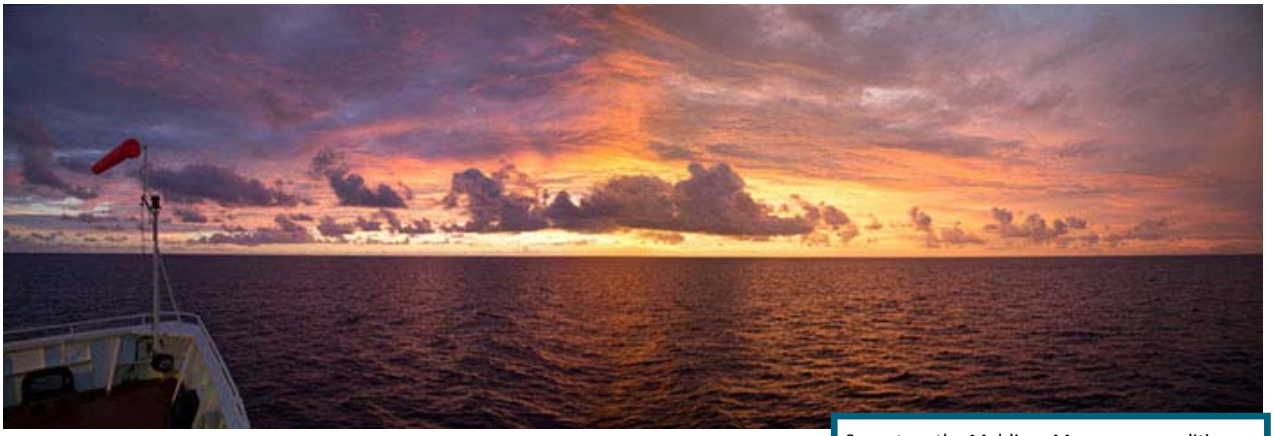
This Annual Report marks the second year of the new ten-year phase of IODP, the International Ocean Discovery Program. Scientific ocean drilling is now in its fifty-first year, and this year has been another outstanding one, with seven ANZIC scientists going to sea. It was also the year when Australia's future in IODP was assured by a five-year grant from the Australian Research Council (ARC). This grant underpins our participation in this program – a great sign that the science community fully understands the benefit of ocean drilling to Australian science. We are very grateful to the Federal Government for its generous ongoing financial assistance through ARC/LIEF.

Ocean science addresses globally significant problems. Two-thirds of our world is covered by oceans, with some 60% of Australia's and 95% of New Zealand's territory offshore. As the world's largest geoscience research program (and with ocean drilling the best method of direct sampling below the ocean floor) the IODP is a broad and vital collaborative effort, continually developing insights into how the Earth has worked, how it is working now, and how it may work in the future. These insights can be of great societal relevance.

Collaboration is central to most science and to its effective application, and few of the world's scientists work for us. With 26 member countries in 2015, involving nearly all the major scientific countries on Earth, we have direct access to, and active engagement with, the world's best scientific minds. Our scientific contribution since IODP began in 2003 has been substantial, with the involvement of Australians in 10.2% and New Zealanders in 2.2% of all publications – all for about a 1% contribution to its overall $US180 million annual international operational budget.

Australia and New Zealand, through the ANZIC consortium, are important players in this exciting project, with the eager participation of many scientists. We estimate that at this moment at least 100 Australians and 25 New Zealanders are working on ocean drilling science, and our scientists' voices are respected internationally. I have very much enjoyed seeing our 21 ANZIC member universities and research organisations working so well, together and with their international counterparts.

Membership of IODP is critical in helping us maintain our leadership in Southern Hemisphere marine research. The Australasian region has seen six IODP expeditions since late 2009, including one in 2015, and there will be more expeditions in the region in 2016, 2017 and 2018. The generosity of our major partners means that we get a wonderful return on our modest investment in the international operating budget, with access to assets worth more than $US1 billion.



Sunset on the Maldives Monsoon expedition
Credit: Tim Fulton, IODP/TAMU

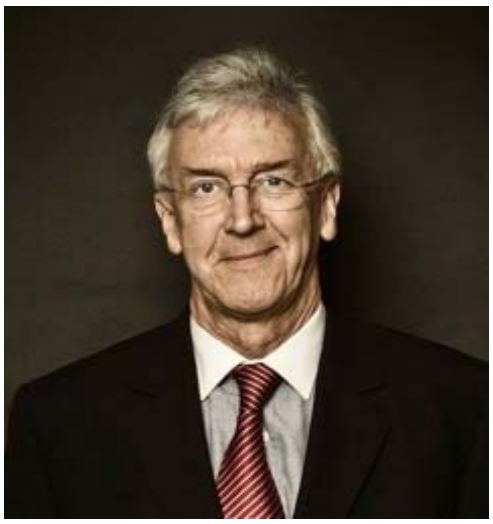
Australian and New Zealand IODP Consortium

Over the next ten years, IODP research will cover, among other things: the nature of the Earth's mantle and crust, and the nature of the related deep forces that drive the Earth's tectonics; past and future climate change; the history of life as revealed in sedimentary strata; the nature of the extraordinary microbes found deep in the sediments and volcanic rocks beneath the sea floor; and major natural hazards such as earthquakes, tsunamis, and submarine landslides. Note that an average two-month IODP expedition recovers thousands of metres of sediments and rocks that provide a wonderful store of highly varied information for subsequent investigation.

Over this past year IODP results have continued to advance our understanding of the history of Great Barrier Reef in the last 20,000 years, as global temperatures and sea levels rose. Stephen Gallagher of the University or Melbourne has been the intellectual driver in designing a *JOIDES Resolution* expedition to study the climatic and ocean history of north-western Australia this year, and was Co-Chief Scientist of the expedition.

Outreach activities remain central to our mission, and in the last year these included funding twenty bright young university undergraduate students, who will attend a Marine Geoscience Masterclass in Perth in February 2016, with the aim of inspiring the next generation of scientists to work in this exciting research field. The port calls of *JOIDES Resolution* to Fremantle and Perth were a great opportunity to sell the IODP program to scientists, students and politicians. In particular, the visit to the ship of the Assistant Minister for Science, Karen Andrews, helped demonstrate to her that Government funds are well spent on this program.

Finally, it has again been a great pleasure to work with a Council membership of talented and enthusiastic scientists of international calibre. Strong leadership has been provided by the Program Office team of Neville Exon and Catherine Beasley.



Dr Geoff Garrett AO,
Chairman of the ANZIC Governing Council and
Chief Scientist of Queensland

Program Scientist's Summary

Ocean Drilling in General

Ocean drilling addresses scientific problems of global interest. Its broad aim is to explore how the Earth has worked in the past, how it is working now, and how it may work in the future – a big task! It takes continuous cores of sediments and rocks from all the world's oceans, at times reaching several kilometres below the sea bed. Two large coring vessels, *JOIDES Resolution* and *Chikyu*, and mission specific alternative platforms, 'ground truth' scientific theories that have been based largely on remote sensing techniques.

The International Ocean Discovery Program is the successor to earlier ocean drilling programs – the Deep Sea Drilling Project (DSDP), the Ocean Drilling Program (ODP), and the Integrated Ocean Drilling Program (IODP). This, the new phase of IODP, has similar general aims but some changes in detail.

The many ocean drilling expeditions conducted in our region since 1968 have provided new scientific knowledge of global significance. Hundreds of scientists participate each year, tackling 'big science' questions in fields ranging from climate change to the deep biosphere and to plate tectonics. Every expedition in our region brings not only high-technology drilling vessels, but also about 30 outstanding scientists to work with our participants on issues of great scientific interest to them and us.

Alireza Rastegar, sedimentologist of Curtin University, prepares a sediment sample for X-ray diffraction analysis. Credit: Bill Crawford, IODP JRSO .

Australia and New Zealand Consortium

Australia and New Zealand are members of IODP, in their own *Australian and New Zealand IODP Consortium (ANZIC)*. Our IODP scientists work with research teams from around the world, and post-cruise research cooperation often extends far beyond IODP. Our geoscientists and microbiologists are making important scientific contributions, and coring expeditions in our region and elsewhere have improved and will keep on improving our understanding of global scientific questions.

Membership of IODP helps us maintain our edge in marine research, and our region's geography, climate, oceanography and plate tectonics make its study vital in addressing various global science problems. The Australasian region has seen a great deal of ocean drilling since 1968, including seven IODP expeditions from 2009 to 2015; more will occur in the region from 2016 to 2018.

In 2015, the ANZIC consortium consisted of 17 universities, 4 government agencies, and one marine geoscience peak body. Australia is the major ANZIC financial contributor but benefits are shared between our two countries. ANZIC funding of about $A3 million for 2015 came from: an ARC/LIEF grant of $A1.8 million; contributions from 18 Australian partners of $A855,000; and from contributions from four New Zealand partners of $A320,000. Expenditure of $US1.8 million p.a. gives us automatic access to an average of four annual shipboard places on *JOIDES Resolution*, one on *Chikyu* and one on an alternative platform, plus a variety of other benefits.

In 2015, Australia and New Zealand paid an annual membership fee of $US1.5 million to the US National Science Foundation for membership of the US/ European consortium. Our membership of the Japanese consortium was in abeyance this year as *Chikyu* was not active in IODP science. We very much hope that *Chikyu* will have enough future funding to return to its very valuable IODP activities.

Australian and New Zealand scientists are prolific authors of scientific ocean drilling publications. In total (Table 5), nearly 32,000 peer-reviewed ocean drilling publications have appeared since 1968. Australians were involved in 3247 refereed publications (10.2%) and New Zealanders in 689 (2.2%). Of the total, 523 publications were in the leading science journals *Nature*, *Science* and *Proceedings of the National Academy of Sciences* with Australians involved in 31 of these and New Zealanders in 11 (Table 6).

Our scientists gain by shipboard and post-cruise participation, by building partnerships with overseas scientists, by being research proponents and co-chief scientists who can steer programs and their scientific emphasis, and by early access to key samples and data. Post-doctoral and doctoral students have opportunities to train in areas of geoscience and microbiology that could not be studied in any other way. For logistical reasons the 2015 Marine Geoscience Masterclass for outstanding undergraduate students from all our university partners was deferred but successfully held in Perth in February 2016.

ANZIC's Governing Council has set aside money from the scientific members to support post-cruise research by shipboard participants. In 2015, six grants of $A20,000 were made and three of $10,000, to encourage Australian scientists to work on interesting problems that can be addressed by studying legacy material (DSDP-ODP-IODP) and hence increase output from our overall investments in ocean drilling. Work is proceeding under both this and the two previous years' grants, and research papers will start to be published soon.

Scientific Activities

ANZIC has active members on all key IODP committees. In 2015, eight Australians took part in all *JOIDES Resolution* expeditions (Table 4). The five *JOIDES Resolution* expeditions (see Map 2 below) were:

- Expedition 354, *Bengal Fan*
- Expedition 355, *Arabian Sea*
- Expedition 356, *Indonesian Throughflow*
- Expedition 359, *Maldives Monsoon*
- Expedition 360, *Indian Ridge Moho*

The alternative platform expedition was:

- Expedition 357, *Atlantis Massif Serpentinization and Life*

IODP Platforms

JOIDES Resolution funded by NSF, USA

Chikyu, funded by JAMSTEC, Japan

Mission specific platforms
RRS James Cook, alternative platform in 2015 funded by ECORD
Courtesy of National Oceanographic Centre, Southampton

The Future of IODP

A new ten-year phase of ocean drilling, under the name *International Ocean Discovery Program*, commenced in late 2013, and funding is agreed for the *JOIDES Resolution* and the European alternative platforms for five years. Long-term funding for the Japanese vessel *Chikyu* is still under negotiation. Australia is funded through until the end of 2020.

The themes of the new Science Plan – ***Illuminating Earth's Past, Present and Future*** - are:

- Climate and Ocean Change: Reading the Past, Informing the Future
- Biosphere Frontiers: Deep Life and Environmental Forcing of Evolution
- Earth Connections: Deep Processes and their Impact on Earth's Surface Environment

Earth in Motion: Processes and Hazards on Human Time Scales

In 2016 there will be two *JOIDES Resolution* expeditions in our region, and both will be of high scientific and societal interest: the Sumatra Seismogenic Zone Expedition 362, and the Western Pacific Warm Pool Expedition 363.

Acknowledgements

All our partners are thanked for their wholehearted support and advice, with special thanks to the members of the ANZIC Governing Council and Science Committee. Our strength is in our breadth of support in the geoscience community. Geoff Garrett is an imaginative and dynamic Chairman of Governing Council, and New Zealander Rob McKay has been a very active and innovative Chairman of the Science Committee. Special thanks are due to Catherine Beasley for her excellent administrative work and friendship, to Stuart Henrys as my very responsive New Zealand counterpart, and to Michelle Burgess for skilfully editing this Summary and the Chairman's Overview.

We are very grateful to the Australian Research Council for their ongoing financial support, and to all our Australian and New Zealand partners for their vital financial and scientific input. Our successful bid for long-term ARC/LIEF funding was written and funded this year, the positive result surely being due to the widespread realisation of the value of IODP globally and regionally, and of our significant role in it.

Professor Neville Exon,
Program Scientist

Australian and New Zealand IODP Consortium

General Report for 2015

ANZIC IODP Organisation

The organizational involvement of Australians and New Zealanders in IODP falls into a number of categories: IODP panels, ANZIC committees, conferences and workshops.

Australian and New Zealand partners in IODP in 2015

Australian IODP partners:

- Australian National University
- CSIRO Earth Science and Resource Engineering
- Curtin University of Technology
- Geoscience Australia
- James Cook University
- Macquarie University
- Monash University
- MARGO (Marine Geoscience Office) which is the marine geoscience peak body
- Queensland University of Technology
- University of Adelaide
- University of Melbourne
- University of New England
- University of Queensland
- University of Sydney
- University of Tasmania
- University of Technology Sydney
- University of Western Australia
- University of Wollongong

Helen McGregor, Sedimentologist from the University of Wollongong, examines a thin section of carbonate under the microscope. Credit: Bill Crawford, IODP JRSO

New Zealand IODP partners:

- GNS Science
- University of Otago
- Victoria University of Wellington
- NIWA

ANZIC members of IODP committees

ANZIC has participation rights on most IODP Scientific Advisory Structure panels, with ANZIC representatives listed in Table 1.

Table 1: ANZIC Members of IODP Committees in 2015

Committee or Panel	Member	Organisation
***JOIDES Resolution* Facility Board**	Mike Coffin;	University of Tasmania
	alternate Gary Wilson	University of Otago
***Chikyu* IODP Committee**	Andrew Heap;	Geoscience Australia
	alternate Greg Yaxley	ANU
***ECORD* Facility Board**	Leanne Armand;	Macquarie University
	alternate Craig Sloss	Queensland University of Technology
	Special scientific adviser Stephen Gallagher	University of Melbourne
Science Evaluation Panel	Timothy Naish;	Victoria University Wellington
	alternate Zanna Chase	University of Tasmania
	Ben Clennell;	CSIRO
	alternate Andrew Gorman	University of Otago
	Special scientific adviser Andrew Roberts	ANU
Environmental Protection and Safety Panel	David Campin;	Queensland Government
	alternate Suzanne Hurter	University of Queensland
IODP Forum	Neville Exon	ANZIC Office, ANU

ANZIC Governing Council

The Governing Council is a steering committee for the Australia-NZ IODP Consortium, and looks after broad policy. Its 2015 membership is listed in Table 2, opposite. Professor Ian Jackson had been the ANU representative, responsible for ANZIC finances, for several years. When he stood down from the Directorship of the Research School of Earth Sciences during the year, he was replaced on Council by the new Director, Professor Stephen Eggins.

In February, Professor Gary Wilson hosted a two-day Governing Council meeting at the University of Otago in Dunedin. In November, Associate Professor Kelsie Dadd hosted a meeting at Macquarie University in Sydney. Two intervening meetings were convened by telephone, and other business was carried out by email.

Table 2: Members of the ANZIC Governing Council in 2015

Person	Position	Institutions	Expertise
Geoff Garrett	Chairman	Queensland Chief Scientist	Metallurgy and science management
Richard Arculus	Lead scientist of ARC/LIEF grant	ANU, Canberra	Igneous petrology, volcanology. ODP shipboard participant. IODP co-chief scientist
Ben Clennell	CSIRO representative	CSIRO Petroleum Exploration and Production	Petroleum geologist. ODP shipboard participant. SEP panel member
Kelsie Dadd	Australian university representative	Macquarie University, Sydney	Physical volcanology
Neville Exon	ANZIC Program Scientist	ANU, Canberra	Marine geology and geophysics. ODP co-chief scientist
Andrew Heap	GA representative	Geoscience Australia, Canberra	Marine geology and sea bed mapping
Stuart Henrys	Chair, NZ IODP	GNS Science, Wellington, NZ	Marine geophysics
Stephen Eggins	ANU representative*	ANU, Canberra	Geochemistry
Robert McKay	ANZIC Science Committee Chair	Victoria University Wellington	Sedimentology, Antarctic glacial history
Jody Webster	Australian university representative	University of Sydney	Carbonate sedimentologist
Kevin Welsh	Australian university representative	University of Queensland	Carbonate sedimentologist, paleoclimate
Gary Wilson	NZ university representative	University of Otago, Dunedin	Paleomagnetism
Clive Baldock	ARC observer	Australian Research Council, Canberra	Medical physics
Chris Yeats	Independent expert adviser	NSW Geological Survey Executive Director	Hydrothermal systems. ODP and IODP shipboard experience

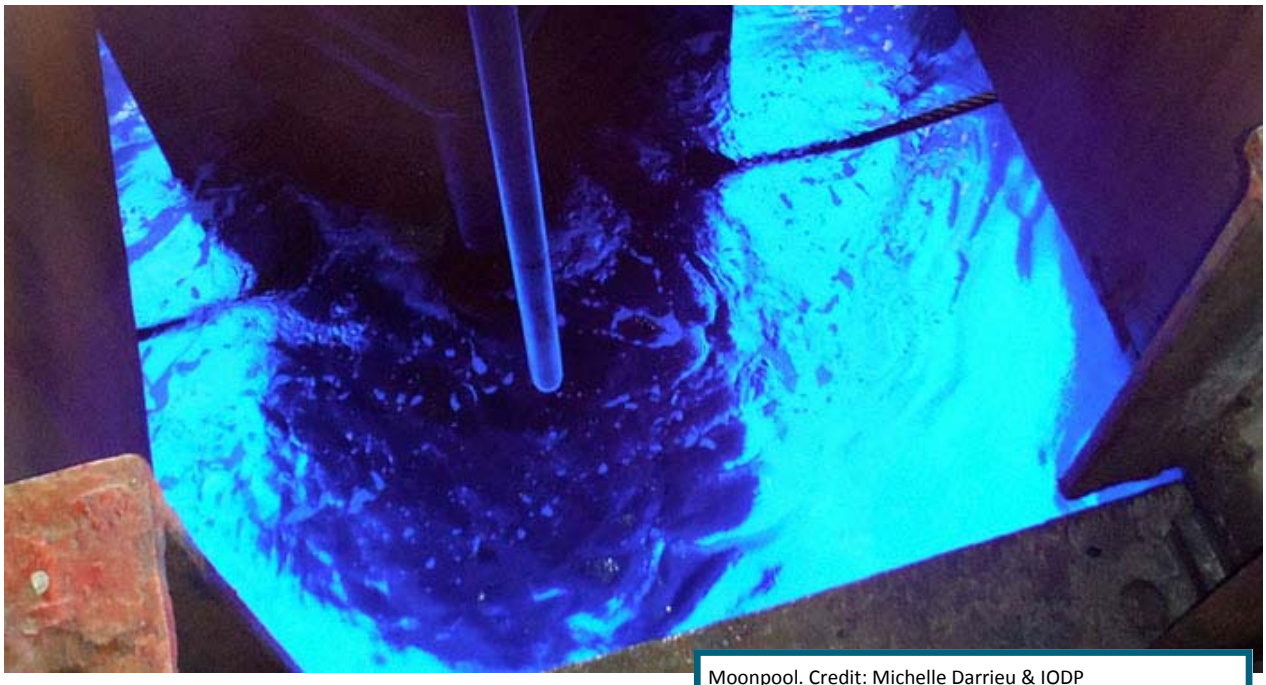
*Stephen Eggins replaced Ian Jackson as the Director of RSES, ANU, and on the ANZIC Governing Council during 2015.

ANZIC Science Committee

The Science Committee encourages and assists the development of science proposals, organizes topical workshops, assesses cruise applicants, applicants for IODP panel membership, and applications for special analytical funding, and helps get quality speakers to visit Australian and New Zealand research centres. A subcommittee considers applications for post-cruise analytical funding for science party members (shipboard and sampling parties). The committee's revised membership in 2015 is listed in Table 3 (opposite).

All business was conducted by email or telephone. Most of that business was related to assessing applicants for places on forthcoming expeditions. Those deemed suitable were ranked, and their details and our ranking were sent on to the relevant expeditionary planners. In general, our top-ranked applicant was scheduled for each expedition.

Governing Council authorised grants for work on material and data from ocean drilling material, which were made from the funds provided by our partners, but excluding ARC/LIEF funds. A small sub-committee dealt with requests for general post-cruise scientific funding (maximum grant of $A40,000 per person). Two shipboard participants were awarded a total of $A80,000. The full committee ranked applications in a special call to Australian scientists for post-cruise analytical funding to cover legacy ocean drilling material. Seventeen scientific groups applied. $A20,000 was awarded to seven of the applying groups and $10,000 to three groups, amounting to $A150,000 in all.



Moonpool. Credit: Michelle Darrieu & IODP

Table 3: Members of ANZIC Science Committee in 2015

People	Institutions	Expertise
Robert McKay, Chairman	Victoria University, Wellington	Sedimentology
Leanne Armand	Macquarie University	Diatoms, Southern Ocean geoscience
Alan Baxter	University of New England	Sedimentology, tectonics, micropaleontology
Irina Borissova	Geoscience Australia	Marine geophysics and basin studies
Ben Clennell	CSIRO	Petroleum geology
Mike Coffin	University of Tasmania	Marine geophysics, large igneous provinces
Chris Elders	Curtin University	Continental margins, seismic interpretation, petroleum geology
Neville Exon	Australian National University	Marine geology and geophysics
Trevor Falloon	University of Tasmania	Igneous petrology, neotectonics
Anna Kaksonen	CSIRO	Microbiology
John Moreau	University of Melbourne	Microbiology
Joanna Parr	CSIRO	Seafloor ore deposits
Wouter Schellart	Monash University	Plate kinematics
Virginia Toy	University of Otago	Structural geology
Jody Webster	University of Sydney	Carbonate sedimentology
Greg Yaxley	Australian National University	Igneous petrology

ANZIC IODP Science

Participants in IODP Expeditions in 2015

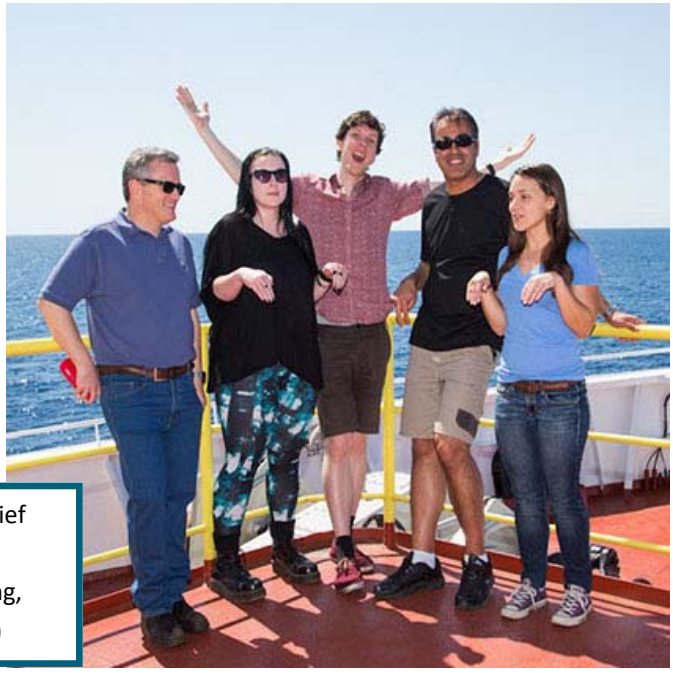
ANZIC is entitled to put up to six scientists aboard IODP expeditions each year, and the bulk of these positions are on the US drilling vessel *JOIDES Resolution*. Forty-three Australians and nine New Zealanders have been members of a science party between 2008 and 2015. In 2015, eight Australians took part as members on all the *JOIDES Resolution* expeditions that took place (rather than the six we were formally entitled to). Four of our participants took part in the Indonesian Throughflow Expedition 356 on the northwest margin of Australia. Stephen Gallagher of the University of Melbourne had been a driver in designing the expedition and was a Co-Chief scientist. There was also the alternative platform Expedition 357 late in the year but the shipboard party was small. Our participant joined the description and sampling party early in 2016. For interest, all *JOIDES Resolution* expeditions of the first phase ofIODP are shown in Map 1 (opposite)

The five *JOIDES Resolution* expeditions (see Map 2 p.15) were:

- Expedition 354, *Bengal Fan*: Neogene and late Paleogene record of Himalayan orogeny and climate: a transect across the Middle Bengal Fan
- Expedition 355, *Arabian Sea*: Deep sea drilling in the Arabian Sea: constraining tectonic-monsoon interactions in South Asia
- Expedition 356, *Indonesian Throughflow*: Reefs, Oceans, and Climate: a five million year history of the Indonesian Throughflow Current, Australian monsoon, and subsidence on the northwest shelf of Australia
- Expedition 359, *Maldives Monsoon*: Sea Level, Currents, and Monsoon Evolution in the Indian Ocean
- Expedition 360, *Indian Ridge Moho*: Southwest Indian Ridge Lower Crust and Moho: the nature of the lower crust and Moho at slower spreading ridges

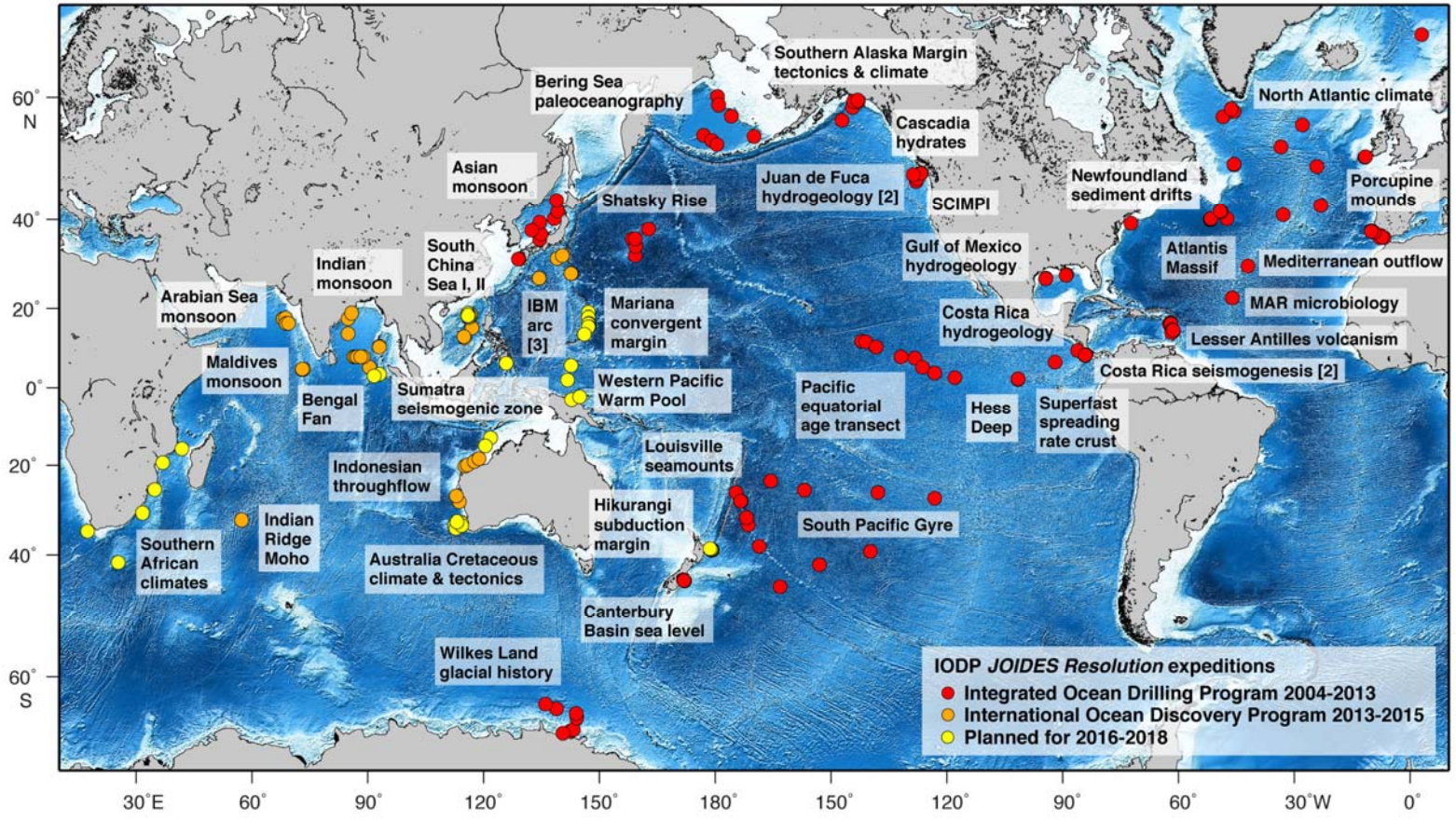
The alternative platform expedition was:

- Expedition 357, *Atlantis Massif Serpentinization and Life*: Microbiological, alteration, and tectono-magmatic processes in young mafic and ultramafic seafloor [land-based science party meeting was held in early 2016]



Exp 356 Australian contingent including (L-R) Co-chief Stephen Gallagher (Melbourne), Dr Briony Mamo (Macquarie alumnus), Education officer Thomas Lang, Alireza Rastegar (Curtin) and Chelsea Korpanty (UQ)

Map 1: All JOIDES Resolution IODP Expeditions from 2004 to 2018

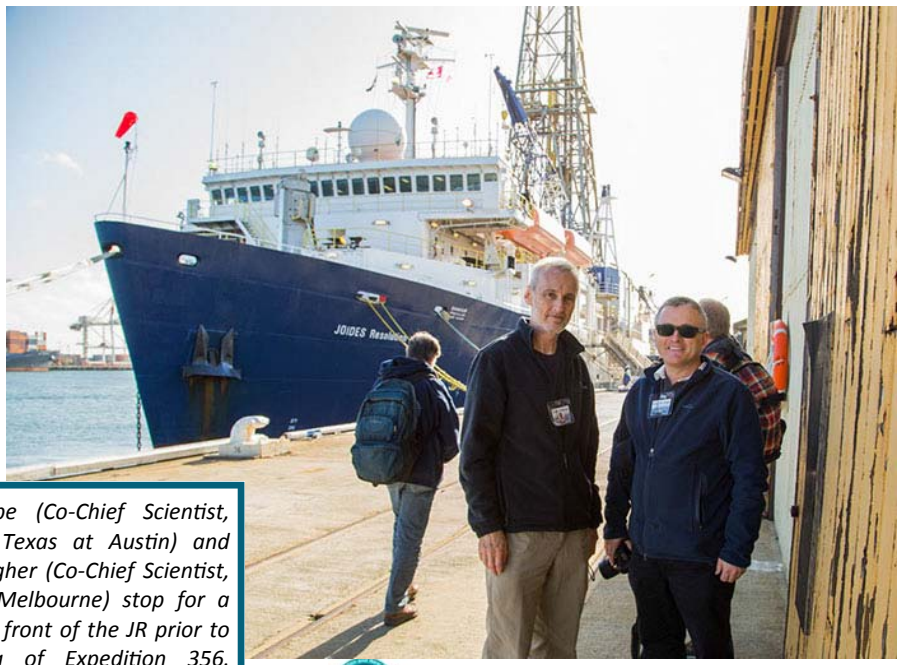


This map (courtesy Katerina Petronotis IODP-USIO) does not show expeditions on alternative platforms or Chikyu expeditions.

Table 4: Participants in IODP Expeditions in 2015

All expeditions, apart from the alternative platform Atlantis Massif Serpentinisation and Life Expedition (357), were on *JOIDES Resolution*. Expedition 357 conducted off-shore operations from October-December 2015. ANZIC's participant, Morgan Williams of ANU, joined the on-shore science party in Bremen in early 2016.

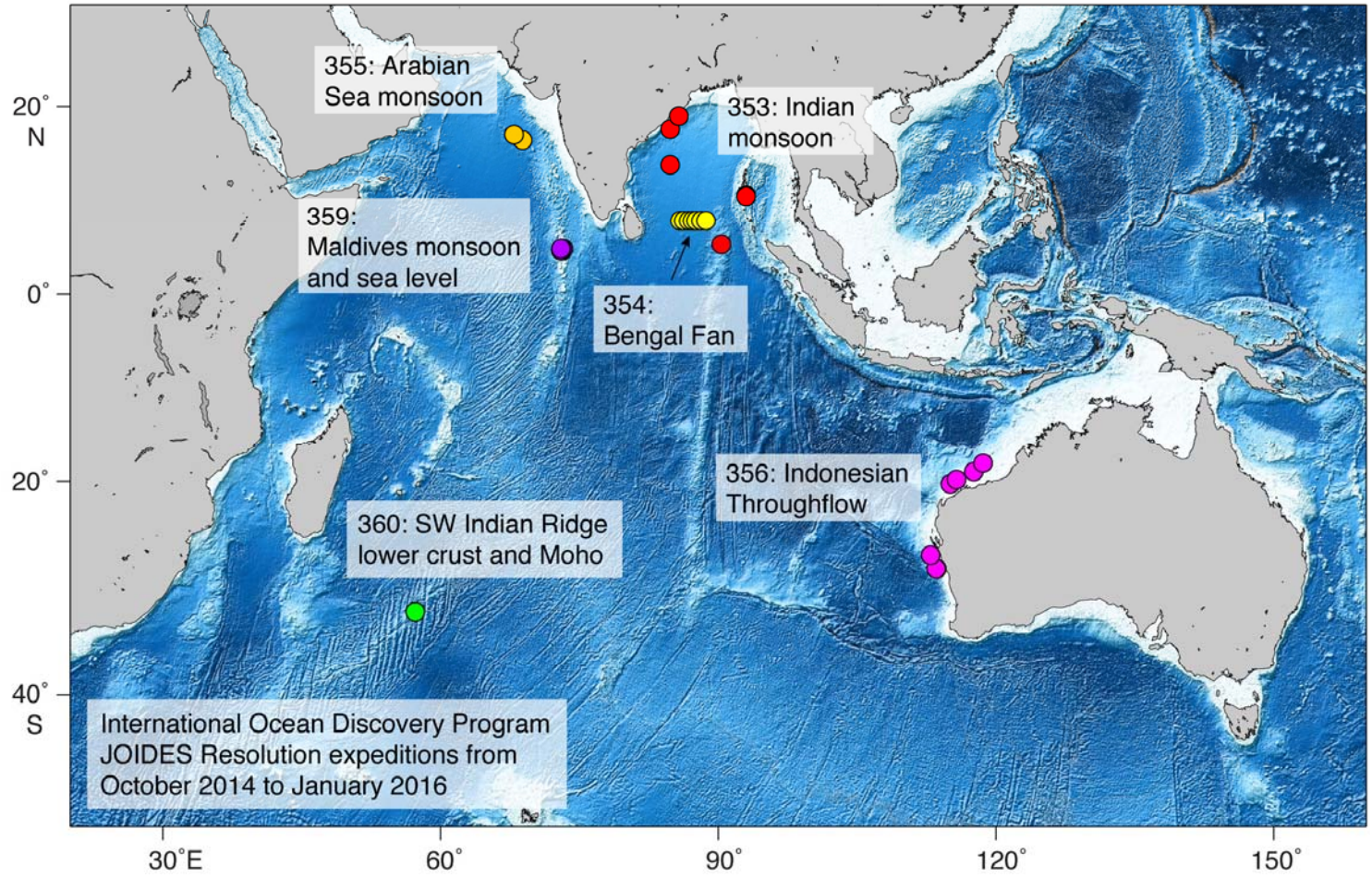
Expedition	Date	Participants
354: Bengal Fan	January 29 – March 31, 2015	Alan Baxter (New England), nannofossils
355: Arabian Sea	March 31 – May 31, 2015	Sophia Bratenkov (Macquarie), organic geochemist
356: Indonesian Throughflow (Fremantle to Darwin)	July 31 – September 30, 2015	Stephen Gallagher (Melbourne), co-chief scientist; Helen McGregor (Wollongong), Alireza Rastegar Lari (Curtin) and Chelsea Korpanty (UQ), all sedimentologists; Thomas Lang (Museum Victoria), education and outreach officer
359: Maldives Monsoon and Indian Peninsula Paleoclimate (from Darwin)	September 30-November 30, 2015	Craig Sloss (QUT), sedimentologist
360: Indian Ridge Moho	November 30, 2015-January 30, 2016	Mark Kendrick (ANU), petrologist



Craig Fulthorpe (Co-Chief Scientist, University of Texas at Austin) and Stephen Gallagher (Co-Chief Scientist, University of Melbourne) stop for a quick photo in front of the JR prior to the beginning of Expedition 356. (Credit: Bill Crawford, IODP JRSO)

Australian and New Zealand IODP Consortium

Map 2: JOIDES Resolution IODP Expeditions in 2015



Note that Expedition 353 started in late 2014, but ran into 2015; it was covered in the 2014 annual report

Personal reports on IODP Expeditions in 2015

Expedition 354: Bengal Fan record of Himalayan orogeny and climate

February and March, 2015

(Alan Baxter, then at the University of New England, Armidale)

The Bengal Fan Expedition 354 began in Singapore on the 30th of January 2015. After a few days portside, getting acquainted with the ship and crew, we began our transit from Singapore through the Malacca Straits and emerged into the northern Indian Ocean four days later.

The main objectives of the expedition were to (1) study the early stages of Himalayan erosion, in order to shed light on the India-Eurasia collision and the development of the Himalaya and Tibet; and (2) study the Neogene development of the Asian monsoon and its impact on sediment supply and flux. To this end, we drilled seven sites across the Bengal Fan on a 320 km long east–west transect at 8°N. The seven sites included:

Alan Baxter in action aboard the JOIDES Resolution

- One deep site to about 1200 meters below seafloor (mbsf) to recover a complete sequence of fan deposits, targeting pre-fan deposits (Site U1451);
- Two sites to about 900 mbsf (Sites U1450 and U1455), complementing Site U1451 to provide a transect of three sites across about 300 km to recover Pliocene and upper Miocene sediment, in order to study Neogene fan evolution and the impact of the monsoonal system on sediment supply and flux; and
- Four dedicated shallow sites to 200–300 mbsf to recover a complete terrigenous record of the Himalayan flux over the last 1–2 My, complemented by the shallow portion of the other three deep-penetration sites.

I was one of three calcareous nannofossil biostratigraphers on board. It was our job, in conjunction with the foraminferal biostratigraphers and palaeomagnetists, to construct an age model for the Bengal Fan. This model then could be used to date important parameters such as sediment accumulation rates and the first appearance of fan sedimentation along this transect line.

The transect approach proved particularly successful in capturing the laterally shifting depocentres across the fan system, and in recovering sections that were washed out or drilled without recovery in adjacent sites. In a remarkable feat that attests to the skill of the drillers on board, we also broke the scientific ocean drilling record for the deepest advanced piston corer (APC) core (687.4 mbsf), providing an unprecedented set of undisturbed cores.

Despite the difficult drilling conditions, the expedition was a great success as we addressed all of the cruise objectives. This was due to the staff, scientists and crew on board who adapted to challenges quickly and worked very well together. It took over 18 years for this proposal to be drilled, but from the work completed onboard, in addition to that planned for post-cruise study, it was well worth the wait.

Expedition 355: The interactions of tectonics and the Arabian Sea monsoon

April and May, 2015

(Sophia Bratenkov, Macquarie University)

The interplay between the development of the Asian summer monsoon and the growth of the mountains in South and Central Asia is perhaps the most compelling example of the relationship between climate and the solid Earth, and this relationship was explored on IODP Expedition 355. This was a co-funded Complementary Project Proposal (CPP) in collaboration with the Indian government. We drilled in the eastern part of the Arabian Sea in the Laxmi Basin about 470 km west of the Indian coast in water depths of 3600 m. The overall purpose of the expedition was to examine the erosion and chemical weathering of the Himalayas during the last 23 million years (Ma). We planned to determine the correlation between uplift of the mountains and the changes in the amplitude of the summer monsoon. We also planned to date the basement of the Arabian Sea, and thus help constrain the timing of the India/Eurasia collision that caused the Himalayan uplift.

We were able to recover more than 2000 m of sediment with the oldest sediment dated to about 18 Ma. We also were very lucky to recover the very first basement rock from the area in the last core!

JOIDES Resolution is a fully equipped, floating coring facility and laboratory. To operate the laboratory we had scientists from all over the world: India, USA, UK, Italy, Germany, France, Brazil, South Korea, China, and Japan, so there was a mix of languages and cultures. I was sailing as an organic geochemist and was the only Australian representative among 30 scientists from various backgrounds and at different stages of their careers. But all of us had something in common – our passion for science.

Our scientific curiosity pushed us to work around the clock. Biostratigraphers and palaeomagnetists were dating the material. Sedimentologists were describing the cores and identifying the provenance of the sediments. Physical properties specialists were describing colour, density, magnetic susceptibility, natural gamma radiation and more. In the geochemical lab we analysed pore water salinity, alkalinity, and tested for the presence of soluble ions. We also did a lot of work in identification of gases such as methane and ethane in the sediments, and measured variations in organic carbon, nitrogen and sulphur.

We worked hard during our shifts and had a lot of fun in between times. Some of us saw 60 different sunrises over the Indian Ocean and some saw 60 different sunsets. We organized a ping pong tournament, watched movies, and did a lot of different sporting activities including yoga. We celebrated the end of each week with a barbeque on deck, played guitar, and spent hours and hours discussing geology and palaeoclimate.

We left the *JOIDES Resolution* as good friends and research collaborators, with wider scientific horizons.

I worked hard as a geochemist but also enjoyed myself.

Sophia Bratenkov on the *JOIDES Resolution*

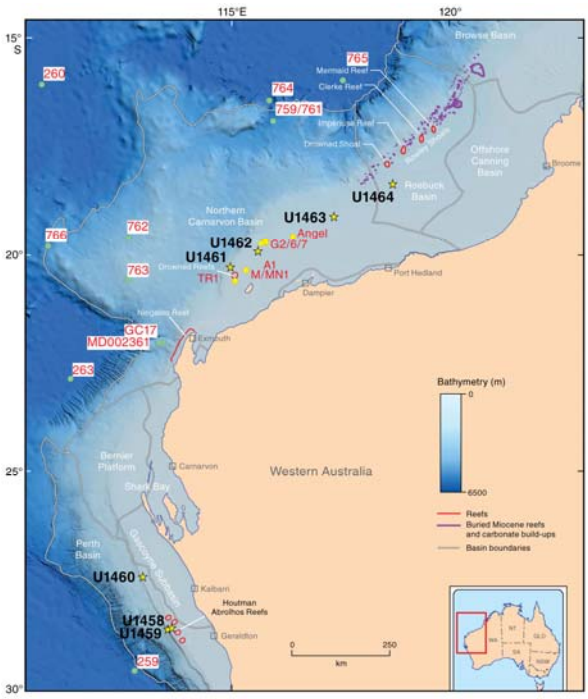
Expedition 356: Indonesian Throughflow

August and September, 2015

(Stephen Gallagher, University of Melbourne)

This expedition cored seven sites off northwest Australia, covering a latitudinal range of 29°S to 18°S, to obtain a 5 million year record of the southerly flowing Indonesian Throughflow current (ITF) and Indo-Pacific Warm Pool climate evolution and subsidence. The coring strategy was designed to reveal a detailed history of ITF variability and its relationship to climate. The seven sites, drilled from south to north in this transect, were U1458 to U1464. I was a co-chief scientist with Craig Fulthorpe (University of Texas at Austin). Three additional ANZIC scientists were on board: Chelsea Korpanty (University of Queensland), Helen McGregor (University of Wollongong) and Alireza Rastegar (Curtin University); and there was also an ANZIC-funded Education and Outreach person, Thomas Lang of Museum Victoria.

It was great to see our ANZIC-supported Proposal 807 (submitted in October 2012) finally drilled, and it was highly satisfactory that we exceeded all our aims, with a few surprises along the way to add interest. Site U1458 proved to be difficult to core with hard layers near the seabed; in the end this site was abandoned for a more seaward Site U1459. U1459 yielded an unanticipated 50 million record of shelfal to upper slope marine sedimentation, albeit with discontinuous core recovery. Nevertheless, this site's excellent archive of Neogene strata, together with that from the adjacent Site U1460 (with a continuously cored Plio-Pleistocene sequence) will provide an unparalleled oceanic, climatic and subsidence record for the northwest margin of Australia.



Map of Expedition 356: Geraldton to Port Hedland

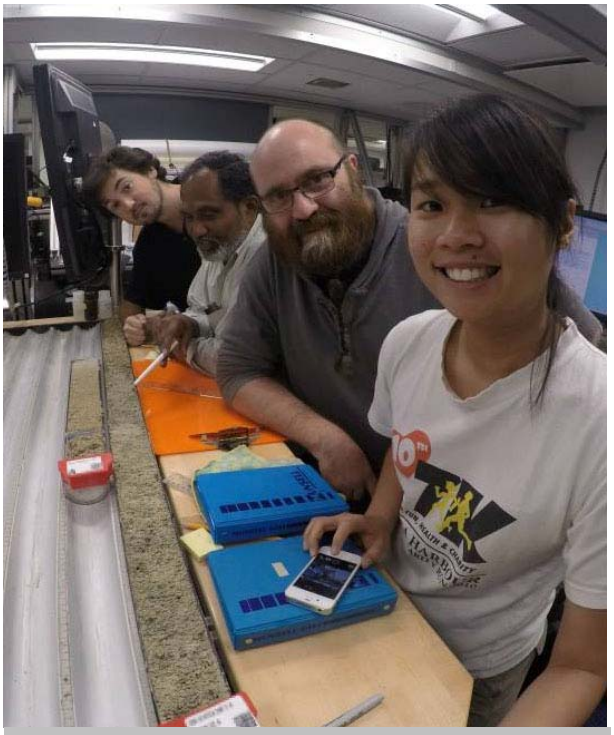
We were able to continuously core 400 m of bathyal to shelfal Plio-Pleistocene strata at Site U1463 and 1000 m at Site U1461. The excellent recovery and well preserved microfossils in these sections suggest they are potentially the best sampled paleoceanographic and climate archives along the western continental margin of Australia. Sites U1462 and U1464 were cored near a series of 'fossil" drowned reefs, enabling us to date the history of their onset. These two sites also yielded an amazing array of different Middle Miocene (unanticipated!) to Recent sediment types, that were deposited in supratidal (sabkha), shallow shelf (oolitic), outer shelf and bathyal environments. This extraordinarily evocative series of strata will allow us to investigate the subsidence and tropical carbonate history of the region in great detail. On behalf of the co-chiefs, staff scientist (Kara Bogus) and Expedition 356 Scientists, I thank ANZIC for its support for workshops to initiate the proposal and its ongoing support for myself and the other ANZIC participants.

Expedition 359: Sea Level, Currents, and Monsoon Evolution from the Maldives, October and November, 2015

(Craig Sloss, Queensland University of Technology)

I joined the IODP Expedition 359 in late 2015, as a sedimentologist. The two-month expedition recovered 3097 m of sedimentary cores from the Inner Sea of the Maldives, from buried reefs that reveal the growth and demise of ancient coral reefs, and from sediments laid down by ocean currents that reveal the onset and fluctuations of the Indian monsoon.

My role aboard the research vessel *JOIDES Resolution* was to provide sedimentological and stratigraphic analysis of collected cores. For me this expedition was a new and exciting scientific experience. As a siliciclastic sedimentologist I was working with a world-renowned team of carbonate sedimentologists on carbonate sediments, so this was an opportunity for me to broaden my skills as a geologist and open new opportunities for research. The first two weeks in transit was a steep learning experience, but I quickly up-skilled my carbonate sedimentology skills and background knowledge. Once the cores hit the table the learning experience continued as I applied my new skills. The expedition opened up new research opportunities, with new collaborations, and will allow me to apply and advance my skills as a sedimentologist in geological settings I never previously envisaged working in.



Night shift sedimentologists on Expedition 359; Craig sports the longest beard.

Although we worked long hours it was also an excellent time to develop new friendships and we quickly became a tight family unit, with birthdays celebrated and also American Thanksgiving. One of the most eventful social celebrations was Halloween. Being an Australian, and not having previously celebrated Halloween, it was exciting to see the whole science party dress up for the Halloween Costume Competition.

Post-cruise I am continuing to work on the nature of carbonate contourites and deep marine sedimentation with shipboard colleagues. Specifically, I am using sediment characteristics to provide a detailed understanding of carbonate contourite deposition and down-slope processes. I aim to develop widely applicable models of how sediment supply, transport and bottom current flows are influenced by changes in climate and sea-level. This will also open opportunities for Post-Graduate students to work on the Maldives' samples at the Queensland University of Technology.

Expedition 360: Southwest Indian Ridge Lower Crust and Moho

December, 2015 and January, 2016

(Mark Kendrick, Australian National University)

Expedition 360 was the first of three planned 'SloMo' expeditions to drill a single deep hole in the Atlantis Bank on the slow-spreading Southwest Indian Ridge. The Atlantis Bank is a bathymetric high where gabbro in an oceanic core complex is exposed on the seafloor and previous work has suggested there are suitable drilling conditions for a deep hole. The SloMo project aims to drill through a hard-rock magnetic reversal in an ultra-slow spreading ridge and on into the mantle, at an estimated depth of ~2 km below seafloor. Mantle penetration will test models for crustal accretion and the hydration state of the mantle beneath a slow-spreading ridge, determining if the seismic Moho at 5.5 km represents a hydration front.

The expedition embarked from the port of Colombo in Sri Lanka on the 5th of December 2015 and crossed the equator on the 7th of December, where a large part of the ship's company, including myself, were initiated into the secrets of the deep. We survived Neptune's barber and a vat of food slops to reach the drill site on the 16th of December. Drilling proceeded rapidly at first with plenty of 'core on deck' by Christmas day. The first of several tungsten carbide cones from the drill bit was then lost in the hole, causing problems with the drilling, and one of the lab techs required medical evacuation to Mauritius, both slowing things down considerably. Once back on site, the cone was retrieved in time for New Year's Eve celebrations and we then drilled through a fault zone with abundant carbonate veins and very low recovery. Once the fault zone was cleared we entered a final phase of rapid progress with very high (96%) recovery, and set a depth record of 790 metres below sea floor for a newly established basement hole by the end of the expedition.

Mark Kendrick examining oceanic crust on JOIDES Resolution

The recovered rocks were dominated by olivine gabbro, with minor oxide gabbro and gabbro. We drilled through three diabase dykes and numerous felsic veins that were estimated to amount to 1.2% of the recovered rock types. High temperature amphibole veins were abundant in the first part of the hole and were overprinted by red clay alteration that persisted to a depth of ~580 mbsf. The majority of the rocks in the hole was reversely polarised, but discrete zones of greenschist facies alteration in the deepest parts of the hole held normal magnetisation, suggesting proximity to the magnetic reversal. I sailed as the shipboard geochemist, and my post-cruise research will focus on determining the halogen and noble gas contents of oceanic gabbros, the origin and pressure/temperature conditions of the carbonate veins, and the role of seawater in the generation of late felsic melts.

Publications by Australian and New Zealand Ocean Drilling Participants

Australian and New Zealand scientists have proud track records in IODP and its predecessors, the Deep Sea Drilling Program (DSDP) and the Ocean Drilling Program (ODP). Neither Australia nor New Zealand was a member in the early days of ocean drilling, but many of our scientists participated. Australia eventually became a member of ODP from 1989 to 2003. During ODP (1988-2003) seventeen expeditions occurred in our region, many of them with lead proponents from Australia and New Zealand. Seven Australians were co-chief scientists on these expeditions, and the resulting literature is ground-breaking and very large. Australia and New Zealand joined IODP in 2008, and since then there have been five expeditions in our region, with Australian co-chief scientists on two of them.

Membership strongly affects publication, with a time lag of some years. The number of actual publications from IODP expeditions since we joined is only a small proportion of what we expect in the longer term.

Table 5 (p.22) shows that, at latest count, the number of all DSDP-ODP-IODP publications with Australian and/or New Zealand authors was 3,686, 11.5% of all publications. ANZIC authors are known to have been involved in at least 11.9% of ocean drilling publications since 2003. Note that it is likely that many relevant papers have not been identified by this automated system.

Table 6 (p.23) indicates that, since 2003, ANZIC involvement in publications in the top three science journals was 10.2%, and in the top twelve journals it was 5.4%.

JOIDES Resolution, in Fremantle, Australia, Exp 356. Credit: Bill Crawford, IODP JRSO

Australian and New Zealand IODP Consortium

Table 5: Scientific ocean drilling publications involving Australian and New Zealand scientists

Date of publication	Publications with authors representing Australia	Publications with authors representing New Zealand	Total publications with authors representing Australia and/or New Zealand	Total scientific ocean drilling publications	Percentage of publications with authors representing Australia and/or New Zealand
1968–1974	122	79	**140**	1,586	**8.8**
1975–1981	21	19	**40**	3,622	**1.1**
1982–1988	94	88	**128**	4,504	**2.8**
1989–1995	1,103	39	**1,135**	6,007	**18.9**
1996–2002	971	83	**1,032**	6,014	**17.2**
2003–2009	501	142	**605**	6,252	**9.7**
2010–2014	373	223	**537**	3,698	**14.5**
*2015**	***62***	*16*	***69***	*246*	***28.0***
Total	**3,247**	**689**	**3,686**	**31,929**	**11.5**

Notes: This table was prepared in February 2016 by IODP Publication Services based on data in the Ocean Drilling Citation Database, a subset of GeoRef hosted by the American Geosciences Institute (http://odp.georef.org/dbtw-wpd/qbeodp.htm). The criteria for the country-specific queries were the date ranges listed and institutional affiliation containing the words "Australia" or "New Zealand." Totals include peer-reviewed articles in science journals; published conference proceedings and abstracts; books and chapters in books; theses; and DSDP, ODP, and IODP publications. *Statistics for 2015 only reflect citations that were added to the database by February 2016 and do not represent a complete total of 2015 publications.

Table 6. Peer-reviewed scientific ocean drilling articles written by authors representing Australia or New Zealand and published in top-tier journals, compared to all peer-reviewed scientific ocean drilling articles.

Date of Publication	Scientific ocean drilling journal articles in top three science journals*			Scientific ocean drilling journal articles in top twelve Earth science journals†			All peer-reviewed scientific ocean drilling journal articles	
	Authors representing Australia	Authors representing New Zealand	All authors	Authors representing Australia	Authors representing New Zealand	All authors	Authors representing Australia and/or New Zealand	All authors
1968–1974	0	0	18	0	0	22	201	**1,474**
1975–1981	0	0	69	0	0	148	36	**2,550**
1982–1988	5	3	95	0	2	168	150	**2,540**
1989–1995	8	0	65	11	3	419	79	**1,509**
1996–2002	6	0	79	25	5	662	130	**2,054**
2003–2009	3	3	133	36	14	1,114	189	**2,649**
2010–2014	7	4	59	35	15	658	144	**1,597**
2015‡	*2*	*1*	*5*	*7*	*3*	*72*	*26*	***171***
Total	**31**	**11**	**523**	**114**	**42**	**3,263**	**955**	**14,544**

Notes: This table was prepared in February 2016 by IODP Publication Services based on data in the Ocean Drilling Citation Database, a subset of GeoRef hosted by the American Geosciences Institute (http://odp.georef.org/dbtw-wpd/qbeodp.htm). *Top three science journals (based on Eigenfactor.org ranking) = *Nature, Science,* and *Proceedings of the National Academy of Sciences of the U. S. A.* †Top twelve Earth science journals (determined by article impact factor of journals in ISI Web of Knowledge categories related to Earth science) = *Nature Geoscience; Geology; Earth and Planetary Science Letters; Quaternary Science Reviews; Lithos; Geochimica et Cosmochimica Acta; Geophysical Research Letters; Geological Society of America Bulletin; Paleoceanography; Chemical Geology; Contributions to Mineralogy and Petrology;* and *Journal of Geophysical Research.* Criteria for country-specific queries were the date ranges listed and institutional affiliation containing the words "Australia" or "New Zealand," with conference proceedings and abstracts; theses; books; and DSDP, ODP, and IODP publications filtered out. ‡Statistics for 2015 only reflect citations that were added to the database by February 2016 and do not represent a complete total of 2015 publications.

Workshops, Conferences and other Outreach activities

IODP Forum meeting in Canberra in July

The IODP Forum Meeting is an opportunity for leading IODP scientists and administrators to look at the implementation of the scientific program as compared to the published IODP Science Plan for 2013 to 2023, and to recommend changes in emphasis if needed. This year the meeting was held in Canberra from 8 to10 July, with Neville Exon and Catherine Beasley heavily involved. About 30 scientists from around the world attended this meeting. It was chaired by Keir Becker of the University of Florida, and his successor Jamie Austin of the University of Texas at Austin also attended. The meeting was an excellent clearing house of information and led to some valuable discussions of future activities and needs.

There was particular emphasis on assuring future funding, especially for the *JOIDES Resolution* from 2019 onwards, for which the US National Science Foundation wants more funding from its partners. The Chinese delegate suggested that China will play an increased role in future and might indeed provide more funding to NSF. The dynamic Jamie Austin will become a key player in visiting potential new partners and lobbying existing partners. Dinner functions involved participants and Canberra-based VIPs, and Geoff Garrett, Chairman of the ANZIC Governing Council.

Three key participants in the Canberra Forum meeting: Susan Humphris, Chair of JOIDES Resolution Facility Board; Jamie Austin, incoming chairman of IODP Forum; Kier Becker, incumbent chairman of IODP Forum.

JOIDES Resolution port call, Fremantle in July

The port call of *JOIDES Resolution* in Fremantle, before it sailed on the Northwest Shelf IODP Expedition 356, featured tours of the ship on 31 July. The expedition was to investigate the last 5 million years of paleoceanography, paleoclimate and vertical tectonics off northwest Australia. Stephen Gallagher of the University of Melbourne is a co-chief scientist, and three other Australian scientists were aboard.

The 190 tour participants were drawn largely from high school science classes, CSIRO, the University of Western Australia and Curtin University, but also included 60 scientists from the petroleum exploration industry. All were impressed by the unique capabilities of the ship, including the wonderful laboratory facilities, and the exhaustive core description and analysis production line that can handle 6000 m of core on a single two-month expedition.

A VIP visit involving politicians and senior scientists included presentations about the vessel and the forthcoming expedition, and an address by Aidan Byrne from the Australian Research Council, which provides the bulk of the funding for ANZIC. There was an associated press conference, a tour of the vessel, and excellent media coverage, especially from ABC TV and radio. Jane Gardner, from the University of Melbourne, organised the media coverage and estimated that it reached an audience of 310,000. Many thanks are due to the tour guides: Mitch Malone, in charge of *JOIDES Resolution* science operations; Richard Arculus from ANU; Alexandre Bandini from the University of Western Australia; and Sophia Bratenkov from Macquarie University. Neville Exon and Catherine Beasley put a great deal of effort into the port call - planning in advance, and work on the day - and we were very pleased with the results.

JOIDES Resolution port call in Darwin in September

The *JOIDES Resolution* was in Darwin on 30th September, after the Northwest Shelf IODP Expedition 356, which was described as a great success. Much credit for the very successful outreach activities is due to the two shipboard co-chief scientists, *JR* support groups, and media people from Melbourne University and Charles Darwin University. Neville Exon coordinated the activities and went up to Darwin for the visit.

JOIDES Resolution and its science are very impressive by any standard, and the IODP group did an excellent job in explaining things to the VIPs and the media. Everyone was lucid and convincing and the ship and the labs tell quite a story by themselves. On Wednesday 30 September, a group of senior people from Charles Darwin University, the Australian Institute of Marine Science, and the Northern Territory Government were given talks about IODP and the expedition and were then shown around. The visit went well.

The next day, Thursday 1 October, there was a tour for another, smaller VIP group - Federal Assistant Minister Karen Andrews, Federal local member Natasha Griggs, and NT Parliamentary Secretary Nathan Barrett, plus their advisers - plus the media. The program included filming on the wharf and aboard ship, and expositions on IODP, ANZIC and the expedition, and some encouraging words from the Assistant Minister. ABC and Channel 9 TV channels did a lot of filming. There was good TV coverage in Darwin, Brisbane and Canberra at least.

Those interviewed were Karen Andrews, Brad Clement (*JR* Science Operations), co-chiefs Stephen Gallagher and Craig Fulthorpe, and Tom Lang (Australian educator aboard ship). The Minister was very interested and well informed, and asked searching questions; she was at the ship nearly two hours. She was particularly interested in the outreach program from the ship, run in part by Thomas Lang. The picture below gives the correct impression of a relaxed group talking about fascinating things.

The Assistant Minister for Science, the Honourable Karen Andrews, MP, shares a joke with Stephen Gallagher, Brad Clement and Neville Exon beside JOIDES Resolution in Darwin

Alex Bandini explains coring bits to visitors to JOIDES Resolution in Fremantle harbour

Lord Howe Rise Chikyu planning workshop in Sydney in April

About 40 scientists attended the two-day *Chikyu* IODP planning workshop to push on with building a full proposal for deep Cretaceous drilling on the Lord Howe Rise. Pre-proposal 871-CPP (Gondwana Margin deep drilling) was well received by the IODP Science Evaluation Panel late last year, and the two major proponents, Geoscience Australia and JAMSTEC (which runs the *Chikyu*) had set up the workshop at Sydney University. This proposal for several months of expensive riser drilling would be jointly funded under a JAMSTEC/GA MOU, if scientific and financial support for it is sufficient. JAMSTEC's Wataru Azuma, who led a team of a dozen Japanese scientists, was one organiser, and Clinton Foster and Andrew Heap of Geoscience Australia were the Australian organisers. The Chairman of the meeting was Mike Coffin of the University of Tasmania, and scientists attending included the organisers and Yasuhiro Yamada, Shuichi Kodaira and Shin'ichi Kuramoto, all from JAMSTEC, Dietmar Mueller from the University of Sydney, Julien Collot from New Caledonia, Nick Mortimer from GNS Science, Ron Hackney from Geoscience Australia, and Neville Exon from the ANZIC office, and had a very broad span of expertise including tectonics specialists, igneous petrologists, paleoceanographers and geomicrobiologists. The ANZIC office funded half a dozen participants from our member organisations.

The discussion largely surrounded the global scientific arguments for drilling the first stratigraphic core hole into the Cretaceous strata of Lord Howe Rise, as well as basement rocks. There was also discussion of what was actually feasible in order to best address the desires of all the scientists present. The deep hole would be drilled up to 3500 m below the seabed, with all but 600 m of it in the Cretaceous and continuously cored. It was a very fruitful workshop and a writing group led by Ron Hackney of Geoscience Australia was formed to continue preparation of a full proposal. There was also discussion of the site surveys to be carried out by GA and JAMSTEC in 2016 and 2017. A brief report on the workshop was prepared and put up on the ANZIC, Japanese IODP, and general IODP websites.

Members of the Lord Howe Rise proposal writing team and a number of Japanese geoscientists gathered for a post-symposium dinner in Tokyo, 25 August 2015. [Photo credit: Dietmar Mueller]

Lord Howe Rise deep stratigraphic drilling proposal development workshop in Tokyo in August

To build on the work towards a full IODP proposal for deep stratigraphic drilling on the Lord Howe Rise that commenced at the Sydney Science Workshop in April, a proposal development workshop was held at JAMSTEC headquarters in Tokyo in late August. The *Chikyu* IODP Board provided funds that allowed the coordinators of each proposal theme (Earth, Oceans/Climate and Life), and several other key proponents from outside Japan, to participate in the workshop.

The workshop was preceded by a half-day symposium that was intended to provide the broader Japanese scientific community with information on the project. The symposium was attended by 69 scientists from JAMSTEC and other Japanese institutions, and several attendees committed to future involvement.

The goal of the three-day proposal development workshop was to finalise a draft of the full proposal in preparation for submission to IODP by 1 October 2015. Eighteen scientists from Japan, Australia, the United Kingdom and the United States participated for the full duration of the workshop. Several other scientists and technicians contributed specific input at various times (e.g. on planning for site surveys and drilling).

By the end of the workshop, a near-final draft of the full proposal was completed. This draft was refined following the workshop and circulated to all proponents for feedback and further input prior to submission. The full proposal, entitled "First deep stratigraphic record for the Cretaceous eastern Gondwana margin: Tectonics, paleoclimate and deep life on the Lord Howe Rise high-latitude continental ribbon", was submitted to IODP on 1 October 2015. With submission of the full proposal, the project is now on schedule for drilling by late 2018 if all the key elements, including the funding, fall into place.

Science meets Policy Makers in Canberra in February

'Science meets Policy Makers' was arranged by *Science & Technology Australia*, and held at the Crawford School of Public Policy at ANU. Neville Exon went along on behalf of ANZIC and found it well-attended and very interesting.

The aim, in the words of the delegate's handbook was "to enable policymakers and scientists to achieve better policy outcomes", something that we would all like to see. Eminent researchers and policymakers from various departments gave very illuminating introductory talks to panel sessions. The topics were:

- Policy making and the role of science: a talk by Dr Michael Keating, the head of three Australian Government departments from 1983 to 1996.
- Taking it to the top: scientific advice at the most senior levels in government. Panellists included Ian Chubb, Australian Chief Scientist, and Brian Schmidt, Nobel Prize winning astrophysicist.
- Learning to talk policy. Panellists included Hugh White, Professor of Strategic Studies at ANU and Martin Hoffman, Deputy Secretary at the Department for Industry and Science.
- Shifting perspectives: policymaking from the inside out and the outside in. Panellists included Aidan Byrne, CEO of the Australian Research Council
- Dealing with policy complexity – ways and means. Panellists included Tom Kompas, Director of the Crawford School.

In addition there was a brief but positive 'Australian Government Address' from the Honourable Karen Andrews, MP, Parliamentary Secretary to the Minister for Industry and Science.

The overall message was that the timing and credibility of scientific input is important in building public policy. Policy making is interactive, involving many stakeholders, and the steps in the process are not always logical. Opportunities to influence the process may come up at odd times and on short notice, so prepare your ideas early when you know that a policy opportunity may arise. Be prepared to write something short and punchy, but accurate, in your field. Martin Hoffmann noted that the 'need for more research' is not what departmental policy makers want to hear once planning is underway….

Science meets Parliament in Canberra in March

'Science meets Parliament' is a two-day annual gathering of scientists with interested Federal politicians, arranged by *Science and Technology Australia*. A dinner is held in the Great Hall of the Australian parliamentary building, and there are interesting talks from politicians and from eminent scientists. This is an excellent opportunity to meet the 'Parliamentary Friends of Science', a body comprising about half of all the members – in itself an encouraging thing. All the 200 scientists attending are matched with individual politicians, and two or three scientists in related science areas meet a member in their own room to outline their science and its significance.

Richard Arculus (ANU) and Helen McGregor (University of Wollongong) represented ANZIC at this year's two-day function. Richard Arculus met John Cobb, member for Calare in the Hunter district who was very interested in practical geoscience assistance for his constituents. Helen McGregor met Warren Entsch, federal member for Leichardt in North Queensland. He was aware of some of the research being carried out in his electorate, was focused on the economic development of his region, and wanted to know how science could help with that development and benefit his constituents.

Andrew Carroll (Geoscience Australia) and Neville Exon (ANU) attended on behalf of the Australian Marine Sciences Association, and a full report from them, entitled *Reflections on Science Meets Parliament*, was published in the *Australian Marine Science Bulletin* (Number 196, issue 1, June 2015, pp. 9-13). We were part of a delegation of three who met the well-known Labor Senator Doug Cameron in his room, who was welcoming and friendly. Unfortunately, there were almost continuous 'divisions' in the Senate, signalled by a flashing red light in his room, so most of our discussion on matters of marine science, including the lack of sea time for R.V. *Investigator* and the doubt about funding for NCRIS, were with his highly experienced advisor while Doug met his parliamentary duty elsewhere.

The function saw the launch of *The importance of Advanced Physical and Mathematical Sciences to the Australian Economy*, a joint report from the Office of the Chief Scientist and the Australian Academy of Science that quantifies science in economic terms. The report found that Physical and Mathematical Sciences contribute 11% of Australia's GDP - 22% if indirect contributions are included - and deliver 23% of exported goods and services. Yet these sciences employ only 7% of Australia's workforce. At his National Press Club address (which we attended), Chief Scientist Ian Chubb quantified the high value of science to the economy, and emphasised the absolute importance of science to Australia's future.

'Science meets Parliament' is an activity which brings all areas of science to the attention of many influential people, and it has strong support from the scientific and technological community.

Geoscientists at Science meets Parliament: Tara Martin (CSIRO), Andrew Carroll (Geoscience Australia), Neville Exon (ANU) and Helen McGregor (University of Wollongong).

Australian and New Zealand IODP Consortium

ANZIC Marine Geoscience Masterclass in Perth, February 2016

This course was funded by ANZIC and involved 20 high-achieving students drawn from all member universities, involving second year students from Australia and third year students from New Zealand. For logistical reasons the course was held in early 2016. It was hosted by CSIRO, Curtin University and the University of Western Australia, and introduced students to the exciting world of marine geoscience, focussing on the themes of the new IODP Science Plan. One highlight was practical experience of marine geoscience using the small CSIRO research vessel *Linnaeus*, and another was the study of marine cores in a core library. Many thanks go to Asrar Taludker and Andrew Ross (CSIRO) for coordinating the Masterclass, and to all those who provided scientific input and support. The students have provided highly favourable feedback.

Dr. Andrew Ross of CSIRO demonstrates CTD deployment aboard *RV Linneaus* *Credit: Adelaide Scheimer.*

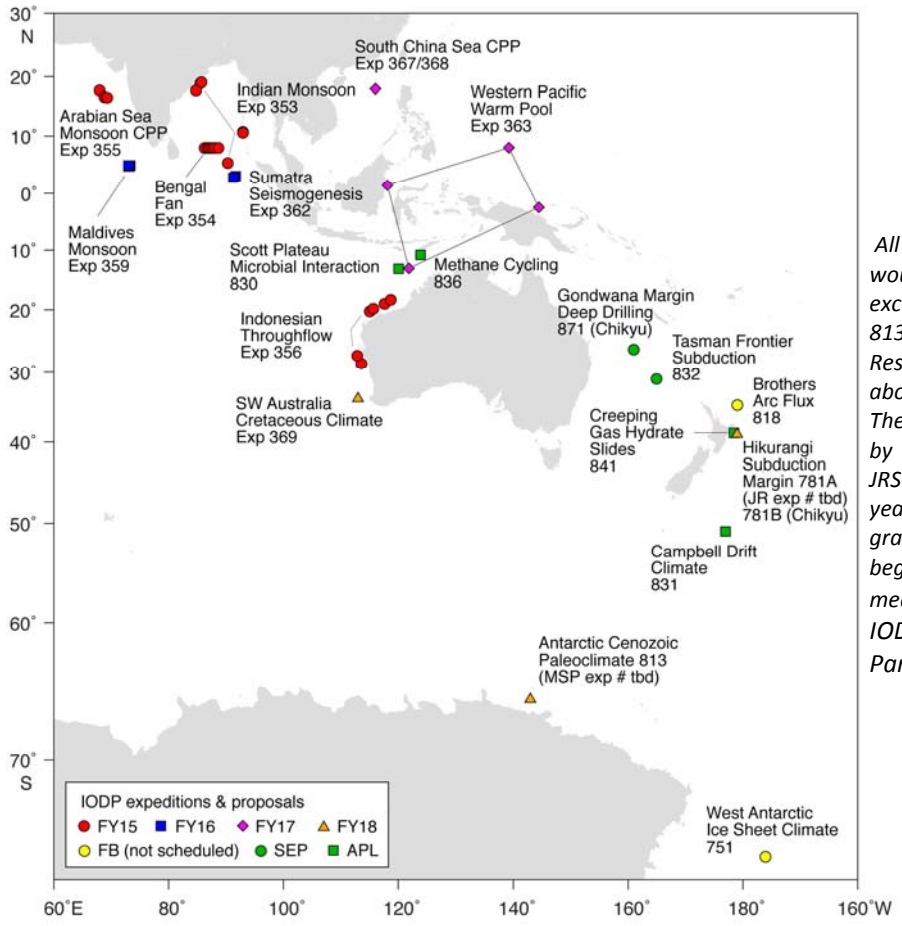
RV Linneaus Credit: Stelios Kondylas

The Future of IODP

Various national and international reviews of ocean drilling have been held recently, some of them tightly focussed on IODP and others also including its predecessors. This is obviously necessary from time to time when considering renewal of a program that costs about $US180 million per year for its logistics, and has two large drill ships with a replacement value of about $US1.1 billion. The additional costs of the science participants are carried by their own countries and amount to many millions of dollars.

The ten-year phase of ocean drilling from 2013 to 2023 was approved under the new name *International Ocean Discovery Program*. Key funding decisions were made by the US National Science Foundation (NSF), the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the European Consortium for Ocean Research Drilling (ECORD) in late 2013, and they determine the future scope of IODP. The structure of the new program is much looser than the previous one, with those who provide the vessels – the US, Japan and Europe – having ultimate control of their programs. Australian and New Zealand scientists have helped design proposals for research expeditions in the new IODP, with some of these expeditions already carried out.

Map 3: Recently completed, approved and proposed IODP Expeditions for our region as of January 2016

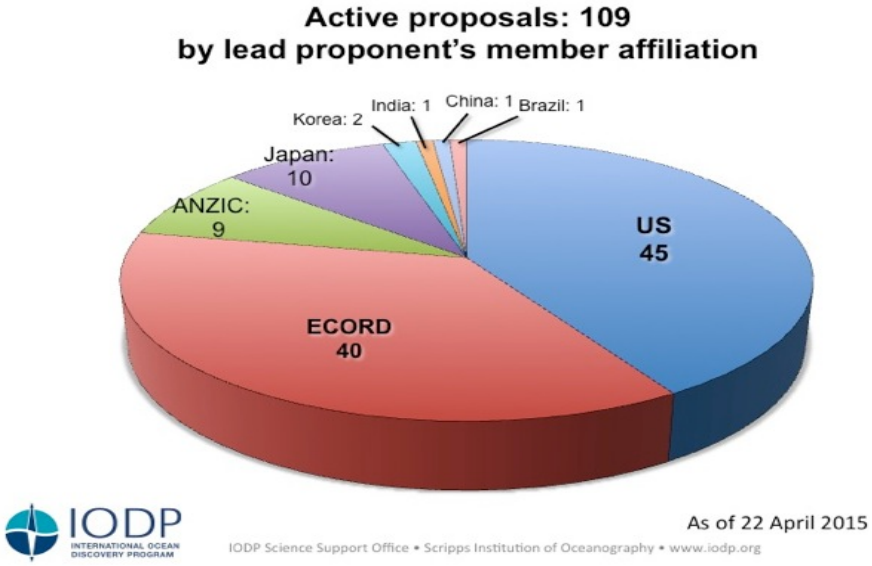


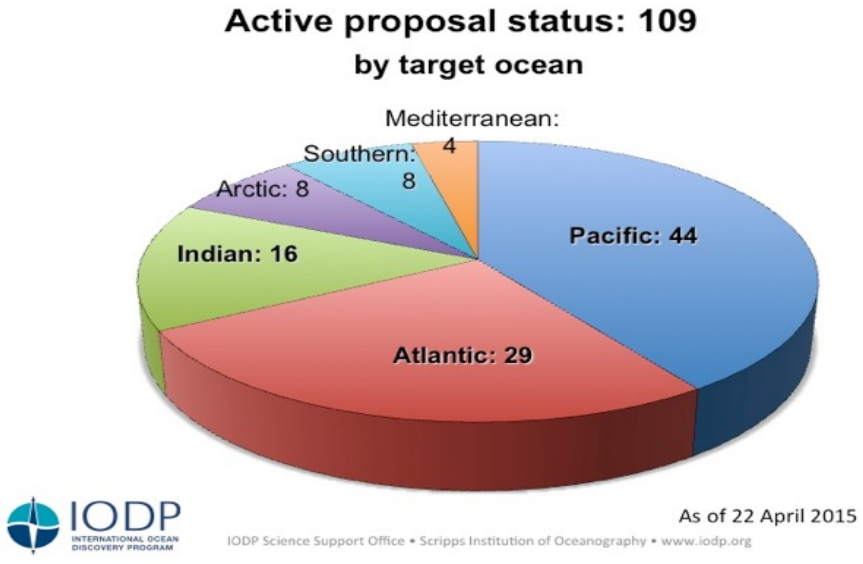
All these expeditions will or would use JOIDES Resolution except for proposals 781B, 813 and 871. A single JOIDES Resolution Expedition costs about $US8 million to mount. The map was kindly prepared by Katerina Petronotis of JRSO. Note that the US fiscal year is used in these diagrams: for example FY16 begins in October 2015. 'SEP' means a proposal with the IODP Science Evaluation Panel in February 2016.

Australian and New Zealand IODP Consortium

Map 3 (p.30) was prepared after the decisions of the January 2016 Science Evaluation Panel meeting. Approved future *JOIDES Resolution* expeditions in our area are the Sumatra Seismogenic Zone Expedition 362 in August-September 2016, the Western Pacific Warm Pool Expedition 363 in October-November 2016, the SW Australia Cretaceous Climate Expedition 369 in October-November 2017, and the Hikurangi Subduction Margin Proposal 781A in 2018. The alternative platform Antarctic Cenozoic Paleoclimate Proposal 813, funded by ECORD, should be drilled in early 2018. The map also indicates that other regional expeditions are possible in 2018.

The diagrams below show that nearly 10% of active but not approved proposals are led by ANZIC scientists, and that 60% of all active proposals are in the Indian and Pacific Oceans (data and diagrams provided by Holly Given at the IODP Science Support Office). These diagrams are another indication of ANZIC's value within IODP, and IODP's value to us.





Australian and New Zealand IODP Consortium

The IODP Science Plan

The IODP Science Plan ***Illuminating Earth's Past, Present, and Future*** was published in early 2013 (www.iodp.org/Science-Plan-for-2013-2023). The themes are:

Climate and Ocean Change: Reading the Past, Informing the Future

Ocean floor sediment cores provide records of past environmental and climatic conditions that are essential for understanding Earth system processes.

Biosphere Frontiers: Deep Life and Environmental Forcing of Evolution

Samples recovered by ocean drilling permit study of Earth's largest ecosystems, offering insight into the origins and limits of the deep biosphere, evolution of marine microfauna through times of environmental change, and human origins.

Earth Connections: Deep Processes and their Impact on Earth's Surface Environment

The dynamic processes that create and destroy ocean basins, shift the position of continents, and generate volcanoes and earthquakes extend from Earth's core to its atmosphere, and are fundamental for understanding global change within the context of planetary evolution.

Earth in Motion: Processes and Hazards on Human Time Scales

Many fundamental Earth system processes, including those underlying major geologic hazards, occur at "human" time scales of seconds to years, requiring new sampling, downhole measurement, monitoring, and active experimental approaches.

ANZIC Financial Situation

Australia's financial situation is sound, always depending on the actual cost of membership fees, which are denominated in $US. From 2014, Australia (on behalf of ANZIC) increased its annual Associate Membership payments for American (*JOIDES Resolution*) and European platforms to $US1.5 million, and agreed to pay another $US300,000 to Japan for Associate Membership and access to the *Chikyu*. In fact, with the *Chikyu* not very active in 2015 and 2016, we intend to transfer the $US600,000 for those two years to the *JOIDES Resolution* program, in exchange for additional shipboard positions in 2016 and 2017.

Our income in 2015 was $A3.0 million: $A1.8 million from ARC/LIEF, $A855,000 from our Australian partners, $A320,000 from New Zealand, and $A22,000 from investments. Our expenditure was $A2.51 million, with a carry forward from the previous year of $A1.46 million.

We now have five-year funding from 2016 under ARC/LIEF grant LE160100067, amounting annually to $A2 million from ARC, $A875,000 from our Australian partners, and $US300,000 from New Zealand.

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Expedition details:

http://www.iodp.org

http://iodp.org/expedition-map

Apply to sail:

http://www.iodp.org.au

http://drill.gns.cri.nz

Australian and New Zealand IODP Consortium

JOIDES Resolution IODP Expeditions in 2015