



2019

Australian and New Zealand
IODP Consortium

ANNUAL REPORT



Australian and New Zealand
IODP Consortium

Exploring the Earth under the Sea

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ANZIC LEADERSHIP

Australian and New Zealand IODP Consortium (ANZIC)

ANZIC Governing Council Chairperson - Dr Ian Poiner

ANZIC Program Scientist - Associate Professor Leanne Armand

New Zealand Lead Representative - Dr Stuart Henrys

Lead ARC Chief Investigator - Professor Richard Arculus

Science Committee Chairperson - Professor Mike Coffin

Science Committee Co-chair - Dr Joanna Parr

Host Organisation Representative - Professor Steve Eggins

Office Administrator – Kelly Kenney

Communications Officer – Larisa Medenis

About ANZIC



ANZIC is the Australian and New Zealand International Ocean Discovery Program Consortium, part of the 23 nations engaged in deploying state-of-the-art ocean drilling technologies. IODP advances the scientific understanding of the Earth and unifies the international research community to explore Earth's last exploration frontier, the ocean's seafloors.

The current ANZIC consortium joined the new phase of IODP in September 2013. Australia's participation is funded under an Australian Research Council Linkage Infrastructure, Equipment and Facilities (LIEF) grant, whilst New Zealand's participation is provided principally through GNS Science and other partnership contributions from NZ universities and the National Institute of Water and Atmospheric Research.



Australia and New Zealand form the Australia-New Zealand IODP Consortium (ANZIC), and the two countries have access to all IODP activities including shipboard and post-cruise research, participation in planning committees and panels and visits from outstanding scientific researchers.

Two-thirds of the world is covered by oceans, and 60% of Australia's and 95% of New Zealand's territory lies beneath the ocean. Much of this marine environment remains unexplored. IODP brings together researchers from Earth, ocean, atmospheric and life sciences with a common goal, to understand the Earth's past, present and future from around the world.

IODP carries out deep scientific coring in all the world's oceans using a variety of platforms, and provides 'ground truthing' of scientific theories that are commonly based largely on remote sensing techniques. New technologies and concepts in geoscience are continuously being developed through IODP.

To achieve its aims, the program draws on information from beneath the ocean floor, brought to the surface by ocean coring technologies and borehole observatories monitoring processes in real time.

The primary platforms are the American (*JOIDES Resolution*) and Japanese (*Chikyu*) drilling vessels. The European Consortium for Ocean Research Drilling (ECORD) employs charter coring platforms to drill in unusual locations, or for purposes for where the primary vessels are not suitable.

Cores from the various expeditions are studied by scientists around the world and stored in specialised core repositories for long-term use by all scientists.

IODP's key research areas, as described in the IODP Science Plan for 2013-2023, are:

- **Climate and Ocean Change: reading the past, informing the future**
- **Biosphere Frontiers: Deep life, biodiversity, and environmental forcing of systems**
- **Earth Connections: deep processes and their impact on Earth's surface environment**
- **Earth in Motion: processes and hazards on human time scales**

ANZIC supports early and mid career researchers and provides opportunities for all researchers (including PhD students) to participate in a variety of ship board roles—including, but not limited to, sedimentologists, micropalaeontologists, palaeomagnetists, inorganic and organic geochemists, petrologists, petrophysicists, microbiologists, and borehole geophysicists.

ANZIC members consist of four government agencies and sixteen universities across Australia and New Zealand.

Australian ANZIC partners:

- The Australian Research Council
- The Australian National University
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Geoscience Australia
- Curtin University
- Macquarie University
- Monash University
- The University of Queensland
- Queensland University of Technology
- University of New South Wales
- The University of Sydney
- The University of Adelaide
- The University of Melbourne
- The University of Tasmania
- The University of Western Australia
- University of Wollongong

New Zealand ANZIC partners:

- GNS Science
- National Institute of Water and Atmospheric Research (NIWA)
- The University of Auckland
- University of Otago
- Victoria University of Wellington



ECORD mission specific platform



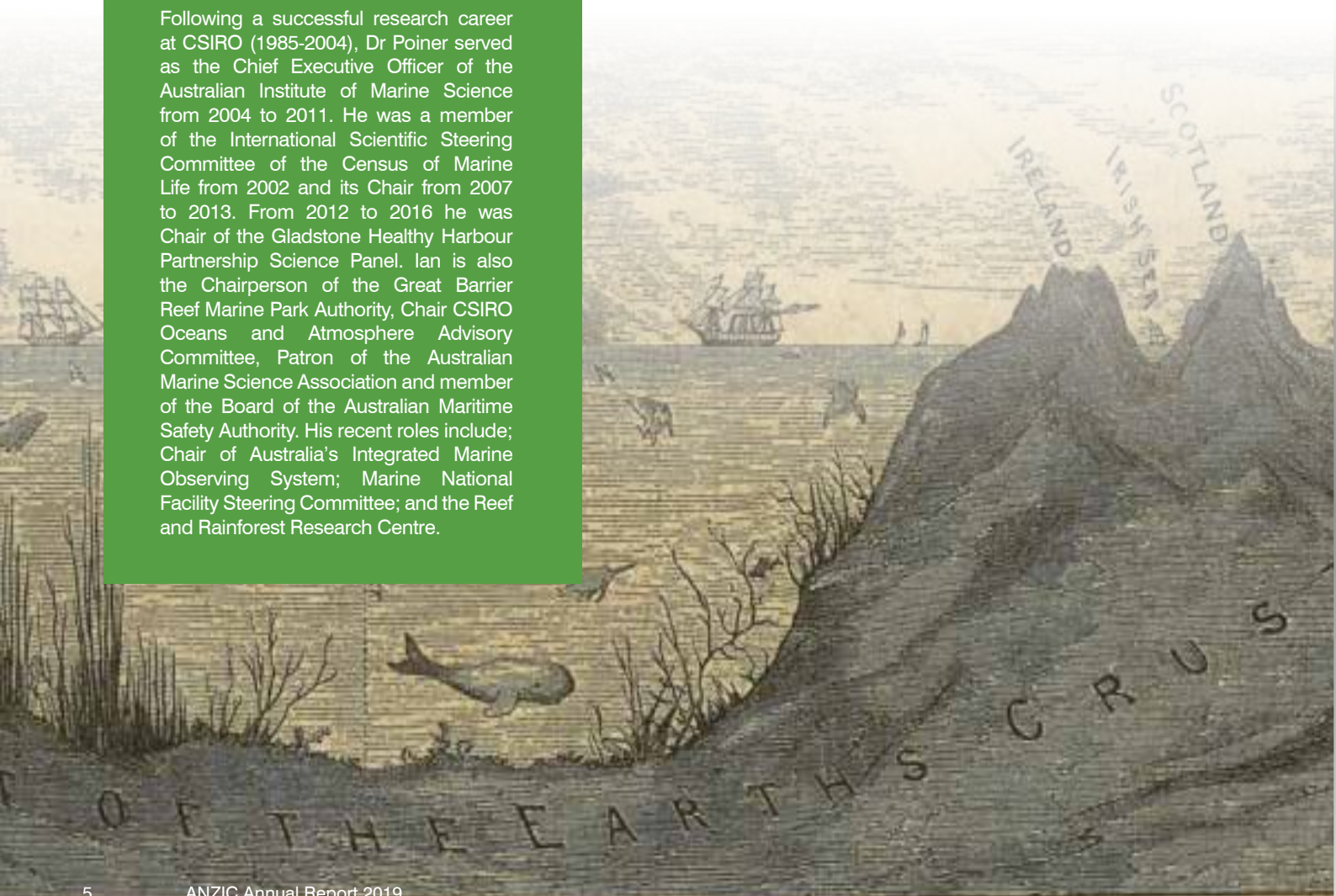
The JR in Townsville

Chairman's Overview



Dr Ian Poiner was appointed as the Chair of the ANZIC Governing Council in 2013.

Following a successful research career at CSIRO (1985-2004), Dr Poiner served as the Chief Executive Officer of the Australian Institute of Marine Science from 2004 to 2011. He was a member of the International Scientific Steering Committee of the Census of Marine Life from 2002 and its Chair from 2007 to 2013. From 2012 to 2016 he was Chair of the Gladstone Healthy Harbour Partnership Science Panel. Ian is also the Chairperson of the Great Barrier Reef Marine Park Authority, Chair CSIRO Oceans and Atmosphere Advisory Committee, Patron of the Australian Marine Science Association and member of the Board of the Australian Maritime Safety Authority. His recent roles include; Chair of Australia's Integrated Marine Observing System; Marine National Facility Steering Committee; and the Reef and Rainforest Research Centre.



The extreme events of the 2019 austral summer emphasise the impact of climate change on our world. Australia and New Zealand face significant environmental and economic impacts from climate change and other pressures across a number of sectors including coasts and oceans. This highlights the ongoing need and value of marine science to Australia, New Zealand and the world. Marine science provides understanding of how Earth systems work and essential knowledge of ocean systems and resources. Essential knowledge that underpins decisions by government, industry and society generally.

With about 60% of Australia's and 95% of New Zealand's territory offshore, our two nation's vast oceans are central to the heritage, heart, and economic future of our countries. Despite their importance, much of our ocean territories remain unexplored and poorly understood. A challenge for the 21st Century is to manage our oceans sustainably under a rapidly changing climate so we can continue to enjoy the economic, environmental, social, and cultural benefits they provide for generations to come. As such, our countries share common marine science needs that recognise the value of international collaborative ocean science to both nations and participation in the International Ocean Discovery Program (IODP) is a wonderful example. IODP is an international marine research collaboration that explores Earth's history and dynamics by examining seafloor sediments and rocks and by monitoring subseafloor environments focused on providing essential knowledge of climate change, deep life, planetary dynamics, and geohazards.

Scientific ocean drilling through IODP is a continuation of the world's longest running and most successful international geosciences research collaboration. Scientific ocean drilling celebrated its 50th anniversary in 2018. IODP operates deep-sea drilling vessels to collect continuous core samples of sediments and rocks from below the sea and this is the sixth year of the current program that is guided by a decadal science plan (2013-23) – Illuminating Earth's Past, Present and Future.

ANZIC is one of IODP's 23 international partners and is a 0.5 associate member of the US/European Consortium via a MOU with the United States National Science Foundation. Australia and New Zealand's contribution to IODP through ANZIC is significant. In 2019 ANZIC scientists participated in four internationally located

expeditions enabling ANZIC members to contribute to significant breakthroughs in understanding global climatic events and geo-hazards and be exposed to the new technology surrounding drill technology.

This was a year marked by a sense of commitment and energy by all involved to ensure ANZIC's continued support and success in IODP. ANZIC authors are represented in 11.8% of all IODP publications over the 51-year life of the Program for a very small contribution to operational costs. ANZIC success is a tribute to the commitment of our 20 member universities and research organisations and their international counterparts with excellent leadership and support from the Governing Council and Program Office team lead by our Program Scientist Assoc. Prof. Leanne Armand.

With the current IODP decadal science plan ending in 2023 and with ANZIC's current funding ending in 2020 a key focus for us this year was on the future of ANZIC and IODP. Assoc. Prof. Armand visited all consortium members early in the year to brief them about the value of the Program, opportunities for engagement and our plans for the future. Under Assoc. Prof. Armand's leadership the ANZIC Strategy Team, an *ad hoc* committee established by Governing Council, developed a proposal to the Australian Department of Education and Training for continued support beyond 2020. The proposal was endorsed by Governing Council and submitted to the Australian National Collaborative Research Infrastructure Strategy (NCRIS) scheme to support a new 10 year program with a new title the Oceania Scientific Drilling Program (OSDP). Congratulations to all involved and we expect a decision as part of the 2020 Budget. With the current tight science funding budget situation and to cover any delays in NCRIS funding, Governing Council agreed it would be appropriate to develop a new proposal to the Australian Research Council's (ARC) Linkage Infrastructure, Equipment and Facilities (LIEF) scheme in 2020.

ANZIC is also playing a key role in the development of IODP's new 2050 Science Framework for Scientific Ocean Drilling. We held a very successful Ocean Planet Workshop in April 2019 as the first step in our contribution to the new Framework that is expected to be finalised by 2020. This was one of five IODP endorsed international planning workshops, the outcomes of which will underpin the new Framework. Congratulations to all involved on what was

a very successful workshop but in particular Prof. Mike Coffin, Dr Joanna Parr, and Assoc. Prof. Leanne Armand.

ANZIC continues to be supported by an outstanding Program Office team. My gratitude and appreciation to Assoc. Prof. Armand and our Communication Officer Ms Larisa Medenis for their ongoing significant contributions to ANZIC. Welcome to our new ANZIC Administrator, Ms Kelly Kenney, who joined the team in February 2019. Kelly is contributing significantly including the revitalisation of our administrative processes. ANZIC continues to benefit from the strong support of our host organisation the Research School of Earth Sciences, The Australian National University.

Looking to the future, a key focus of Governing Council will be to continue to work with our member universities and research organisations and the broader Australian and New Zealand Earth science communities to ensure the continued support of the Australian and New Zealand governments beyond 2020. ANZIC is an essential part of Australia's and New Zealand's research portfolios as IODP attracts the best and brightest talent, and the collaboration of Australia and New Zealand in ANZIC demonstrates we can be successful in bringing this talent to Australasia.

I am inspired by the work and commitment of the Program Office team, the many scientists from our 20 member organisations who participate in ANZIC and IODP Committees and, most importantly, our many scientists who participated in IODP research. Together, they are ensuring Australia and New Zealand's continued success in IODP. I look forward to working with the Governing Council and the Program Office team to ensure the ongoing success of ANZIC. In closing and on behalf of Governing Council congratulations to ANZIC's former Program Scientist Professor Neville Exon on being awarded the Order of Australia, Member (AM) in the General Division for his significant service to marine geology and to higher education. Appropriate recognition of an outstanding career including significant contributions to ANZIC and IODP.

Dr Ian Poiner
ANZIC Governing Council Chair

Program Scientist's Summary



Associate Professor Leanne Armand is a marine scientist and an expert in the identification of diatoms in the Southern Ocean. She is known for her contributions to the understanding of past Southern Ocean dynamics and sea ice as a result of her knowledge of diatom distributions and ecology.

Leanne is a researcher at the Research School of Earth Sciences, ANU and joined ANZIC as the Program Scientist in September 2017. Prior to her current appointment, Leanne was a member of the Dept of Biological Sciences at Macquarie University (2009-2017).



2019 was a significant year for ANZIC as a consortium, for scientists and also within the ANZIC office. At the international consortium level, five ANZIC scientists participated in four expeditions as detailed below:

- Expedition 385 (NanTroSEIZE Plate Boundary Deep Riser 4) on DV *Chikyu* (7 October 2018- 31 March 2019). ANZIC participant: Toby Colson (University of Western Australia) as a real-time Geomechanics watch leader.
- Expedition 379 (Amundsen Sea West Antarctic Ice Sheet History) on RV *JOIDES Resolution*. 18 January - 20 March 2019. ANZIC participant: Joe Prebble (GNS-Science) as a Palynologist.
- Expedition 383 (Dynamics of Pacific Antarctic Circumpolar Current DYNAPACC) on RV *JOIDES Resolution*. 20 May - 20 July 2019. ANZIC participants: Christina Riesselman - University of Otago (Diatom Paleontologist); Christopher Moy - University of Otago (Sedimentologist).
- Expedition 382 (Iceberg Alley and Subantarctic Ice and Ocean Dynamics) on RV *JOIDES Resolution*. 20 March - 20 May 2019. ANZIC participant: Linda Armbricht - University of Adelaide (Diatom Paleontologist and sedaDNA).

Their experiences and the outcomes from their participation are included further in this report. What has been most pleasing to see is that our ANZIC expeditioners represent a new wave of talented early and mid-career researchers across the IODP science plan themes. We know their experience and engagement will help increase our profile both internationally and nationally as well open new opportunities for future research based on the work they have planned related to each of these expeditions.

On a consortium level, I connected with all consortium partners at the start of 2019 with a Roadshow around Australia and across to New Zealand, thus providing an update on general activities and an understanding to geoscientists, biogeoscientists, and their relevant institutional research heads, of the opportunities available to them through IODP in the coming year. This opportunity also enabled consortium members to reflect on their success through the program and their willingness to continue with membership post-2020 when the current phase of funding through the ARC LIEF grant comes to an end. The ANZIC Strategy Team submitted a National Collaborative Research Infrastructure Strategy (NCRIS) submission to the Dept of Education and Training, Research Infrastructure section. The submission outlines a new 10 year program, identified as the Oceania Scientific Drilling Program (OSDP) to replace ANZIC. The implementation plan outlined the case for Australia's continued membership of the

IODP and benefits in preserving Australia's position at the forefront of global ocean geoscience. The mission of the Oceania Scientific Drilling Program (OSDP) is to enhance and augment Australian leadership in global marine geosciences and the emerging field of geobiology, through full membership in the IODP, ensuring continuity in our obligation to responsibly explore, utilise and protect resources, understand and mitigate future hazards, and strengthening our societal, cultural and economic prosperity. An outcome on the submission is not expected until late 2020.

As part of the worldwide effort to develop the next Scientific framework for scientific ocean drilling, the ANZIC Ocean Planet Workshop was held over three days in April 2019 at the ANU, bringing together 75 experts from Australia, New Zealand, and abroad, to formulate research themes and define new challenges for a new strategic plan for global scientific ocean drilling. Many attendees were early- and mid-career researchers, highlighting the wide interest in continued engagement in this international program. The outcome from the meeting included the ANZIC Ocean Planet Workshop report, "Ocean Planet: An ANZIC workshop report", focused on future research challenges and opportunities for collaborative international scientific ocean drilling" (<http://hdl.handle.net/1885/197025>) and a meeting report led by Prof. Mike Coffin in EOS (<https://eos.org/meeting-reports/australia-new-zealand-plan-for-future-scientific-ocean-drilling>).

Four additional international planning workshops were held in Japan, Europe, China and the US to capture the opinions of the science communities based in those regions. These workshops assessed the continuing relevance of the 2013-2023 science plan and each workshop provided input toward the next stage of designing the post Science Strategic Plan (2024-2050) for scientific ocean drilling. The plan is expected to be completed in the third quarter of 2020. Through the IODP Forum, I was able to raise the need for a new IODP Code of Conduct and Anti Harassment policy. This effort was taken up by a sub-committee of the FORUM, in which I participated and represented ANZIC's views. The new code was developed and released in 2019 having input from all 24 nations. It is available from: <http://www.iodp.org/top-resources/program-documents/policies-and-guidelines>

Nationally, ANZIC supported eight Legacy grants up to \$145,000 to conduct analyses on pre-existing IODP-collected material. ANZIC also awarded the Geoscience Masterclass to a Sydney-based university consortium led by Prof. Simon George at Macquarie University. There were 18

student participants from 15 institutions, and another three from New Zealand. The Masterclass was organised by Macquarie University (S. George and S. Loehr) and the University of Sydney (J. Webster and M. Seton) and CSIRO (J. Parr) and had contributions from many other university and institutional staff. Bushfires along the south coast and smoke haze interrupted plans for field work at Kioloa, but the students still gained practical experience in marine geoscience through boat trips out of the Sydney Institute of Marine Science, including obtaining piston cores, grab samples and chemistry data from Sydney Harbour, and worked on freshly obtained sediment core samples. The field trip was changed to the Illawarra, NSW to look at Late Permian outcrops, and finished the course with a visit to the Geological Survey of NSW core store at Londonderry.

Locally, within the ANZIC Office, we welcomed Ms Kelly Kenney as the new ANZIC Administrator having farewelled Catherine Beasley at the end of 2018. Kelly is a welcomed team member and has been working hard to bring her diverse experience in managing the administration of NGOs to ANZIC. She has been instrumental in updating procedures and providing vital financial input to the NCRIS bid to aid in the continuation of ANZIC into the future. ANZIC's previous Program Scientist, Prof. Neville Exon, was honoured with an Order of Australia, Member (AM) in the General Division for his significant service to marine geology and to higher education across his career including his contributions to ANZIC. The Order of Australia confers the highest recognition for outstanding achievement and service in Australia, and is the principal means of recognising outstanding members of the community at a national level. Our community thanks Neville for his many contributions over the years to ANZIC and IODP.

Finally, we are heading in to the last year of our membership in IODP and equally, the current consortium supported by the Australian Research Council. The year ahead is one with a lot riding on the NCRIS bid submitted, and others we will submit in 2020 as back up and transitional plans. We remain in great shape to support our national level activities and expeditioners through 2020, and we aim to celebrate our current program's achievements at the end of the year. The dawn of a very vibrant, yet evolving, future for International scientific ocean drilling will break in 2020 and ANZIC aims to remain in the glow of this sensational moment built on the reveal of the 2050 Strategic Framework.

Assoc. Prof. Leanne Armand
ANZIC Program Scientist

New Zealand IODP Report



Stuart Henrys is a Principal Scientist and Research Leader of Land and Marine Geosciences at GNS Science based in Wellington, New Zealand. GNS Science is a New Zealand Government Crown owned Institute that undertakes earth science research in New Zealand and the Ross Sea, Antarctica.

Stuart Henrys has led the New Zealand consortium of institutions that comprise membership of IODP since 2015. Prior to his leadership role, Stuart served on the ANZIC Science Committee 2008-2011 and was a representative on the IODP Site Survey Panel 2009-2011.

New Zealand participates in IODP through the Australian and New Zealand IODP Consortium (ANZIC)

A national membership structure includes GNS Science, NIWA, Otago University, and Victoria University of Wellington.

The NZ IODP committee is made up of two representatives from GNS Science as the lead organisation and one representative from each of the participating universities and research organisations.

New Zealand's position astride the active Pacific-Australian plate boundary provides an ideal natural laboratory to host many current IODP Themes and future Strategic Objectives and Flagship Initiatives related to sea level change, past ocean and climate variability, the physical processes that control geohazards, and the geophysical, chemical, and biological character for exploring life and its origins.

New Zealand benefits greatly from the economies of scale of the pooled international resources of IODP to have access to world-class facilities beyond the capabilities of New Zealand (or of any single nation). New Zealand's investment since 2008 has leveraged over US\$80M of international funding for drilling expeditions and connecting GNS Science, the National Institute of Water and Atmospheric Research (NIWA) and University of Auckland, Victoria University of Wellington, and Otago University in complementary international science projects.

Two expeditions involving New Zealand scientists were successfully completed in 2019. Expedition 379, Amundsen Sea West Antarctic Ice Sheet History (18 January to 20 March 2019), with ANZIC scientist Joe Prebble (GNS Science) joining the expedition. Expedition 383, Dynamics of Pacific Antarctic Circumpolar Current (DYNAPACC) took place from 20 May to 20 July 2019. ANZIC scientists participating were Chris Moy and Christina Riesselman (both University of Otago).

The post-cruise meeting for Expedition 376, Brothers Arc Flux took place December 2019 in Kagoshima, Japan

and was attended by Cornel de Ronde, Fabio Caratori Tontini, Cécile Massiot, and Agnes Reyes.

In February, Victoria University of Wellington hosted the 2019 ANZIC Roadshow, presented by Leanne Armand (ANU) and Stuart Henrys (GNS Science). The meeting was attended by members of NZIODP, Juliet Gerard (Prime Minister's Chief Science Advisor) and representative of the Ministry of Business Innovation and Employment. The main focus of the meeting being the continued financial support for New Zealand's participation in ANZIC.

Eight NZIODP members from across GNS Science, University of Otago, NIWA and Victoria University of Wellington participated in the Ocean Planet Workshop in Canberra (April) and contributed to the development of the next Framework for scientific ocean drilling. This work fed in to the work of the 2050 Science Framework Meeting in the USA (July), where Stuart Henrys (GNS) represented NZIODP. In September 2019, Laura Wallace (GNS Science) and Rob McKay (Victoria University of Wellington) were selected to be part of the Science Framework Writing Team.

NZIODP research was well represented at the Geoscience Society NZ conference held at Waikato University, Hamilton (24 - 27 November). Lessons from Climates Past in Zealandia and Antarctica, a super symposium co-led by Chris Hollis (GNS Science) and Peter Barret (Victoria University of Wellington), included results from on-land New Zealand marine sedimentary rocks, marine IODP expeditions in the New Zealand region and Antarctica, ice sheet and ice shelf dynamics, as well as climate and environmental change from terrestrial archives including lakes and caves, and sea-level change. The Hikurangi Subduction Margin symposium co-led by Dan Bassett (GNS Science) and Phil Barnes (NIWA) focused on structure and tectonic processes along the margin including results from IODP drilling expeditions 372/375 results. Stuart Henrys and Marianna Terezow (both at GNS Science) ran the ANZIC booth at the conference, showcasing a promotional poster and IODP local-expedition-related microfossil material.

During the year two proposals were submitted to IODP led or co-led by New Zealanders; Full-proposal 964, Antarctic Cryosphere Origins (Rob McKay, VUW), and Pre-Proposal 959, Probing the physical controls on a locked vs. creeping megathrust with ocean drilling, Hikurangi Subduction Margin, New Zealand, (Dan Bassett, GNS Science).

This year's ANZIC Masterclass in Marine Geoscience took place in Sydney, Australia. Three NZIODP tertiary students from our member Universities attended the masterclass.

GNS Science is the custodian of one of nine IODP Micropaleontological Reference Center (MRC) Collections, and the only one in the southern hemisphere. MRC collections are hosted by major institutions around the world and are held either in full collections, and have all four fossil groups represented, or satellite collections, which typically hold material for one fossil group or from expeditions local to the MRC. These collections contribute to a wide range of research, including paleobiogeography, paleoclimate, biostratigraphy, and chronology projects. The GNS Science MRC also curates DSDP and ODP paleo samples once New Zealand researchers had finished their research projects. During 2019, the New Zealand-based MRC has contributed to the work of four researchers across 10 studies.

Stuart Henrys
New Zealand Lead Representative
GNS Science

MEMBERSHIP BENEFITS

ANZIC MEMBERS



Australian and New Zealand scientists have access to a range of resources and opportunities, including participation in IODP expeditions.

ARC LIEF CI & PI:

Every member institution has a representative Chief Investigator (CI) or Partner Investigator (PI).

LEGACY GRANTS:

ANZIC provides grants to researchers for analytical research on previously recovered ocean drilling material. From \$10,000 - \$20,000.

EXPEDITIONERS:

ANZIC members have an opportunity to apply for a berth (ANZIC contribution per expeditioner approx. \$377,000). A total of 53 scientists from Australia and New Zealand have participated on expeditions between 2014-19. 38 Australian and 15 NZ scientists.

POST-CRUISE FUNDS:

ANZIC funds up to \$40,000 for post-cruise analytical work for Australian members. 42 researchers have received post-cruise support from ANZIC during the period 2014-2019.

Note: New Zealand does not currently offer post-cruise support.

MASTERCLASS STUDENTS:

The annual ANZIC Marine Geoscience Masterclass introduces up to 30 high-achieving undergraduate students from our member institutions, to the specialist techniques and unique opportunities available through IODP. Students are selected by their institutions and ANZIC provides a budget of \$65,000 for the Masterclass to be run by ANZIC members.

CONFERENCE/WORKSHOPS:

ANZIC provides members with travel support and/ or funding to attend relevant workshops and conferences relating to IODP and ANZIC activities in Australia and abroad.

ANZIC GOVERNANCE:

ANZIC is overseen by a Governing Council steered by our independent chair, Dr Ian Poiner. The Council provides scientific and financial oversight of Australian activities including those of the Australian IODP Office and the Science Committee.

ANZIC SCIENCE COMMITTEE:

The ANZIC Science Committee encourages and assists the development of science proposals, organises topical workshops, and evaluates cruise applications, funding applications and candidates for IODP panel membership. The Science Committee has a chair, vice-chair, and 14 representatives from our consortium members, with expertise across the four current IODP science plan themes.

INTERNATIONAL IODP PANELS AND BOARDS:

ANZIC members represent and serve on international IODP panels and boards including platform facility boards, which make decisions on fulfilling the objectives of the IODP Science Plan, including updates to the expedition schedule. Other advisory panels include - the Science Evaluation Panel and the Environmental Protection and Safety Panel - to evaluate the science, sites, environmental protection, and safety of proposed expeditions.



DETAILING 100 MILLION YEARS OF CLIMATE CHANGE



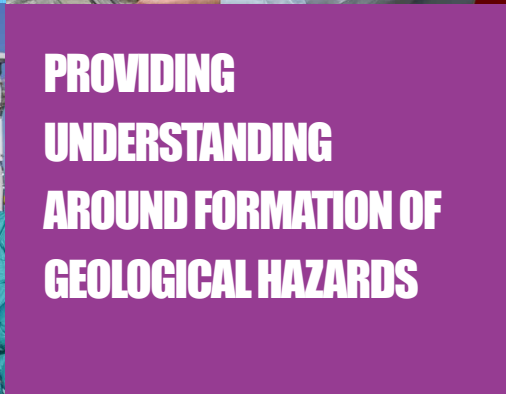
UNDERSTANDING THREATS TO OCEAN HEALTH



DEFINING THE 7TH CONTINENTAL PIECE, ZEALANDIA



ADDING TO OUR UNDERSTANDING OF ASTEROID IMPACT DINOSAUR WIPE-OUT



PROVIDING UNDERSTANDING AROUND FORMATION OF GEOLOGICAL HAZARDS

LEGACY FUNDING

Every year ANZIC provides legacy grants to researchers for analytical research on previously recovered ocean drilling material.

This successful program has supported many legacy grant projects centred on the analysis of previously collected DSDP/ODP/IODP samples and has facilitated the rapid production of high-quality publications, conference presentations and/or outreach activities.

The International Ocean Discovery Program not only offers the global community the opportunity to propose, undertake and participate in expeditions to address challenges outlined in the IODP Science Plan (2013-2023), but also values the collected cores for future scientific research open to the global community. Collected cores are housed in three core repositories based in the US (Gulf Coast Repository - GCR) Japan (Kochi Core Centre - KCC) and Germany (Bremen Core Repository - BCR) (<http://www.iodp.org/resources/core-repositories>).

Cores are curated based on broad expedition-based geographic locations (illustrated below). The majority of samples collected from the Australian region are curated in the Kochi Core centre (Japan), whilst Antarctic cores are maintained in the Gulf Coast Repository, USA.

ANZIC ensures that our members make use of the vast collections of previously collected DSDP, IODP-I and IODP-II, under the ANZIC IODP Legacy Analytical Funding Program (AILAF). In 2019, eight projects (listed in the table below) were supported representing a total investment of \$145,054. Results from these projects should be forthcoming in 2021. Looking forward to 2020, New Zealand members will also be able to apply for funding under this program.

Note: New Zealand members of ANZIC currently do not participate in this program.

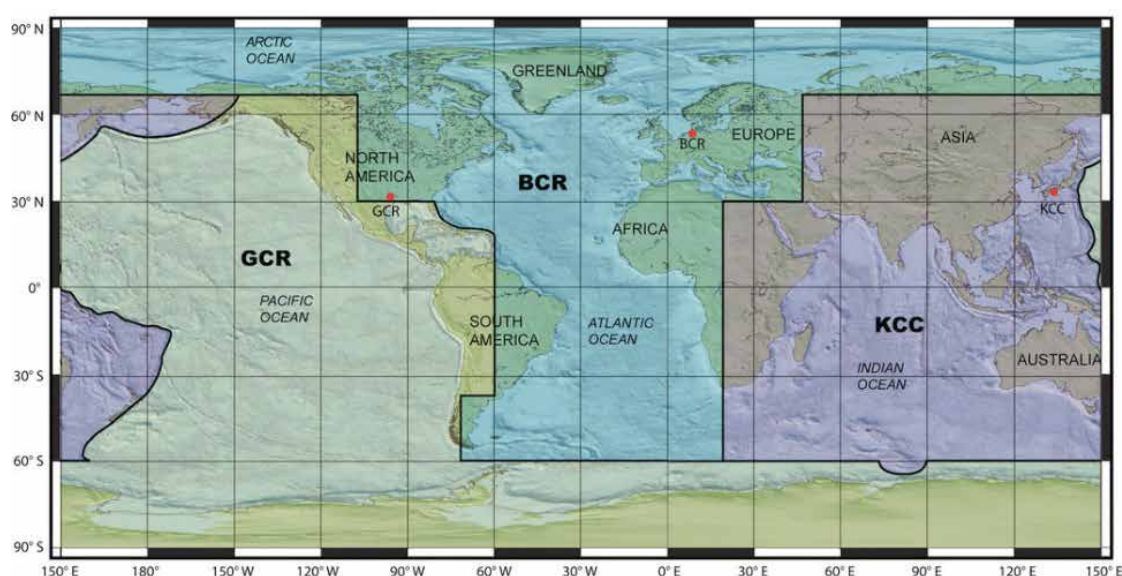


Figure of core repository holdings by geographic location. Figure by U. Röhl adapted from Firth et al. 2009, [Map Mar. 15, 2016].

Institution	Applicant	Application Title	Funding (AUD)
The University of Sydney	A/Prof Jody Webster (USYD)	Death by a thousand cuts: understanding the role of paleowater quality (high sediment & nutrient flux) in the growth and demise of the Great Barrier Reef over the past 30,000 yrs	\$ 19,707.00
The Australian National University	Dr Katharine Grant, Prof Andrew Roberts, and Song Zhao (ANU)	Australian monsoon variability through the Pleistocene	\$ 20,000.00
The University of Queensland Queensland University of Technology	Dr Teresa Ubide (UQ), Prof Balz Kamber, and Dr David Murphy (QUT)	Taking the pulse of oceanic crust formation: unlocking the magmatic secrets stored in cumulate pyroxene crystals	\$ 19,850.00
The University of Adelaide	Dr Lucy McGee, Dr Juraj Farkas (UA), and Dr Chris Yeats (Geol. Surv. NSW)	Calibrating metal isotope proxies in modern hydrothermal environments for ancient ore deposit applications	\$ 19,419.00
Macquarie University	Dr Stefan Loehr, A/Prof Nathan Daczko (MQ), A/Prof Jo Whittaker (UTAS), and Dr Tony Hall (UA)	Constraining the palaeodepth evolution of the South Tasman Rise and determining its role in development of the Antarctic Circumpolar Current (ACC)	\$ 17,838.00
The University of Tasmania	Dr Martin Jutzeler and Dr Rebecca Carey (UTAS)	Volcanic architecture and eruption behaviour at Site U1347 Izu-Bonin-Mariana rear-arc, IODP 350	\$ 20,000.00
The University of Sydney	Dr Maria Seton (USYD)	Queensland and Marion Plateaus: the birthplace of eastern Australian volcanism?	\$ 10,000.00
The University of Western Australia	Dr Aleksey Sadokov and Dr David Haig (UWA)	Evolution of Cretaceous foraminiferal geochemistry and its links to seawater carbonate chemistry	\$ 18,240.60

ANZIC Activities

ANZIC Australian and New Zealand scientists have access to a range of resources and opportunities.

Every year ANZIC members represent ANZIC at various conferences, meetings and forums have access to all IODP activities including shipboard and post-cruise research, workshops, participation in planning committees and panels, and visits from outstanding scientific speakers.



The annual IODP Forum meeting was held in Osaka, Japan on 11-14 September with ANZIC representatives at Leanne Armand, Joanna Parr and Mike Coffin in attendance. Jo and Mike, as part of the ANZIC strategic writing committee, were there to discuss the draft Strategic Framework and Road Map.

2019 Expeditions

In 2019 five ANZIC scientists participated in four expeditions. Details pages: 22-26.

ANZIC Roadshow: January-February, Australia Wide

During the months of January and February, ANZIC's Program Scientist Leanne Armand conducted a nation wide roadshow visiting most Member Institutions. The purpose, including updating institutions on their successful participation in the current program, was to provide updates on ANZIC activities and outline future opportunities for continued IODP participation.

ANZIC Ocean Planet Workshop: 14 -17 April, Canberra

On 14 April 2019, more than 75 experts from the ANZIC and IODP Community from Australia, New Zealand, and abroad gathered in Canberra, at the ANU campus to formulate research themes and define new challenges for a new decadal (2024-2034) plan for global scientific ocean drilling. The Workshop was conducted over three days. The first day was for early career researchers with a gala icebreaker for all on the first evening. Details pages 17-18.

Chikyu IODP Board Meeting: 11-12 June, Kobe Japan



In attendance Leanne Armand

ICP13: 2-6 September, Sydney

Over 400 scientists across the globe attended ICP13 where ANZIC hosted a booth. Program Scientist Leanne Armand held a session where she presented "Oceanography: Scientific Ocean Drilling" and Stephen Gallagher talked about his three recent IODP expeditions to the west coast of Australia. See pictures below.

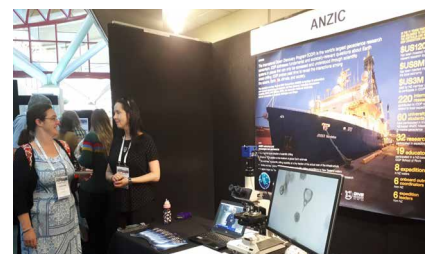


Several ANZIC members presented posters at the event also.

On the last day of this conference Dr Liz Truswell launched her book "A Memory of Ice," the story of the 1972/73 voyage where the Glomar Challenger was the first vessel of the Deep Sea Drilling Project (DSDP) to venture into the seas surrounding Antarctica. For the launch, films by Peter Barrett of DSDP Leg 28 provided visual context and Rob McKay presented highlights of IODP Exp. 374 to the Ross Sea. All books sold out, please contact ANU Press <https://press.anu.edu.au/publications/memory-ice> if you are looking for a copy.

Geoscience Society of New Zealand Conference: 24-27 November, Hamilton NZ

Marianna Terezow (NZIODP) highlighted ANZIC research and exhibited collected Radiolaria with attendees at this year's Geoscience Society of New Zealand Conference. (Photo : S. Henrys)



Science Meets Parliament: 6-27 November, Canberra

Program Scientist Leanne Armand and Ron Hackney (GA) represented ANZIC at the annual Science Meets Parliament. With meetings, keynote speakers, networking, and events. Leanne met with Susan Templeman MP to discuss the importance of Australia & NZ's continuing involvement with IODP and Ron Hackney met with Josh Wilson, shadow assistant Minister for Environment.



2019 ANZIC Masterclass, 2-10 December, Sydney Details pages 19-20.



Ocean Planet Workshop

*Developing
the new IODP
Strategic
Framework.*

*14 -16 April 2019,
Canberra*



Developing the new IODP Strategic Plan, 14-16 April 2019, Canberra

All parts of the Earth system are linked through flows of mass, energy, and life. Buried beneath the ocean floor are records of millions of years of Earth's climatic, biological, chemical, and geological history. Scientific ocean drilling allows researchers to access these records and explore, analyze, theorize, and test models that address how our planet works on local-to-global spatial scales and on decadal-to-millennial time scales. IODP advances understanding of Earth's past to be able to better understand and predict its future, and can inform decision-making about some of the most important environmental issues facing society today.

The current IODP Science Plan Illuminating Earth's Past, Present, and Future, is intended to guide multidisciplinary international collaboration on scientific ocean drilling during the period 2013-2023. ANZIC's Ocean Planet workshop was part of the worldwide effort to develop the next decadal science framework. ANZIC ran a three day workshop, bringing together Australian and New Zealand experts in marine geoscience and geomicrobiology relevant to drilling to help formulate a new science framework for ANZIC and its international partners.

The workshop, hosted at the Australian National University, encouraged early to mid career researchers, to attend and to

define new themes and new challenges. The participants provided fresh and innovative ideas and approaches to generate a new science framework, emphasizing research interests and expertise focused on Oceania and Antarctica for the next decade.

The first day of the workshop consisted of plenary and breakout sessions culminating with a gala ice-breaker event at the National Museum of Australia.

Over three days participants attended seminars, plenary, and planning sessions, deliberating new research themes, gaps in the current IODP Science Plan, and improved engineering, technological, drilling, logging, and observing capabilities.

A writing committee consisting of ANZIC members: Mike Coffin, Joanna Parr, Kliti Grice, Anais Page, Agathe Lisé-Pronovost, Ben Clennell, Nick Mortimer, Robert McKay, Helen McGregor, Christina Riesselman, Ian Poiner and Leanne Armand, and together with community and workshop participant consultation, the final ANZIC Ocean Planet Workshop report, **"Ocean Planet: An ANZIC workshop report focused on future research challenges and opportunities science framework for collaborative international scientific ocean drilling"** was formalised. The report forms part of the future 2050 Science Framework for Scientific Ocean Drilling. <https://doi.org/10.25911/5e1c39629af61>



The report was presented at an international science framework workshop in Osaka in September 2019, bringing together the input and results from all 23 IODP member nations to finalise the globally agreed next science framework for international scientific ocean drilling.

The science framework (2024-50) will guide future research that will address globally and regionally critical scientific and societal questions including how best to respond to geohazards such as tsunamis, earthquakes, and volcanic eruptions to a changing climate.

Read the EOS report on "Australia-New Zealand Plan for Future Scientific Ocean Drilling" here <https://eos.org/meeting-reports/australia-new-zealand-plan-for-future-scientific-ocean-drilling>



ANZIC Marine Geoscience Masterclass 2019



Every year ANZIC runs a week long Marine Geoscience Masterclass introducing up to 30 high achieving undergraduate students to the specialist techniques and unique opportunities available through the International Ocean Discovery Program.

Students participate in marine and geological fieldwork, seminars and workshops, and get to meet researchers involved in IODP and ANZIC.

The 2019 ANZIC Masterclass was held from the 2-10 of December in Sydney and surrounds. There were 18 student participants from 15 institutions with three from New Zealand.

The activities started in Sydney with an introduction dinner attended by organisers Simon George and Stefan Löhr (Macquarie University) and ANZIC Program Scientist Leanne Armand.

The first day was held at Sydney University where Leanne Armand introduced the students to IODP/ANZIC, and showed the cores of the PETM and K-Pg. Jody Webster, University of Sydney (USYD) gave a talk on "Overview of scientific results and highlights from the various IODP reef drilling expeditions (specifically expeditions 310, 325 and 389)", which was followed by a virtual IODP reef logging exercises (Exp. 310, 325), which also exposed the students to actual fossil reef cores that are archived at USYD. In the afternoon Maria Seton (USYD) led a workshop on plate reconstructions for IODP, using GPlates (plate reconstruction software).

On Wednesday and Thursday, activities were based at the Sydney Institute of Marine Science (SIMS). By water taxi, the whole group was transported direct to/from Kirribilli and Chowder Bay for fieldwork. Matt Kosnik and April Abbott (Macquarie University) led a day of boat work, which involved grab sampling Sydney Harbour sediments from various properties and locations, and determining water column chemistry using a CTD. The grab samples, piston cores and chemistry data were later analysed and interpreted in the SIMS labs. The students also had six talks about various aspects of marine geoscience and IODP.

On the last day of fieldwork in Sydney the students went on an afternoon kayaking trip around the Sydney Harbour foreshore, shrouded with bush-fire smoke. At that time the Australian bush-fires had been burning already for six months.





On Friday, Simon George and Stefan Löhr took the students on a geological fieldtrip to Sussex inlet on the south coast of NSW. The fieldtrip turned out to be the most problematic part of the Masterclass to organise, due to the Currowan bushfire which at that time surrounded Kioloa and most of the intended fieldwork sites to the south of Kioloa. After re-scheduling accommodation and devising new locations to visit, they visited the following locations, which involved examining sedimentary rocks mostly from the upper part of the Permian:

- Culburra Beach: Crookhaven Lighthouse, Penguin Head (upper part of Wandrawandian Siltstone, and the overlying Nowra Sandstone)
- Warden Head (Wandrawandian Siltstone)
- Westley Park, Kiama and Bombo Quarry (Broughton Formation)
- Late Permian Sydney Basin sedimentary and volcanic succession of the Illawarra coast, including the P-T boundary at Coalcliff.

The location change was an advantage as new areas were explored, some of which will be useful for future fieldtrips.

A workshop on “Biostratigraphy and magnetochron reversal, and their application for building age-depth models, identifying sedimentation rates, and the implications of hiatuses/gaps in the sedimentary record”, was also held during the fieldtrip.

On the last day the group visited the [Geological Survey of NSW](#) core store at Londonderry, Western Sydney. With morning tea, and a guided tour of the core repository, the students examined the DM Callala DDH1 core (Shoalhaven Group, Jervis Bay area (0-520 m), which included some of the Permian lithologies they had examined in outcrop.. The students practiced some core logging

and description. In the afternoon back at Macquarie University, the students were given a guided tour through some of the research labs, finished with an informal afternoon tea.

Thank you to the Masterclass organisers Simon George and Stefan Löhr from Macquarie University and other contributors including, April Abbott, Dietmar Muller, Maria, Setton, Adriana Dutkiewicz, Rosa Didonna, and all the other speakers and contributors who helped make the ANZIC 2019 Masterclass a success!



Getting creative onboard *The JR*



Clockwise from top left: ■ Exp 382 - The scientists took a break to learn the art of origami penguins. (Credit: Lee Stevens) ■ Exp 382 - Sarah Kachovich (Marine Laboratory Specialist, IODP JRSO) puts the finishing touches to her artwork on the side of the X-ray core imager. (Credit: Sarah Kachovich) ■ Exp 382 - Styrofoam cups shrunk by pressure at the bottom of the ocean. Many of these were decorated by children from two schools in Rhode Island, USA. (Credit: Lee Stevens) ■ Exp 379 - The Entire Chief Cook and Lead Steward pose with a decorative fruit ornament. (Credit: Anna Halberstadt) ■ Exp 382 - A hardhat decorated by Sara Kachovich (Marine Laboratory Specialist, IODP JRSO). (Credit: Sarah Kachovich) ■ Exp 382 - Linda Armbrrecht & Brendan Reilly show off their matching *JOIDES Resolution* temporary tattoos! (Credit: Linda Armbrrecht).

IODP Expeditions 2019

- Expedition 385 - NanTroSEIZE Plate Boundary Deep Riser (7 October 2018- 31 March 2019)
- Expedition 379 - Amundsen Sea West Antarctic Ice Sheet History (18 January - 20 March 2019)
- Expedition 382 - Iceberg Alley and Subantarctic Ice and Ocean Dynamics (20 March - 20 May 2019)
- Expedition 383 - Dynamics of Pacific Antarctic Circumpolar Current DYNAPACC (20 May - 20 July 2019)

These are a few of my favourite things!



"Going to sea with creature comforts like a Bluetooth speaker and a kimono-style robe, which is great for navigating the JR's tiny quad-share bathrooms."

"Cinnamon Toast

Crunch" - which tastes good on everything! It also makes an excellent snack during a daily catch-up routine in the lounge, re-living the first adventures of the "survivors" of Oceanic Flight 815 in the TV show "Lost".

"The food on the JR? Excellent, every day the crew were absolutely spoiled by the JR chefs and kitchen crew"



"Bringing my favourite whole beans from a hole-in-the-wall Dunedin coffee roaster (Mazagran)."



"Chocolate and a camera to take pictures of the amazing scenery and wildlife."



Say "Cheese!"



Work out!

Expedition 385 - NanTroSEIZE Plate Boundary Deep Riser DV *Chikyu* (7 October 2018- 31 March 2019).

Toby Colson (University of Western Australia)



Expedition 358 saw the implementation of a Real-Time Geomechanics (RTG) operations team, established to assist the CDEX Drilling Group in the safe and successful drilling of hole C0002Q and C0002R. The RTG team was composed of geomechanics specialists, geologists, geophysicists, petrophysicists, drilling engineers, LWD engineers and mud engineers. During operations, two assigned RTG Watch Leads were onboard the DV *Chikyu* and were in direct communication with the CDEX Drilling Superintendent regarding geomechanical interpretations and recommendations. Expedition 358 culminated in March 2019 with the drilling of two riserless contingency holes at sites NT1-03C and KB-01C. Scientists from several scientific parties continued with the valuable research on the core that was retrieved during this contingency drilling. The RTG team in which I contributed as a Watch Lead, did not participate in these contingency activities. However, the efforts borne by the RTG team and communication among all disciplines successfully demonstrated the value of a real-time geomechanics team during IODP and complex drilling operations. Current on-going reviews of the Expedition 358 drilling activities and the analysis provided by the RTG team will continue to play an essential role in the future endeavours of both research related to this expedition and other drilling activities, especially in poorly explored frontier settings and tectonically complex environments.

In March 2019 the final phase of the long running Nankai Trough Seismogenic Zone Experiment (IODP Expedition 358) concluded offshore Japan. This was the culmination of 20 years of planning and 11 years of NanTroSEIZE drilling efforts. The expedition was located at IODP Site C0002. Site C0002 had been attempted three times before, in steps, finally reaching 3,058.5 meters below sea floor. IODP Site C0002 was the deep centerpiece of the NanTroSEIZE project intended to access the plate interface fault system at a location where it is believed to be capable of seismogenic locking and slip, and to have slipped coseismically in the 1944 Tonankai earthquake.

DV *Chikyu* was on site between October 2018 and March 2019 and the drilling operations lived up to expectations in difficulty and complexity. The science

party was updating and evolving key objectives almost on a daily basis as operations continued to present unforeseen outcomes. We collected valuable data and learnt new things about the lithology of the overlying accretionary prism including achieving the record for the deepest scientific borehole drilled to date below the seafloor (3262.5 mbsf).

Drilling operations proved difficult with multiple attempts to side-track and ream down the hole proving unsuccessful. Kick off and reaming operations in the previously damaged and highly fractured annulus of hole C0002 upper sections ultimately could not be achieved to plan and material limitations in the operation left contingent activities such as virgin hole attempts not feasible. As a result, it was with great disappointment we were unable to reach the primary target, the plate boundary fault.

Nevertheless, the shipboard scientists collected significant amounts of geophysical, and geological data from cuttings, LWD and drill logs. Real-Time M-LWD logs and monitoring of mud gas and cuttings were conducted and an enormous amount of drilling and operational data were collected, which are currently being assessed to understand what lessons can be learnt for future campaigns. The nature of offshore drilling remains incredibly complex and challenging, even in more benign geological environments. Expedition 358 reminded us all how the scientific evaluation objective of any IODP expedition is only half the story, for without the engineers, technicians, logistics professionals, and service personnel, the search for new data cannot begin.

It was a privilege to have participated with the geomechanics team and served as a watch lead in the real time monitoring group.

The team comprised seven specialists from around the world providing monitoring, modelling, and recommendations to the DV *Chikyu* drilling team. Wellbore

instability issues were ultimately managed successfully as a result and this will no doubt serve as a learning lesson for the next deep riser drilling operation.

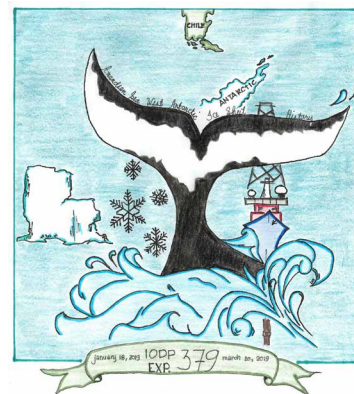
The value of ANZIC's involvement in these operations is what we can learn for future campaigns so we can drill deeper into the unknown and continue to set new records for scientific ocean drilling around the world.

Toby Colson



Expedition 379 - Amundsen Sea West Antarctic Ice Sheet History DV JOIDES Resolution (18 January - 20 March 2019).

Joe Prebble (GNS Science) as a Palynologist.



Expedition 379, which started and ended at Punta Arenas, Chile, recovered the longest sedimentary record yet from the sparsely-studied, yet important sector of the Antarctic Margin. More than 1,000m of latest Miocene to recent drift deposits were recovered from two sites on either side of the informally named "Resolution Drift". This expedition enjoyed generally excellent core recovery, and the sediments will be able to provide a high resolution record of ice sheet and deep ocean variability over the critical warm and transition intervals of the Plio-Pleistocene.

– faster than other areas. But, we do not know how long these changes have been going for, and therefore exactly how sensitive this part of the ice sheet is to the current ocean warming." His post cruise research will focus on understanding the timing and evolution of this sector of the West Antarctic Ice Sheet during the middle and late Pliocene, and on variability during the late Quaternary.

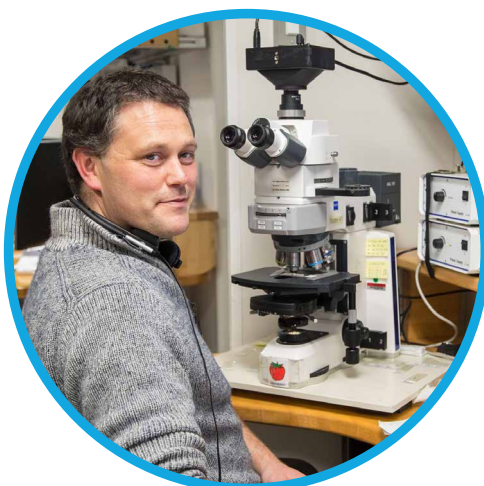
Due to the extreme isolation of the Amundsen Sea region, even compared to other parts of Antarctica, these are the first long drill cores ever obtained in the Amundsen Sea. The long cores were collected in an area that drains parts of the West Antarctic Ice Sheet that currently is experiencing the largest ice mass loss in Antarctica. These cores were taken from a location in the Amundsen Sea where thick sediments were deposited over the last 6 million years. The recovered material contains layers of sediments representing the alternating cycles of cold and warm intervals when the ice sheet expanded and retreated.

This expedition brought together a research group of 27 scientists from participating countries, experts in their fields, who all had to work together to understand the past variability of the ice sheet. With all those great people and facilities, it is a really inspiring and productive way to do research. In fact, these data could not be collected in any other way. It was a really beautiful part of the world to be working in: we were visited frequently by whales and other marine life.

Drilling took place while countless icebergs drifted through the region, often forcing the ship to move off location and start drilling a new hole as quickly as possible, before an iceberg came to that new location."

Expedition 379 to the Amundsen Sea is one of a series of planned and recent IODP expeditions focused on understanding variability and sensitivity of the Antarctic ice sheets and Southern Ocean variability, including Exp 374 the Ross Sea in January 2018, Exp 382 Iceberg Alley, east of the Antarctic Peninsula during April - May 2019, and Exp 383 – Dynamics of the Pacific Antarctic Circumpolar Current – during May - July 2019.

Joe Prebble



The expedition focused on the deeper water drilling targets, as high concentrations of sea-ice this year prevented access to other expedition targets on the continental shelf. The expedition also encountered a series of drilling delays due to icebergs – a problem overcome by a series of hole reentries, and multiple holes at each site.

Dr Joe Prebble from GNS Science in New Zealand sailed on the expedition, as an expert palynologist, supported by ANZIC. His job on the ship was to use fossil pollen and marine algae for biostratigraphy, and to help understand the environmental conditions that prevailed when the sediment were deposited. Joe has been in the paleontology Team at GNS for 6 years, and has spent much of his research career studying past climate change in Antarctica and in the oceans around New Zealand. "This expedition was a truly unique opportunity to understand a really important part of Antarctica. We know from modern observations that this part of Antarctica is changing – melting



Expedition 382 - Iceberg Alley and Subantarctic Ice and Ocean Dynamics DV JOIDES Resolution. (20 March - 20 May 2019).

Linda Armbrecht - University of Adelaide (Diatom Palaeontologist).



Expedition 382 sailed to "Iceberg Alley," the main pathway along which icebergs travel after they have calved from the margin of the Antarctic Ice Sheet on their way into the warmer waters of the Antarctic Circumpolar Current. The expedition's main goal was to drill and recover sediment records in this iceberg-shedding region to investigate how the Antarctic Ice Sheet has responded to past changes in climate, and how periods of ice mass loss contributed to global sea-level evolution throughout the late Neogene. Additional research objectives focused on achieving a much better understanding of past variations in regional atmospheric circulation and carbon dioxide concentrations, dust transport, ocean bio-productivity, the flow of deep water through the Drake Passage, and Antarctic Intermediate Water transport beneath the Subantarctic Front.

To achieve these goals, we drilled five sites, two at the northern edge of the Scotia Sea (Subantarctic Front Sites U1534-U1535) and three sites in the southern Scotia Sea (Pirie and Dove Basin Sites U1536-U1538). From these five sites, we were able to recover a total of 2,810 m of sediment core! The sediments from the Subantarctic Front Sites are currently being used to reconstruct and understand how ocean circulation and intermediate water formation responded to changes in climate, with a focus on the connectivity between the Atlantic and

Pacific basins (the "cold water route"). The sediments from the Scotia Sea are being examined from various research angles to assess both the pace and magnitude of iceberg flux during key times of Antarctic Ice Sheet evolution. Even though we are now distributed across the globe, and life has turned upside down in the year that has passed, the newly formed collaborations amongst Expedition 382 scientists are ongoing at high speed, with exciting new research underway!

For me personally, Expedition 382 meant a unique opportunity to expand my current research in the fields of marine micropalaeontology and sedimentary ancient DNA. I was part of the biostratigraphy team, together with fellow micropaleontologists Jonathan Warnock, IUP, USA, and Yuji Kato, Kochi, Japan. In this role it was our responsibility to closely examine samples from each newly acquired core under the microscope to make first age-estimates based on the diatom-fossil composition. To extend these analyses beyond the fossil record, I also collected samples for the analysis of ancient DNA. To ensure that ancient sediment material was free of contamination, we took special precautions to clean core liners, cutting tools, work bench surfaces, and sampling tools. As a result, we were able to collect over 200 samples of the highest quality for ancient DNA analyses, which are now being used to investigate past marine community assemblages and evolution in response to variations in climate throughout the Holocene, and, potentially even a few hundred thousand years!

A natural side-effect of drilling in an area called "Iceberg Alley" is that icebergs are likely to be encountered – which makes for impressive photos, but also meant that we occasionally had to temporarily abandon the drill site to let icebergs pass. During those times, I was especially euphoric to have brought along the following items: 1. a top camera and some extremely cold weather clothes to be able to capture the outdoor iceberg scenery and wildlife; 2. my travel-mug, and a family-pack of Krüger White Cappuccino instant powder – to keep me warm and make Germany feel less far away; 3. Vegemite, making Oz feel less far away; and 4. My gym-gear, to combat the abundance of cookies in the Scotia Sea. I

definitely had almost everything I needed, except: sufficient souvenir pens from Australia - the number of birthdays during a 2-month expedition is unbelievable.

In summary, Exp 382 was an unforgettable experience filled with exciting science, a brilliant team, and a crew that made living on the *JR* exceptionally easy and comfortable. I'm extremely grateful to ANZIC, the Co-chiefs, staff scientist, and *JR* crew to have had the opportunity to participate in this expedition and be part of the Expedition 382 science party.

Linda Armbrecht

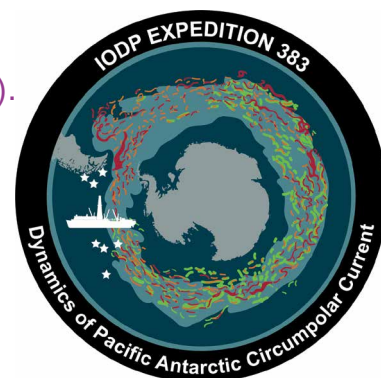
An overview about my research on marine sedimentary ancient DNA can be found in this short video <https://www.youtube.com/watch?v=j23l1Quv0nM>



Expedition 383 - Dynamics of Pacific Antarctic Circumpolar Current DYNAPACC DV JOIDES Resolution. (20 May - 20 July 2019).

Christina Riesselman - University of Otago (Diatom Paleontologist);

Christopher Moy - University of Otago (Sedimentologist).



On 25 May, 2019, IODP Exp. 383 departed Punta Arenas, Chile, sailing westward into the core of the Antarctic Circumpolar Current (ACC). Led by co-chief scientists Frank Lamy (AWI) and Gisela Winckler (LDEO), and IODP Expedition Project Manager Carlos Alvarez Zarikian (TAMU), Exp. 383 successfully drilled six sites selected to address three main research objectives. Sites U1539-U1541 in the central South Pacific were selected to examine how variations in the dynamics of the southern Pacific Ocean and Antarctic Circumpolar Current influence the physical and biological processes that drive the Southern Ocean biological pump, regulating atmospheric CO₂ on geologic timescales. Site U1543, a pelagic site in the eastern Pacific, supports investigation into how the dynamics of the ACC flowing through the Drake Passage impact the efficiency of overturning circulation. Finally, sites U1542 and U1544 on the Chilean continental margin will improve our understanding of the extent, timing, and drivers of Patagonian ice sheet retreat.

Drilling in the “furious fifties” zonal band of the ACC, where strong winds circulate unimpeded in a continuous belt around the planet, came with all of the expected operational challenges. Weather delays were numerous, and at one point, we had to transit 10° of latitude northward to evade a powerful storm system with 9m + swell, meaning we unfortunately could not reach the southernmost planned drilling target in the central South Pacific. Despite these challenges, Exp. 383 expedition was fantastically successful, recovering high quality core from each of the six sites we were able to drill. In total, Chris and the sedimentology team described 2636 m of sediments recovered from a total cored interval of 2649 m, a stunning 99.5% rate of recovery. Christina and the paleontology team identified 291 individual biostratigraphic events; accumulation at all of our pelagic sites appears to be continuous,

including late Miocene sediments recovered from two locations.

One of the things that makes IODP so successful is that multinational collaboration is baked into the structure of the programme. Our science party of 31 comprised representatives of 11 nations, originating from 13 different countries, including an observer from Chile. And like most IODP expeditions, the relative strangers who came together in May to form the Exp. 383 science party disembarked the JOIDES Resolution in July as a close-knit team, looking forward to years of research collaboration and friendship. This work kicked off last October, when Christina met collaborators at the Gulf Coast Repository at TAMU to conduct ultra-high resolution XRF scanning and collect the very first post-cruise Exp. 383 samples for a calibration project. Chris traveled to TAMU in November, where he spent 10 days contributing to the round-the-clock XRF scanning efforts. Both of us returned to College Station in January for the editorial meeting, then all hands were needed to tackle the > 40,000 samples requested by Exp. 383 shipboard and shore-based scientists. The 27 of us who gathered at the Gulf Coast Repository were able to collect more than 28,000 samples during the party, but plans for a second party to collect the last 15,000 samples were scuttled by the Covid-19 pandemic. Carlos and the IODP TAMU team are now making their way through the remaining samples with masks and social distancing, and we're all grateful for their hard work and regular photo updates.

Given IODP's model of allocating berths proportionally to membership level, shipboard positions for ANZIC scientists are very competitive. It's unusual for two ANZIC scientists to join a science party, except as co-chief scientists, so the odds that both members of a dual-career couple from an ANZIC member institution would be selected for the same expedition must be infinitesimal. We therefore felt doubly fortunate, first when Chris's track record in Chilean paleoclimate research led to an invitation to join the expedition as a lead sedimentologist through the initial call for applicants, and again a few months later when Christina was subsequently selected to join the team as a diatom micropaleontologist through an open-nation special call, based on her background of Neogene Southern Ocean reconstructions. Many people have been curious, so here you go: Yes, we were assigned to the same shift. But no, we didn't share a cabin.

Exp. 383 was Chris's second IODP expedition (Exp. 341) and Christina's third (Leg 208; Exp. 318), and we've both sailed with other programmes too. Over the years, we've each dialed in the things that keep us happy at sea. Good coffee is essential: this time, we brought four kilos of whole beans from our favorite hole-in-the-wall Dunedin coffee roaster (Mazagran) and we started most shifts with a freshly-ground long black from the planning room espresso machine. Chris's other Exp. 383 essentials were a jacket on loan from Antarctica New Zealand to keep him warm while on deck and a good selection of music. For Christina, food is important for morale – she picked up good cheeses and a bag of the greenest avocados she could find at the supermarket in Punta Arenas, then rationed them as long as she could. She also goes to sea with creature comforts like a Bluetooth speaker and a kimono-style robe, which is great for navigating the JR's tiny quad-share bathrooms.



Of course, the single favourite thing we brought on this expedition was each other. We feel very fortunate to have shared this experience, and deeply grateful to ANZIC for supporting our participation and to IODP for selecting us both to join the science party. Finally, we owe a huge debt of gratitude to the amazing IODP technicians, ship's crew, science party, and expedition leaders for making Exp. 383 so very successful.

Christina Riesselman & Chris Moy



DID YOU KNOW?

CORE

The long cylinder of material obtained by use of a core drill. Once extracted, they are then cut into lengths to be sampled, analyzed and stored for ongoing research. Currently there are over approx. 500km of cores stored in the four [IODP repositories](#). Cores that are regularly accessed by researchers around the world.

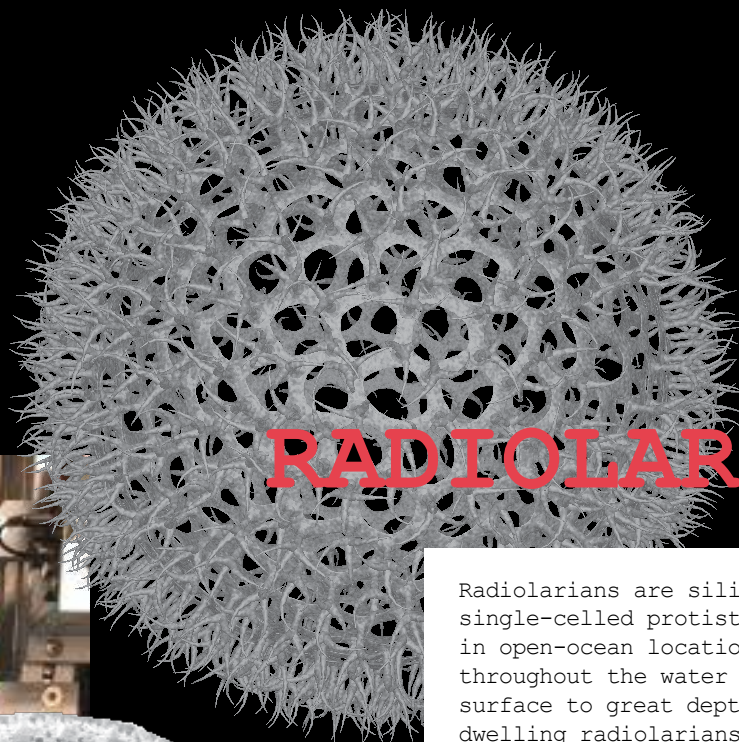
DRILL BIT

A top drive on the drilling platform rotates a drill string and, at the other end, a drill bit grinds through the Earth. The core barrels retrieve and store the core material cut by the drill bit. Technicians recover the long cylinder of sediment or rock. Deep holes often require several changes of drill bits.

MOON POOL

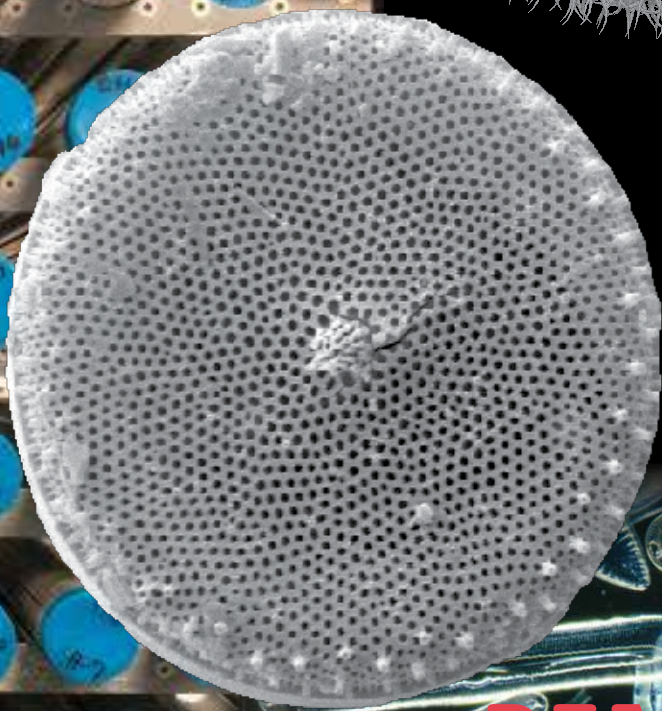
Moon pool is the opening in the hull of a drillship or other offshore drilling vessel through which drilling equipment passes.

SAMPLE



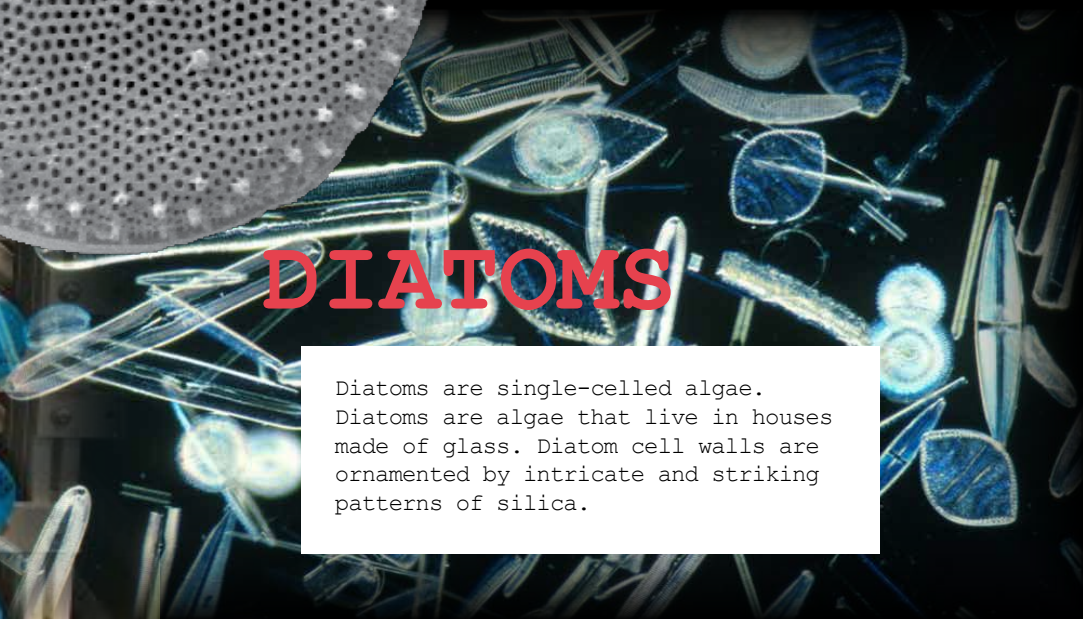
RADIOLARIAN

Radiolarians are silica-secreting, single-celled protists that dwell in open-ocean locations. They occur throughout the water column from near surface to great depths. Some surface-dwelling radiolarians have algal symbionts.



DIATOMS

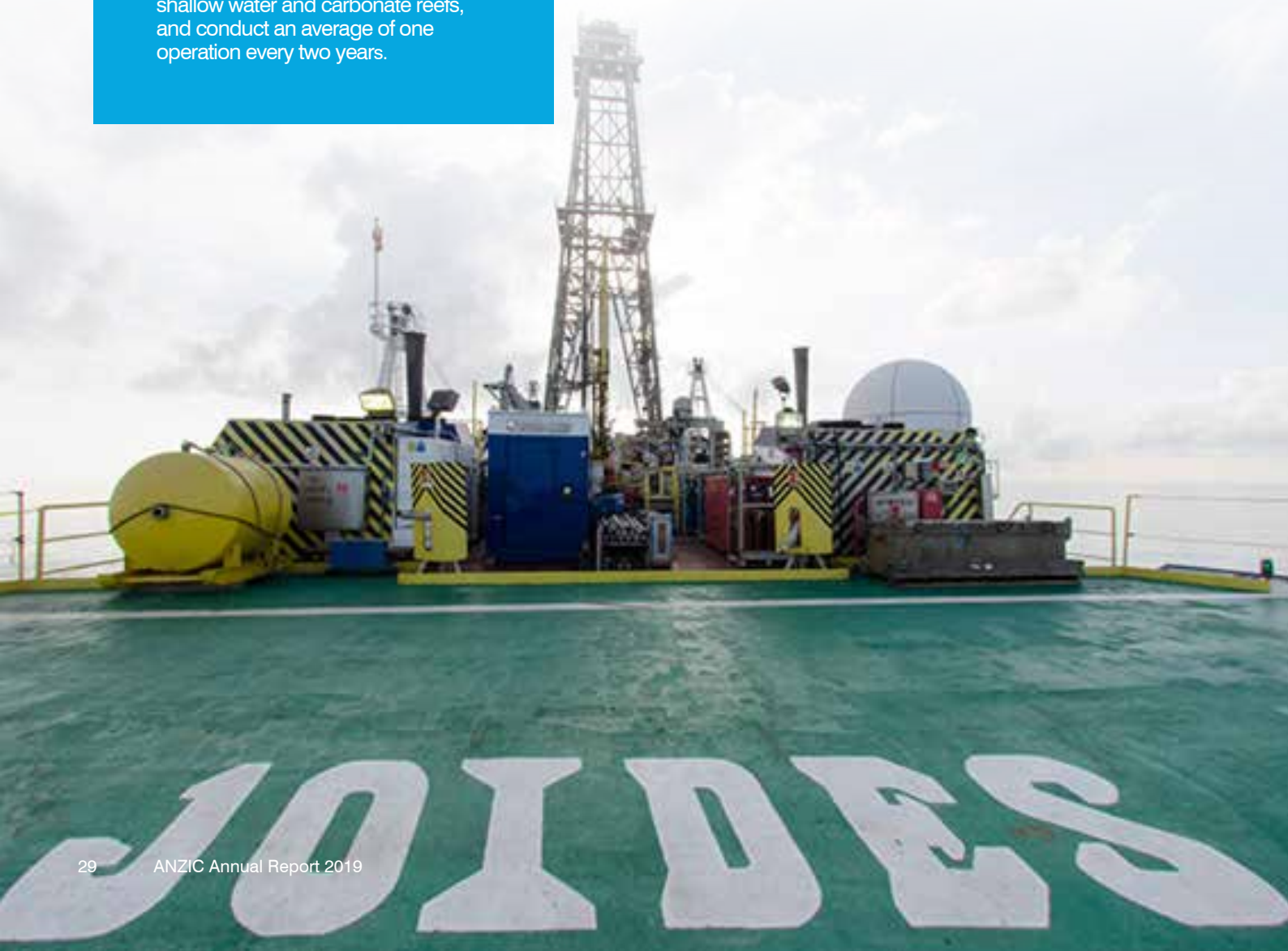
Diatoms are single-celled algae. Diatoms are algae that live in houses made of glass. Diatom cell walls are ornamented by intricate and striking patterns of silica.



Future IODP Expeditions

The *JOIDES Resolution* operates for the program as close to a full-year schedule as possible and the Japanese riser-drilling platform *DV Chikyu* operates on average 2 months/year.

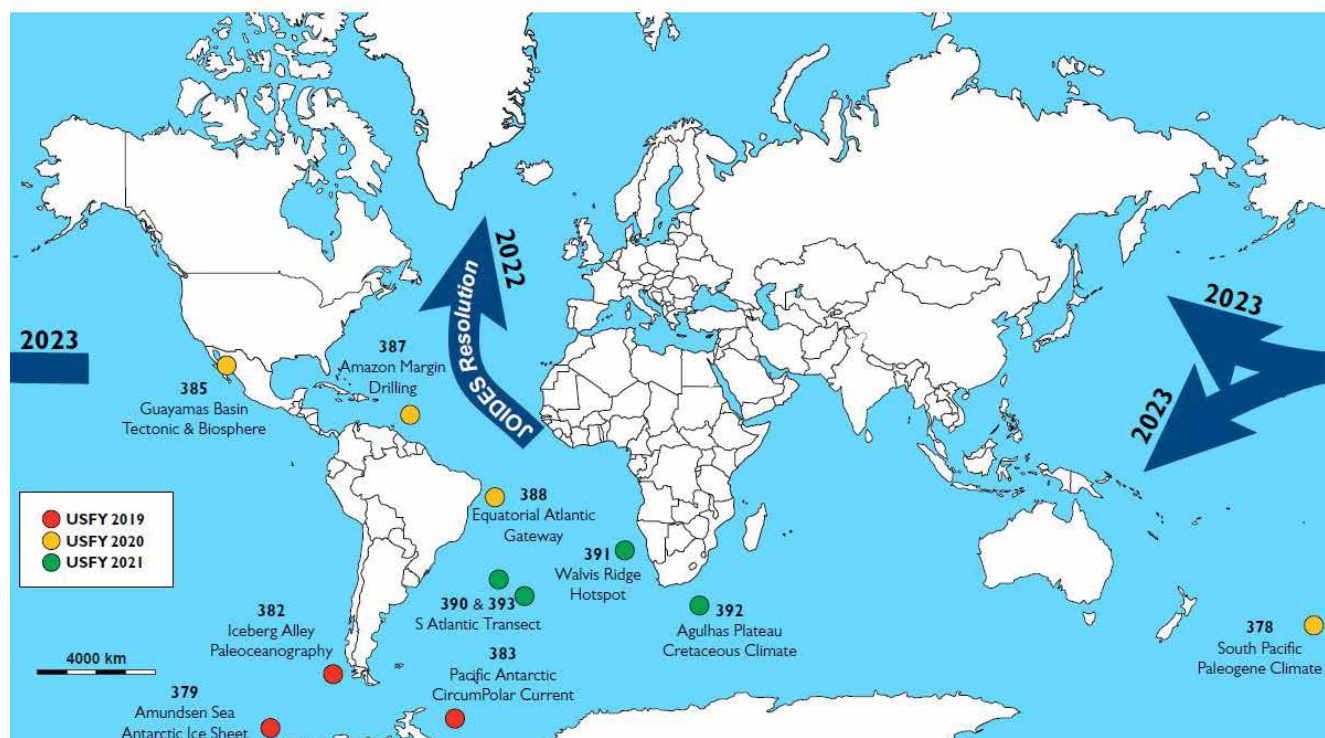
Mission specific EU chartered platforms are used in challenging environments such as high Arctic, shallow water and carbonate reefs, and conduct an average of one operation every two years.



Future IODP Planned Expeditions 2020-2021

Expedition Name	#	Dates	Ports	
South Pacific Paleogene Climate	378	Jan 3 - Feb 6, 2020	Fiji / Papeete	JRSO
JOIDES Resolution Engineering Testing	384	July 20 - Sept 5, 2020	Kristiansand / Las Palmas	JRSO
Reykjanes Mantle Convection and Climate	395	June 6-Aug 6, 2021	Reykjavik / Reykjavik	JRSO
Mid-Norwegian Continental Margin Magmatism	396	Aug 6-Oct 6, 2021	Reykjavik/Kristiansand	JRSO
Walvis Ridge Hotspot	391	Dec 6 2021-Feb 5 2022	Cape Town / Cape Town	JRSO
Agulhas Plateau Cretaceous Climate	392	Feb 5-Apr 7, 2022	Cape Town / Cape Town	JRSO
South Atlantic Transect #1	390	Apr 7-Jun 7, 2022	Cape Town / Montevideo	JRSO
South Atlantic Transect #2	393	Jun 7-Aug 7, 2022	Montevideo / Montevideo	JRSO
Japan Trench Paleoseismology	386	postponed into 2021/22	Yokosuka / Yokosuka	ESO
Amazon Continental Margin	387	postponed	TBD	JRSO
Equatorial Atlantic Gateway	388	postponed	TBD	JRSO
Rio Grande Cone Methane and Carbon Cycling	394	postponed	TBD	JRSO
Arctic Ocean Paleoceanography	377	anticipated summer / fall 2021	TBD	ESO

2019-2021 JOIDES Resolution IODP expeditions and planned JOIDES Resolution ship track



As approved by the JRFB in May 2019: "The JR is expected to operate in the Equatorial and North Atlantic, Gulf of Mexico, Mediterranean, Caribbean, and the Arctic in 2021 and 2022, and to complete its circumnavigation with a return to the eastern Pacific region by 2023, the western Pacific in 2023-2024, and potentially the Indian Ocean by the end of 2024.

For up-to-date schedules please refer to www.iodp.org/expeditions/expeditions-schedule. This map was produced by IODP.

IODP Committees, Governing Council & Science Committee



IODP Panels, Boards, and Forums

IODP evaluates proposals for scientific drilling expeditions based on impact, logistical feasibility, and cost through a system of Facility Boards and Advisory Panels whose membership is drawn from the international scientific community.

Drilling proposals are first evaluated by the Science Evaluation Panel (SEP), which is responsible for evaluating the scientific objectives and technical approach of submitted proposals at all stages, and for forwarding ready-to-drill and top-priority proposals to the appropriate Facility Board. The Environmental Protection and Safety Panel (EPSP) provides critical support to the review process, and engineering panels are convened as needed by the platform operators.

The JOIDES Resolution Facility Board oversees the operations of the JOIDES Resolution, including scheduling expeditions, approving program plans, monitoring the advisory panels to ensure efficient and effective review of drilling proposals, and developing and monitoring policies for data collection, publications, and core curation. Independent Facility Boards also oversee DV Chikyu (Chikyu IODP Board) and Mission Specific Platform (ECORD Facility Board) operations. The ANZIC Program Scientist is our representative on all three facility boards.

The IODP Forum is a venue for exchanging ideas and views on the scientific progress of the International Ocean Discovery Program. The Forum is the custodian of the IODP Science Plan 2013-2023 and provides advice to the IODP Facility Boards on Platform Provider activity. IODP Forum meets annually and membership is open to all countries, consortia, or entities that provide funds to IODP platform operations

ANZIC has participation rights on IODP Scientific Advisory Structure panels, with ANZIC representatives listed below.

Committee or Panel	Member	Institution
JOIDES Resolution Facility Board Chikyu IODP Facility Board ECORD Facility Board	Leanne Armand	ANZIC/The Australian National University
Science Evaluation Panel	Chris Elders Ron Hackney Alternate: Helen McGregor	Curtin University Geoscience Australia University of Wollongong
Environmental Protection and Safety Panel	Ingo Pecher Alternate: Myra Keep	The University of Auckland The University of Western Australia
Core Curation Board	Richard Arculus	The Australian National University
IODP Forum	Leanne Armand Mike Coffin Joanna Parr	ANZIC/The Australian National University The University of Tasmania CSIRO
ANZIC 2050 Science Framework Writing Group (WG) and Writing Team (WT)	Mike Coffin (WG) Stuart Henrys (WG) Anais Pages (WG, WT) Kliti Grice (WT) Rob McKay (WT) Laura Wallace (WT)	The University of Tasmania GNS Science CSIRO Curtin University Victoria University of Wellington GNS Science

ANZIC Governing Council

The Governing Council is a steering committee for the Australia and New Zealand IODP Consortium (ANZIC), and looks after mission and strategic direction, ensuring effective overall governance and management, and responsible finance and risk management. The membership of the Governing Council was determined on a contribution-based arrangement agreed to by the Governing Council in 2013/14.

2019 ANZIC Governing Council Members



Dr Ian Poiner

Chair/Independent Scientist



Assoc. Prof. Oliver Nebel

Monash University



Prof. Richard Arculus

Lead ARC LIEF CI /
The Australian National University



Assoc. Prof. Jody Webster

University of Sydney



Assoc. Prof. Leanne Armand

ANZIC Program Scientist /
The Australian National University



Assoc. Prof. Helen Bostock

University of Queensland



Prof. Stephen Eggins

Host Organisation Representative /
The Australian National University



Dr Lorna Strachan

University of Auckland



Dr Stuart Henrys

GNS Science



Dr Craig Sloss

Queensland University of Technology



Dr Joanna Parr

CSIRO



Prof. Chris Elders

Curtin University



Dr Ben Clennell

CSIRO/University of Western Australia



Prof. Simon George

Macquarie University



Dr Robert Munn

Australian Research Council



Prof. Mike Coffin

University of Tasmania

Observers:

Dr Andrew Heap – Geoscience Australia; Assoc. Prof. Stephen Gallagher – University of Melbourne; Prof. John Foden – University of Adelaide; Prof. Chris Turney – University of NSW; Dr Joshu Mountjoy – NIWA; Prof. David Cohen – University of NSW; Assoc. Prof. Helen McGregor – University of Wollongong; Dr Christina Reisselman – University of Otago; and Dr Anthony Kemp – University of Western Australia

ANZIC Science Committee

The Science Committee encourages and assists the development of science proposals, organises topical workshops, assesses cruise applicants, applicants for IODP panel membership, and applications for special analytical funding. Committee members, who provided valuable and appreciated service in 2019, are listed below.

The Committee is chosen to broadly represent the IODP's key research areas:

- **Climate and Ocean Change:** reading the past, informing the future,
- **Biosphere Frontiers:** Deep life, biodiversity, and environmental forcing of systems
- **Earth Connections:** deep processes and their impact on Earth's surface environment

2019 ANZIC Science Committee Members



Prof. Mike Coffin

Chair/University of Tasmania

- **Earth Connections**
- **Earth in Motion**



Prof. Kliti Grice

Curtin University

- **Biosphere Frontiers**
- **Climate and Ocean Change**



Dr Joanna Parr

Vice-Chair/CSIRO

- **Earth Connections**
- **Biosphere Frontiers**



Dr Simon Holford

University of Adelaide

- **Earth Connections**
- **Earth in Motion**



Assoc. Prof. Leanne Armand

ANZIC Program Scientist /

The Australian National University

- **Climate and Ocean Change**
- **Biosphere Frontiers**



Dr Nick Mortimer

GNS Science

- **Earth Connections**
- **Earth in Motion**



Dr Linda Armbricht

University of Adelaide

- **Biosphere Frontiers**



Dr Lloyd White

University of Wollongong

- **Earth Connections**



Dr Anais Pages

CSIRO/Department of Water and
Environmental Regulation

- **Biosphere Frontiers**



Dr Christina Riesselman

University of Otago

- **Climate and Ocean Change**
- **Biosphere Frontiers**



Dr Agathe Lise-Pronovost

University of Melbourne

- **Climate and Ocean Change**
- **Earth in Motion**



Dr Maria Seton

University of Sydney

- **Earth Connections**



Dr Luke Nothdurft

Queensland University of Technology (QUT)

- **Climate and Ocean Change**



Dr Jo Whittaker

University of Tasmania

- **Earth Connections**



Dr Stefan Loehr

Macquarie University

- **Climate and Ocean Change**

ANZIC OUTPUTS

ANZIC scientists contribute significant knowledge to advance our global understanding of the Earth's geology, climatic evolution, geohazards and biosphere.

Since the inception of scientific ocean drilling in 1968, through to our current International Ocean Discovery Program in 2019, ANZIC scientists have contributed over 37,725 publications, representing 11.8% of publications globally.

Our publication successes are founded on the ANZIC community's genuine engagement facilitated either by participation in Expedition (on-board or shore-based) scientific parties or through the unique ANZIC Legacy analytical grant support program. The 2019 record of ANZIC contributions are extracted from the Scientific Ocean Drilling Bibliographic Database, compiled annually by the *JOIDES Resolution* Support Office (JRSO).

Peer-reviewed scientific ocean drilling articles including 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 next top twenty Earth science journals†			All peer-reviewed scientific ocean drilling journal articles	
	Articles with an author representing Australia	Articles with an author representing New Zealand	All articles	Articles with an author representing Australia	Articles with an author representing New Zealand	All articles	Articles with an author representing Australia and/or New Zealand	All articles
1968–1987	2	3	176	1	0	348	33	1,990
1988–2003	18	1	181	50	11	1,324	221	4,052
2004–2007	3	1	72	19	8	585	108	1,570
2008–2013	8	5	107	45	25	985	140	2,111
2014–2015	8	1	30	24	12	356	66	797
2016–2019‡	3	2	26	48	20	566	128	1,243
Total	42	13	592	187	76	4,164	696	11,763

Notes: This table was prepared in August 2020 by IODP Publication Services based on data in the Scientific Ocean Drilling Bibliographic Database, a subset of GeoRef hosted by the American Geosciences Institute (<http://iodp.americangeosciences.org/vufind>). Date ranges are categorized based on funding periods: 1968–1987 = Pre-Australian membership (indirect), 1988–2003 = Australian Ocean Drilling Program (ODP) membership; 2004–2007 = ODP/Integrated Ocean Drilling Program Phase 1 (indirect), 2008–2013 = Integrated Ocean Drilling Program ANZIC Phase 1, 2014–2015 = IODP ANZIC Phase 2 (direct), 2016–2019 = IODP ANZIC Phase 3 (direct). * = Top three science journals (based on Clarivate Analytics journal impact factor) = Nature, Science, and Nature Geoscience. † = Next top twenty Earth science journals (determined by impact factor of journals in ISI Web of Knowledge categories related to Earth science) = Earth-Science Reviews; Proceedings of the National Academy of Sciences of the United States of America; Earth and Planetary Science Letters; Geology; Geochimica et Cosmochimica Acta; Geophysical Research Letters; Global and Planetary Change; Quaternary Science Reviews; Marine and Petroleum Geology; Journal of Geophysical Research; Geological Society of America Bulletin; Climate of the Past; Journal of Petrology; Sedimentology; Lithos; Chemical Geology; Paleoceanography; Geochemistry, Geophysics, Geosystems; Organic Geochemistry; and Contributions to Mineralogy and Petrology. Criteria for country-specific queries were the journal International Standard Serial Number (ISSN), 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 2019 only reflect citations that were added to the database by June 2020 and may not represent a complete total of 2019 publications.

Scientific ocean drilling publications* including authors representing Australia or New Zealand compared to all scientific ocean drilling publications produced internationally.

Date of publication	Publications with an author representing Australia	Publications with an author representing New Zealand	Total publications with an author representing Australia and/or New Zealand	Total scientific ocean drilling publications	Percentage of publications with an author representing Australia and/or New Zealand
1968–1987	223	181	290	9,085	3.2
1988–2003	2,192	150	2,309	13,830	16.7
2004–2007	330	87	385	3,788	10.2
2008–2013	385	239	586	5,394	10.9
2014–2015	233	105	297	2,114	14.0
2016–2019†	395	218	568	3,514	16.2
Total	3,758	980	4,435	37,725	11.8

Notes: This table was prepared in August 2020 by International Ocean Discovery Program (IODP) Publication Services based on data in the Scientific Ocean Drilling Bibliographic Database, a subset of GeoRef hosted by the American Geosciences Institute (<http://iodp.americangeosciences.org/vufind>). The criteria for the country-specific queries were the date ranges listed and institutional affiliation containing the words “Australia” or “New Zealand.” Date ranges are categorised based on funding periods: 1968–1987 = Pre-Australian membership (indirect), 1988–2003 = Australian Ocean Drilling Program (ODP) membership; 2004–2007 = ODP/Integrated Ocean Drilling Program Phase 1 (indirect), 2008–2013 = Integrated Ocean Drilling Program ANZIC Phase 1, 2014–2015 = IODP ANZIC Phase 2 (direct), and 2016–2019 = IODP ANZIC Phase 3 (direct). * = Totals include peer-reviewed articles in science journals; published conference proceedings and abstracts; books and chapters in books; theses; and Deep Sea Drilling Program, ODP, Integrated Ocean Drilling Program, and IODP publications. † = Statistics for 2019 only reflect citations that were added to the database by June 2020 and may not represent a complete total of 2019 publications.

2019 Outputs Authored by ANZIC Members

In 2019 ANZIC members produced 100+ scientific outputs, including publications and presentations. The following alphabetical list includes records from the Scientific Ocean Drilling Bibliographic Database (<http://iodp.americangeosciences.org/vufind/>) and the IODP publications website (<http://publications.iodp.org/index.html>) as of June 2020 that were published in 2019, with ANZIC members highlighted in bold type.

SCIENTIFIC DRILLING

Deep Earth Sampling and Monitoring

Scientific Drilling of Lake Chalco, Basin of Mexico (MexiDrill)	1
Coring the sedimentary expression of the early Toarcian Oceanic Anoxic Event	17
A roadmap for amphibious drilling at the Campi Flegrei caldera	29
Workshop report on hard-rock drilling into mid-Cretaceous Pacific oceanic crust on the Hawaiian North Arch	47
The Bouse Formation, a controversial Neogene archive of the evolving Colorado River	59

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