

2018

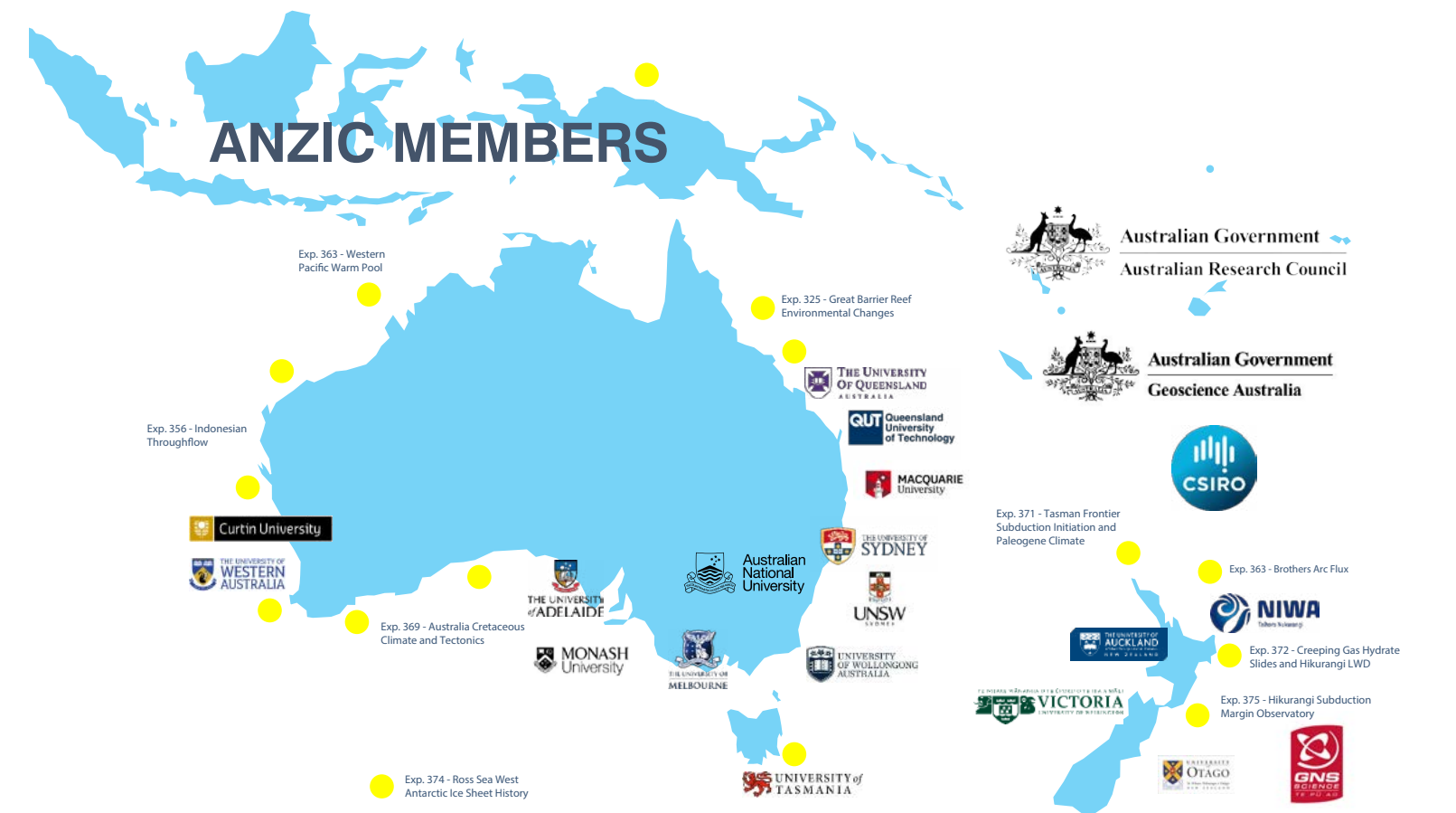
Australia and New Zealand
IODP Consortium

ANNUAL REPORT



Australian and New Zealand
IODP Consortium

Exploring the Earth under the Sea



CONTENTS

2	Chairman's Overview
3	Program Scientist's Summary
6	NZ - IODP Report
7	ANZIC IODP Overview 2014 -2018
9	Scientific Activities
11	IODP Masterclass
12	General Report
14	ANZIC Committee Members
15	ANZIC Governing Council
16	ANZIC Science Committee
17	ANZIC Expedition Participants
18	Expedition Participant Accounts
22	<i>JOIDES Resolution</i> Future Expeditions 2019 - 2021
23	IODP Future Expeditions
25	Australasian Drilling Map 1968 - 2018
27	IODP New Decadal Science Plan 2024 - 2034
29	Summary of Outputs by ANZIC Participants
34	Publications Authored by ANZIC Members 2018

Layout and design: Larisa Medenis

Contributors: Leanne Armand, Ian Poiner, Stuart Henrys, Larisa Medenis, Giuseppe Cortese, Robert McKay, Laura Wallace, Dominique Tanner, Tobias Coulson, and Marianna Terezow.

Publication stats: Ginny Lowe, *JOIDES Resolution* Science Support Office - Publication Services.

Cover photo : The *JOIDES Resolution* at the port of Auckland. (Credit: Philipp Brandl & IODP)

ANZIC OFFICE
 Jaeger 4, Australian National University,
 142 Mills Rd, Acton ACT 2601, AUSTRALIA
 T: +61 2 6125 7999
 E: iodp.administrator@anu.edu.au
www.iodp.org.au

 @ANZICIODP

 @ANZIC_IODP

 @ANZICIODP

Chairman's Overview

Photo credit: IODP/JRSO

Chairman's Overview

With about 60% of Australia's and 95% of New Zealand's territory offshore, our two nations' vast oceans are central to the heritage, heart and economic future of our countries. For example, by 2025, Australia's marine industries are forecasted to contribute around A\$100 billion each year to our economy, with our oceans and coasts providing a further A\$25 billion worth of ecosystem services, such as carbon dioxide absorption, nutrient cycling and coastal protection. 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 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 research 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.

Scientific ocean drilling through the IODP is a continuation of the world's longest running and most successful international geosciences research collaboration. The Program celebrated 50 years of operations in 2018. The IODP operates deep-sea drilling vessels to collect continuous core samples of sediments and rocks from below the sea floor for dedicated research purposes and for the benefit of society. This is the sixth year of the current IODP 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 participation in IODP through ANZIC continues to grow in strength and significance. IODP has conducted significant research in the Australasian region from proposals often initiated, proposed and lead by ANZIC members. Other internationally located expeditions have enabled 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. The value of IODP participation was recognized in the Australian Academy of Sciences (AAAS) Geosciences Decadal Plan released in 2018, which flagged Australian subscription to, and involvement with, the IODP as a key strategic imperative.

This year has been another very successful year for ANZIC, with four *JOIDES Resolution* expeditions in our region, all of high scientific and societal interest, and with very strong ANZIC involvement including four co-chief scientists. A year marked by a sense of commitment and energy by all involved to ensure ANZIC's continued success in IODP. We held another very successful Marine Geoscience Masterclass in New Zealand. Their success is best measured in how they are inspiring the next generation of marine geoscientists. There were four port calls by the *JOIDES Resolution* in Australia and New Zealand that provided wonderful opportunities to communicate the value and contribution of IODP to southern hemisphere marine science, to fellow marine scientists and the community generally. Australian and New Zealand scientists through ANZIC continue to be important contributors to IODP. ANZIC authors are represented in 11.5% of all IODP publications over the 50-year life of the Program for a very small contribution to operational costs. For the 2016 to 2018 period, ANZIC authors are represented in 16% of publications. 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.

This was Associate Professor Leanne Armand first full year as our Program Scientist and through her enthusiasm, expertise, IODP experience and leadership skills, ANZIC continues to be supported by an outstanding Program Office team. My gratitude and appreciation to Ms. Catherine Beasley, ANZIC Administrator, who is leaving ANZIC after seven years of dedicated service. Catherine started with ANZIC in 2010 and has been an integral part of the team. We welcome Ms. Larisa Medenis, our new Communication Officer who joined the team in August 2018 and is already contributing significantly to the team through new communications products and on-going revitalisation of our web site and social media presence. ANZIC continues to benefit from the strong support of our host organisation, the Research School of Earth Sciences, at the Australian National University.

Looking to the future, a key focus of the ANZIC 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 develop the next generation of ANZIC IODP proposals and to ensure the continued support of ANZIC by 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 world's best and brightest talent, whilst the collaboration of Australia and New Zealand in ANZIC demonstrates we can be successful in bringing this talent to Australasia. Another focus for ANZIC in 2019 will be taking a leadership role in the development of the next IODP strategic science plan.

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.



Dr Ian Poiner
ANZIC Governing Council Chair

Program Scientist's Summary

Program Scientist's Summary

The Australian and New Zealand International Ocean Discovery Program Consortium (ANZIC) office, hosted in RSES at ANU, was very busy in 2018 as ANZIC scientists participated on six expeditions and another successful round of Legacy Grants were awarded to 11 ANZIC consortium members to the combined total of \$140K. On top of these ANZIC achievements, IODP celebrated 50 years of a very successful international collaboration, with the release of a Special Volume in Oceanography, which ANZIC supported, and members of our community contributed inspiring articles to.

The six 2018 IODP expeditions were:

- Exp. 372 – Creeping Gas Hydrate Slides and Hikurangi LWD (JR)
- Exp. 374 – Ross Sea West Antarctic Ice Sheet History (JR)
- Exp. 375 – Hikurangi Subduction Margin Observatory (JR)
- Exp. 376 – Brothers Arc Flux (JR)
- Exp. 358 – NanTroSEIZE Plate Deep Boundary Riser 4 (JAMSTEC/Chikyu)
- Exp. 381 – Corinth Active Rift Development (ECORD/ Mission Specific Platform)

Significantly, four IODP Expeditions occurred in the Australian and New Zealand region on the RV *JOIDES Resolution*. The national economic impact to both Australia and New Zealand in having these Expeditions berth at local ports over the last few years has been estimated to be in the order of A\$17.7M (US\$13M).

ANZIC sailed a total of 17 scientists (an excellent outcome given our official quota within the program is one berth per expedition), inclusive of four Co-Chief Scientists, and four Outreach and Education Officers.

One of the previously scheduled 2018 Expeditions, 378 South Pacific Paleogene Climate, for which we have secured one scientific and one outreach berth, was deferred to 2020 due to mechanical difficulties of one of the RV *JOIDES Resolution*'s propeller shafts. The shaft was repaired and both propellers replaced whilst the ship was in dry-dock. The four regional voyages also enabled the ANZIC members to showcase the RV *JOIDES Resolution* to politicians, scientists, students, science educators and industry personnel whilst in port.

In other activities, ANZIC continues to perform as a training conduit for Marine Geoscience in Australia and New Zealand, offering

- a) an undergraduate Masterclass to 20 high-performing second and third year students currently run by New Zealand ANZIC partners headed by GNS;
- b) participation on the International IODP School of Rock, this year held in Auckland, New Zealand, for five Australian and seven New Zealand science educators; and
- c) providing \$140,000 in small analytical grants for research using previously cored IODP material.

ANZIC has an important national voice where we participate and are represented on the National Marine Science Committee (NMSC) and through Science and Technology Australia (STA) and their Science Meets Parliament event. ANZIC facilitates and attends major national and international meetings. In 2018 we held IODP sessions at the Geological Society of Australia's biannual conference in collaboration with our JAMSTEC colleagues, in Adelaide; the NZ Geoscience Society meeting in Napier, New Zealand, and at the American Geophysical Union in Washington D.C..

As the Program Scientist, I represented ANZIC at international IODP governance meetings in Goa, India, and at international

science planning meetings in Venice, Italy, Kobe, Japan, La Hague, Netherlands, and Washington DC, USA. The ANZIC Governing Council and the Science Committee have met quarterly and biannually, respectively, to oversee governance and the selection of scientists to represent ANZIC in all IODP related matters.

Staff news

The ANZIC Office welcomed Larisa Medenis as the new Communications Officer mid-year, and said farewell to long-serving and well-known ANZIC administrator, Catherine Beasley, at the end of 2018. A new ANZIC Administrator will be appointed in 2019.

Visitors to the ANZIC Office in 2018 included:

Dr Maureen Walczak, a research scientist in the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University. Maureen's visit, supported by the American Australian Association, allowed her to work with collaborators and postdoctoral mentors at the ANU Research School of Earth Sciences on manuscripts stemming from her involvement as an ANZIC scientist in IODP Expedition 341: Southern Alaska Margin Tectonics, Climate, and Sedimentation.

Professor Yusuke Yokoyama of the University of Tokyo, who completed a PhD at the ANU, visited ANZIC to conduct paleoclimate research using data obtained from IODP Exp. 325 Great Barrier Reef Environment. Yusuke was co-chief scientist on Exp. 325.

Dr Rob McKay from the Victoria University of Wellington, who provided a presentation on his recent Exp. 374 to the Ross Sea and also completed his hand-over as Chair of the ANZIC Science Committee.

Prof. Neville Exon and Dr Elizabeth Truswell were honorary staff associated with the ANZIC Office in 2018. Both are contributing to major works related to IODP history, accomplishments and or research, which will be published in 2019.

Looking ahead

Having celebrated 50 years of the IODP at the end of 2018, the future is definitely the theme for 2019 activities. The ANZIC community will be engaged to consider the future of ANZIC post 2020. Equally, the development of a replacement for the IODP Strategic Science Plan (2013-2023) will also be on the cards. The first ANZIC Roadshow, to showcase the successes of the program to all stakeholder members, kicks off in February 2019. Riding on this wave of celebration, we'll be surfing on the energy of the ANZIC community as we contribute to the new IODP Science Plan and our consortium's future in a renewal bid for another decade.



Associate Professor Leanne Armand
ANZIC Program Scientist

Photo credit: IODP JR50

NZ-IODP Report



Photo credit: Tim Fulton IODP JR50

2018 IODP Comes to Zealandia and the Ross Sea

New Zealand's position astride the active Pacific-Australian plate boundary in the Southern Ocean provides an ideal natural laboratory to test many globally- and nationally-relevant high-level science questions. Our unique position provides critical information related to sea level change, past ocean and climate variability, the physical processes that control geohazards, and the geophysical, chemical, and biological character of the seafloor environment.

Our formal entry into scientific ocean drilling in 2008 in partnership with Australia brought together GNS Science, the National Institute of Water and Atmospheric Research (NIWA) and three of our leading universities (University of Auckland, Victoria University of Wellington, and University of Otago). Ten years of New Zealand's IODP membership culminated in us being the cornerstone behind six expeditions in the New Zealand and Ross Sea region in 2017-18. In 2018 four expeditions were successfully completed and co-led by New Zealanders: Expedition 372, (Creeping Gas Hydrate Slides and Hikurangi Subduction Margin Logging While Drilling), 374 (West Antarctic Ice Sheet), 375 (Hikurangi Subduction Margin), and 376 (Brothers Arc Flux). During Expedition 375 two underwater observatories were installed, the first in the southern hemisphere. In total, 13 New Zealand scientists and four outreach officers took part in these expeditions, in partnership with scientists from more than 20 other countries.

New Zealand also hosted the *JOIDES Resolution* (JR) for four port calls: Lyttelton (4-5 Jan), Timaru (8-9 March), Auckland (5-6 May), Auckland (5 July). The January Lyttelton port call provided an exciting opportunity to showcase the scientific objectives of Expeditions 372 (Creeping Gas Hydrates and Hikurangi subduction zone) and 374 (Ross Sea West Antarctic Ice Sheet History). Forty visitors, comprised of VIPs, representatives, community leaders and media, toured the JR and heard about the science led by IODP, with special reference to New Zealand's involvement.

The March port call, which was scheduled for Lyttelton, was moved to Timaru due to an industrial strike at the Lyttelton port. University of Otago organised tours of the JR for some of their students. Two Gisborne high school students, who were the winners of a national competition to name the two observatories installed during Expedition 375, also got to tour the ship, accompanied by outreach officer Akili Weststrate. A special evening event, *Drilling for Past Antarctic Climate: Then and Now*, organised by the New Zealand Antarctic Society was held in Lyttelton on 8 March. The well attended event focused on the many successes of past and present research in Antarctica. Prof. Jim Kennett (UC Santa Barbara) gave an interview on the subject for Kim Hill's Saturday Morning programme, RadioNZ.

During the Auckland May port call, the NZ-IODP office managed tours and an evening reception. A VIP tour was attended by chief researcher from the office of the Prime Ministers Chief Science Advisor, several Auckland City Councilors and Council staff, Deputy Vice Chancellor – Research from University of Auckland, several senior staff from the university and NIWA, Royal New Zealand Navy representatives, several members of the GNS Science Board and senior management team, including the CEO, Ian Simpson, as well as representatives from local iwi, Nga Potiki. The port call attracted media attention, with several articles, and an interview, being published on the ship's activities.

Complementary with the July Auckland port call ANZIC, the NZ-IODP office and the United States Science Support Program (USSSP) jointly organized Te Kura Kōhatu (School of Rock 2018). The successful nine-day ship- and field-based introduction to geoscience for formal and informal science educators from New Zealand and overseas was held 5-13 July. Nineteen participants took part in Te Kura Kōhatu - seven from New Zealand, seven from the USA, and five from Australia. Feedback was very positive, with an immediate uptake of teaching resources and ideas by many educators. The activities and successes of Te Kura Kōhatu were presented in a poster at the 2018 AGU Fall Meeting.

During Geosciences 2018: Our land, Our Ocean, our Responsibility, Napier, (27 – 30 November) ANZIC and the recent IODP expeditions featured prominently, including six plenary speakers, three sessions highlighting IODP expedition science, and a hugely popular public talk on the Hikurangi margin. The NZ-IODP office ran a booth display, which featured the two core replicas (borrowed from ANU), microscope with IODP microfossil material, a promotional poster on the benefits of joining ANZIC, and brochures on ANZIC and IODP.

In December, the last of three Master Classes held in New Zealand took place and was attended by 20 undergraduate students (17 Australian and 3 New Zealand). It began with a day surveying Wellington Harbour on NIWA's vessel RV Rukūwai, followed by field trips to the Wairarapa and Hawke's Bay regions for the rest of the programme. Feedback from the students was very positive, with many enjoying the variety of activities and field sites of the programme.

New Zealand benefits greatly from the economies of scale of the pooled international resources of ANZIC and 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 these drilling expeditions and the direct economic impact of four New Zealand port calls alone in 2018 has been estimated by IODP to be US\$13M.



Dr Stuart Henrys
GNS Science

ANZIC OVERVIEW 2014-2018

Australian and New Zealand scientists have access to a range of resources and opportunities, including participation in IODP expeditions. ANZIC has 16 financially contributing member institutions in Australia and five in New Zealand.

ARC LIEF CI & PI: Every member institution has a representative CI or PI.

\$820K
legacy grants

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

52
scientists from AUS/NZ

EXPEDITIONERS: (ANZIC contribution per expeditioner approx. \$377,000) A total of 52 scientists from Australia and New Zealand have participated on expeditions between 2014-18. 37 Australian and 15 NZ scientists.

\$743K
post-cruise funds

POST-CRUISE FUNDS: ANZIC funds up to \$40,000 for post-cruise analytical work. 24 researchers have received post-cruise support from ANZIC during the period 2014-2018.

\$325K
to run 5 masterclasses

MASTERCLASS STUDENTS: The annual ANZIC Marine Geoscience Masterclass introduces 20 high-achieving undergraduate students 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 for three year periods

50+
participants

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, 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, evaluates cruise applications, funding applications and candidates for IODP panel membership. The current science committee is chaired by Prof. Mike Coffin, vice-chaired by Dr Joanna Parr and has 14 members representative of our institutional membership and 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 ship 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.

PUBLICATIONS: Database records indicate that a total of 653 publications are authored or co-authored by researchers from ANZIC 2014-18. 156 Program-related papers with ANZIC contributors have been published in non-Program, primarily peer-reviewed serial publications. A total of 90 of these research papers were published in 22 highly rated peer-reviewed journals.

2014 - 2018 PORT CALL STATISTICS

During 2014-2018 IODP expedition vessels made five port calls in Australia: Fremantle (x 2), Darwin, Townsville and Hobart, and five port calls in New Zealand: Lyttelton, Christ Church, Timaru and Auckland (x 2)



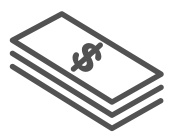
10
AUS/NZ port calls



82.8
days in port



1,974
crew & scientists
departing/arriving at port



\$9M⁺
USD
boost to the AUS/NZ
economy

ANZIC SPEND PER EXPEDITIONER (Average spend)



\$325K +
membership per berth

UP TO \$40K
post expedition
research funding

\$2.5K
travel
expenses

\$9.5K
post travel
expenses

Photo credit: William Crawford IODP JRSO

Scientific Activities



Photo credit: IODP JR50

Expeditions

The Australian and New Zealand International Ocean Discovery Program Consortium participated in six expeditions during 2018. Four of the IODP Expeditions occurred in the Australian and New Zealand region on the RV *JOIDES Resolution*. ANZIC sailed a total of 17 scientists inclusive of four Co-Chief Scientists, and four Outreach and Education Officers.

The expeditions were:

- **Expedition 372 – Creeping Gas Hydrate Slides and Hikurangi LWD** (26 November 2017 - 4 January 2018) Had two primary objectives (1) to investigate the relationship between gas hydrate and underwater landslides; and (2), to characterise sediment and fault zone structures and physical properties associated with recurring shallow slow slip events along the Hikurangi subduction interface (*JR*)
- **Expedition 374: Ross Sea West Antarctic Ice Sheet History** (4 January – 8 March 2018) Unravelling the West Antarctic Ice Sheet (WAIS) evolution through the Neogene and the Quaternary (*JR*).
- **Expedition 375: Hikurangi Subduction Margin** (8 March – 5 May 2018) Investigating the processes and in situ conditions that underlie subduction zone slow slip events (SSEs) at the northern Hikurangi Trough (*JR*).
- **Expedition 376: Brothers Arc Flux** (5 May – 5 July 2018) Investigating the fundamental, interrelated processes governing sub-seafloor hydrothermal activity at Brothers volcano, southern Kermadec Arc (*JR*).
- **Expedition 358: NanTroSEIZE - Plate Boundary Deep Riser 4** (7 October 2018 – 21 March 2019) This expedition represents the culmination of ten years of drilling efforts focused on reaching the plate interface

fault system at seismogenic / slow slip depths. The NanTroSEIZE programme started in 2007 and its completion has required 12 expeditions involving more than 200 scientists from 15 countries. (JAMSTEC/*Chikyu*).

- **Expedition 381 – Corinth Active Rift Development** (23 Oct - 18 Dec. 2017 offshore, 31 Jan - 28 Feb 2018, onshore) The rift is uniquely situated in one of highest seismically active areas in Europe. This project drilled into the main rift, which with its closed drainage system and high sedimentation rates, made it an ideal location to examine the relationship between rift development and faulting, and how the landscape responds to those forcing factors. (ECORD/Mission Specific Platform).

Other Activities

Australian Geoscience Council Convention AGCC

ANZIC together with JAMSTEC hosted a booth at the Australian Geoscience Council Convention, AGCC 2018, held at the Adelaide Convention Centre, 14-18 October, 2018. The ANZIC/IODP session was co-convened by Leanne Armand and Ron Hackney. A special thank you to our presenters, keynote speakers who covered a broad range of IODP expedition findings, including:

- Dr Lloyd White (University of Wollongong): Preliminary insights of deep-sea coring of Australia's frontier Bight and Mentelle basins – IODP Exp. 369.
- Dr Saneatsu Saito (Japan Agency for Marine-Earth Science and Technology): Tasman frontier subduction initiation and Paleogene climate: Preliminary results from IODP Exp. 371.
- Assoc. Prof. Jody Webster (University of Sydney): The response of the Great Barrier Reef to major environmental changes: lessons from the geologic past.
- Prof. Neville Exon (ANU) Achievements of scientific ocean drilling in the Australasian region.



- Prof. Peter Clift (Louisiana State University, Baton Rouge): Erosional response to monsoon intensity change and rock uplift in the Western Himalaya since the Late Miocene.
- Assoc. Prof. Stephen Gallagher (The University of Melbourne): Paleooceanography and monsoonal history of the Japan Sea over the last 460,000 years.
- Dr Kelsie Dadd (University of Sydney): From continental crust to ocean basin – Rapid rifting in the South China Sea – Site U1501, IODP EXP 367/368.
- Dr Yoshihiko Tamura (JAMSTEC) : Origin of Moho Reflections.
- Dr Carol Cotterill (European Consortium for Ocean Research Drilling) ECORD mission-specific platform expeditions in the International Ocean Discovery Program: Flexible operations and technological developments.

Congratulations were also offered to former ANZIC Program Scientist Neville Exon on receiving the W.R. Browne Award presented at the AGCC. Neville celebrated his achievement with friends and members of ANZIC and JAMSTEC. The W. R. Browne Award is awarded to a person distinguished for contributions to the geological sciences in Australia and also at the NZ Geoscience Society meeting in Napier, New Zealand.

IODP Forum

Program Scientist, Leanne Armand represented ANZIC at international IODP governance meetings in Goa, India, and at international science planning meetings in Venice, Italy, Kobe, Japan, La Hague, Netherlands, and Washington DC, USA. The ANZIC Governing Council and the Science Committee have met on four and two occasions, respectively, to oversee governance and the selection of scientists to represent ANZIC in all IODP related matters. The Program Scientist also attended and represented ANZIC at the National Marine Science Committee (NMSC), which met four times in 2018, two Science and Technology Australia (STA) meetings and their annual Science Meets Parliament event.

School of Rock

During *JR*'s July 2018 Auckland port call, ANZIC, the NZ-IODP office and the United States Science Support Program (USSSP), jointly organized Te Kura Kōhatu - School of Rock 2018. The successful nine-day ship- and field-based introduction to geoscience for 19 science educators from New Zealand and overseas was held.

The Totten Glacier pre-proposal workshop was held in November 2018 - a small group of ANZIC sponsored IODP scientists gathered in Canberra to start the process of preparing a pre-proposal for submission to IODP. The title of the is 'Totten Glacier Climate Vulnerability' and the proposal will be largely based on data gathered during the *RV Investigator* expedition to the Sabrina Coast margin in early 2017. The proponents attending the workshop were Bradley Opdyke, Yair Rosenthal, Phil O'Brien, and Yusuke Yokoyama.



AGU 100

The American Geophysical Union's AGU100 Fall Meeting was held in Washington (10-14 December) with ANZIC's Program Scientist and representatives present. There were two IODP focused sessions:

- *Fifty Years of Scientific Ocean Drilling: How the Past Informs the Future.* Co-convened by USSSP, ANZIC, ECORD and JAMSTEC with a historical perspective and overview talks on the four Science Plan themes. Richard Arculus was one of the five invited plenary speakers.
- The Asahiko Taira International Scientific Ocean Research Prize featuring a lecture by the 2018 awardee, Brandon Dugan.

Marine Geoscience Masterclass

A very successful Marine Geoscience Masterclass was organised by Dr Giuseppe Cortese (GNS-Science) and held in New Zealand in Dec. 2018. The Masterclass brings together outstanding undergraduate students from all our university partners, and provides exceptional experiences related to land- and marine-based fieldwork. Feedback from both students and leaders was again very positive. The aim of the Masterclass is to demonstrate that geology and IODP science can provide exciting futures for undergraduate students, many of whom have not yet decided on their long term careers.

See full report next page.



Educating our future geoscientists at the 2018 ANZIC IODP Masterclass

In early December, GNS Science hosted the third-and-final New Zealand-led edition of the annual ANZIC IODP Masterclass. The initiative was funded by the Australia/New Zealand IODP Consortium (ANZIC), via a grant to Dr Giuseppe Cortese, who led a bid involving GNS, University of Otago, NIWA, and Victoria University of Wellington (VUW).

This year, the week-long programme introduced 20 second- and third-year university students (17 from Australia and 3 from New Zealand), to the geosciences through a combination of hands-on activities and geological fieldwork.

It started with a series of laboratory demonstrations and a marine survey in Wellington Harbour aboard *RV Rukūwai* during a day at NIWA as well as a series of talks at GNS, in Avalon. This was followed by 4 ½ days at a hands-on field workshop in the southern Wairarapa and Hawke's Bay areas. The diverse geology of eastern North Island makes it possible to introduce people to a wide range of techniques and skill sets.

The eastern North Island field workshop was led by Malcom Arnot and Kyle Bland from the Petroleum Geosciences department. During the field workshop, participants:

- Examined offset streams across the Wairarapa Fault at Pigeon Bush,
- Interpreted folded Cretaceous turbidites and mapping and measuring earthquake-raised beaches at Tora,
- Evaluated the depositional and paleoenvironmental origin of fossil-rich strata at Castlepoint,
- Interpreted seismic lines from the offshore east coast area and described "cores" of early Miocene Whakataki Formation turbidites at Wharepouri's Mark,
- Examined modern analogues in the Ahuriri and Westshore areas of Napier, and
- Unraveled the sea-level history of non- to shallow-marine strata inland from Napier and Lake Tutira.

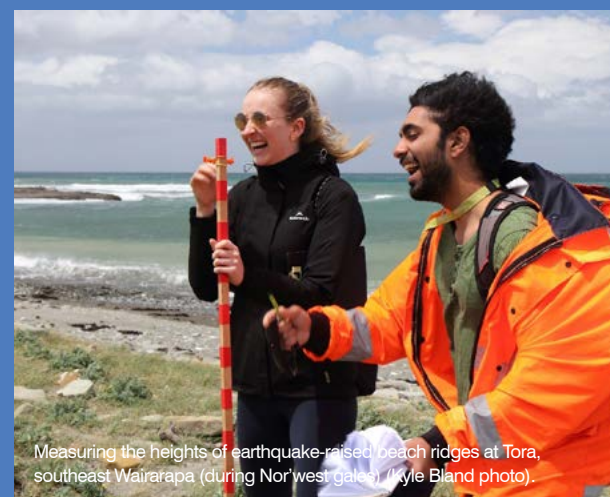
On the last day of the workshop, participants walked along the Cape Kidnappers section, one of New Zealand's best one-day geological field trips. Here, virtually all aspects and kaupapa (topics) from the previous four days are fantastically exposed. The students had to unravel the tectonic, eustatic, and paleoenvironmental history of the site for themselves, using the skills they'd honed during the workshop.

The primary message throughout the field workshop was the importance of making and documenting good observations. The underlying theme was the recognition of the various effects a subducting plate boundary (the Hikurangi Margin, off the east coast of New Zealand) has on the landscape, as it manifests itself in terms of subsidence/uplift, faulting, and relative sea-level rise/fall. The Hikurangi Margin and its associated slow slip events (earthquakes that release energy over weeks and

months compared to fast rupture events) has recently been explored during two recent IODP Expeditions (372 and 375), taking place between November 2017 and May 2018.

In its first year, 2016, the Masterclass activities were split between the Wellington-Wairarapa and Fiordland regions, with multi-day field-based activities centred around southeast Wairarapa and aboard the *RV Polaris* in Doubtful Sound. The latter, involved a strong and significant contribution by University of Otago colleagues. The last two years have essentially been run out of Wellington, through a combined GNS/NIWA effort.

The 2018 ANZIC IODP Masterclass team gratefully acknowledge organisational support from Marianna Terezow, Helen Bostock and colleagues at NIWA, Stuart Henrys, Richard Arculus, and funding from the ANZIC Governing Council.



Measuring the heights of earthquake-raised beach ridges at Tora, southeast Wairarapa (during Nor'west gale) (Kyle Bland photo).



Interpreting the depositional settings of sedimentary rocks at Darkys Spur, inland of Lake Tutira, Hawke's Bay (Kyle Bland photo).

Report by Dr Giuseppe Cortese (GNS Science)

General Report for 2018

ANZIC IODP Organisation

The organisational involvement of Australians and New Zealanders in IODP falls into a number of categories: Program Member Office, Facility Boards, IODP Science Evaluation Panel (SEP) and Environment Protection and Safety Panel (EPSP), ANZIC Science committee, ANZIC representation and organisation of conferences, national workshops and Masterclasses.

Australian and New Zealand partners in IODP in 2018

The current ANZIC Consortium joined the new phase of IODP in September 2013. Australia's participation is funded between 2016 to 2020 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 universities and NIWA.



Australian IODP partners:

- The Australian Research Council
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Geoscience Australia
- MARGO (Marine Geoscience Office)
- The Australian National University
- Curtin University
- Macquarie University
- Monash University
- Queensland University of Technology
- The University of Queensland
- 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 IODP partners:

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





IODP Committees, Governing Council & Science Committee

IODP Committees

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 ship 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 the *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.

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

Table 1: ANZIC Members of IODP Committees in 2018

JOIDES Resolution Facility Board	Mike Coffin alternate: Gary Wilson Leanne Armand	University of Tasmania University of Otago ANZIC
Chikyu IODP Facility Board	Andrew Heap alternate: Greg Yaxley Leanne Armand	Geoscience Australia The Australian National University ANZIC
ECORD Facility Board	Leanne Armand Special scientific adviser Stephen Gallagher	ANZIC The University of Melbourne
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

(Photo credit: Leanne Armand)

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.

In 2018 four Governing Council meetings were held: by teleconference (3/3/18), at The University of Queensland hosted by Craig Sloss (28/5/18), face to face in Canberra (31/8/18) and a final by teleconference (26/11/18).

The 2018 Governing Council members are listed below.

Table 2: Members of the ANZIC Governing Council in 2018

Name	Institution
Ian Poiner	Chair / Independent Scientist
Richard Arculus	Lead ARC LIEF CI / The Australian National University
Leanne Armand	ANZIC Program Scientist / The Australian National University
Stephen Eggins	Host Organisation Representative, The Australian National University
Ben Clennell	CSIRO - Energy
Stuart Henrys	GNS - Science
Lorna Strachan	The University of Auckland
Rob McKay	Outgoing Sci. Comm. Chair / Victoria University of Wellington
Mike Coffin	Incoming Sci. Comm. Chair / University of Tasmania
Craig Sloss	Queensland University of Technology
John Foden	The University of Adelaide
Tony Kemp	The University of Western Australia
Stephen Gallagher	The University of Melbourne
Jonathan Aitchison	The University of Queensland
Chris Yeats	Invited Member: Geological Survey of NSW
Stephen Buckman	Observer: Australian Research Council
Neville Exon	Ex-Officio: The Australian National University

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 2018, are listed below.

Table 3: Members of ANZIC Science Committee in 2018

People	Institutions	Expertise
Mike Coffin (Chair)	Director, IMAS, Hobart	Geophysics
Joanna Parr (Vice-chair)	CSIRO Mineral Resources, Sydney	Seafloor ore deposits and mining
Robert McKay	Victoria University, Wellington, New Zealand	Sedimentology, Antarctic glacial history
Irina Borissova	Geoscience Australia, Canberra	Marine geophysics and basin studies
Ben Clennell	CSIRO - Leader, Petroleum Exploration and Production	Petroleum geologist
Chris Elders	Curtin University of Technology, Perth	Petroleum geologist, seismic interpretation, structural and dynamic evolution of continental margins
Kliti Grice	Curtin University of Technology, Perth	Organic geochemist
Simon Holford	University of Adelaide	Petroleum geoscience
John Moreau	University of Melbourne	Microbiology
Nick Mortimer	GNS Science, Dunedin, NZ	Tectonics, petrology, SW Pacific, Zealandia and Antarctic regional geology
Oliver Nebel	Monash University, Melbourne	High temperature geochemistry
Christina Reisselman	University of Otago	Cenozoic paleoceanography and paleoclimate, Antarctic climate evolution, micropaleontology (diatoms)
Maria Seton	University of Sydney	Marine geophysics and geodynamics
Gordon Southam	University of Queensland, Brisbane	Microbiology
Greg Yaxley	ANU, Canberra	Igneous petrologist
Luke Nothdruff	University of Queensland, Brisbane	Sedimentology and marine geology

2018 Expedition Participants Accounts

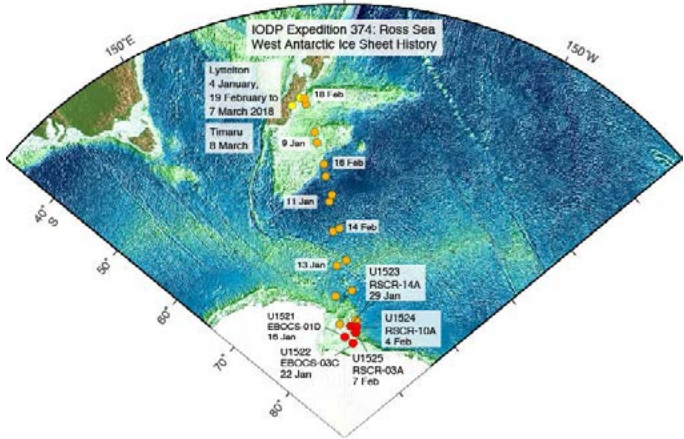
Table 4: ANZIC Participants in IODP Expeditions in 2018

Expedition	Date	Participants	Ports
374: Ross Sea West Antarctic Ice Shelf (751)	January 24– March 8, 2018	Co-Chief Scientist Rob McKay (VUW); Giuseppe Cortese (GNS), radiolarians; Rosa Hughes-Currie (NZ), Education and Outreach	Lyttelton - Lyttelton
375: Hikurangi Subduction margin (781A)	March 8 – May 5, 2018	Co-Chief Scientist Laura Wallace (GNS); Phil Barnes (NIWA), core log and seismic integration; Martin Crundwell (GNS), forams (observer); Annika Greve (JAMSTEC), paleomagnetism; Claire Shepherd (GNS), nannofossils; Alike Weststrate (Outer Reaches), Education and Outreach	Lyttelton - Auckland
376: Brothers Arc Flux (818)	May 5 – July 5 2018	Co-Chief Scientist Cornel de Ronde (GNS); Fabio Caratori-Tontini (GNS), paleomagnetism; Agnes Reyes (GNS), downhole specialist, observer; Dominique Tanner (Wollongong), igneous petrologist; Perry Hyde (Te Papa), Education and Outreach; Cecile Massiot (GNS) Physical Properties and Downhole measurements	Auckland - Auckland
358: NanTroSEIZE 4	Oct 2018– Mar 2019	Tobias Colson (UWA) geologist	Shore based - Bremen

IODP Expedition 374 4 January – 8 March 2018 Ross Sea West Antarctic Ice Sheet History

Robert McKay: Director Antarctic Research Centre, Victoria University of Wellington

The Ross Sea West Antarctic Ice Sheet (WAIS) History Expedition (based on IODP Proposals 751 Full2, 751 Add, 751 Add2, & 751 Add3) investigated the relationship between climatic and oceanic change, and WAIS evolution through the Neogene and Quaternary. Numerical models indicated that this region is highly sensitive to changes in ocean heat flux and sea level, making it a key target to understand past ice sheet variability under a range of climatic forcings.





Expedition 375 investigated slow slip events (SSE) along the northern Hikurangi subduction margin (IODP proposals 781A-Full and 781A-Add2). Hikurangi SSE recur every ~2 years so we can monitor changes in deformation rate and associated chemical and physical properties surrounding the SSE source area throughout an entire slow slip cycle. Sampling material from the sedimentary section and oceanic basement of the subducting plate and from primary active thrusts in the outer accretionary wedge, in combination with LWD data, will reveal the rock properties, composition, and lithological and structural character of the active faults involved in the SSE, as well as material that is transported down-dip to the SSE source region. Coring and downhole measurements from four sites will be integrated with the LWD data collected during Expedition 372. In addition, borehole observatories will be installed at the thrust fault site and a site in the upper plate to monitor hydrologic, chemical, and physical processes during the SSE cycle.

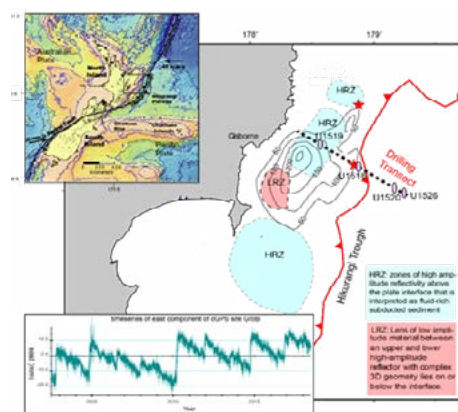
IODP Expeditions 375 (8 March – 5 May 2018) and 372 (26 Nov 2017 – 4 Jan 2018) were run as joint expeditions, with a combined science party. Geophysical logging (using Logging While Drilling) at three of the Hikurangi drill sites was undertaken on Expedition 372. Expedition 375 focused on coring at four sites, and installation of two subseafloor observatories (Figure 2). The combined expeditions had three main objectives: (1) To document the physical, hydrogeological, and chemical properties, lithology, geometry, structure, and thermal state of one of the most active faults near the trench, as well as the inputs of sediment and upper igneous crust of the subducting Pacific plate, with an emphasis on intervals that host, or will eventually host, SSEs; (2) To characterise the stress regime, thermal structure, porosity, permeability, lithology, pore fluid pressure state, fluid chemistry, flow pathways, and structural geology of the upper plate overlying the SSE source region; (3) To install observatories in the upper plate and an active out-of-sequence thrust that span the SSE source region, to monitor volumetric strain (via pore pressure as a proxy) and the evolution of physical, hydrological, and chemical properties throughout the SSE cycle.

The science party for Expedition 375 consisted of 32 scientists and two outreach officers, including five ANZIC participants from New Zealand. Laura Wallace (GNS Science, New Zealand), and Demian Saffer (Pennsylvania State University, USA) were co-chief scientists for the expedition. Four sites were cored on the expedition (Sites U1518, U1519, U1520, and U1526), spanning a transect from the subducting Pacific Plate, and across the trench to the overriding plate (Figures 1, 2). In total, 1.15 km of core was recovered at the four sites. Two subseafloor observatories were installed, one at Site U1518 (to ~420 m below the seafloor), which penetrated a major active fault near the trench, and the second at Site U1519 (to ~275 m below the seafloor), overlying the region of large slow slip (Figures 1, 2). Both observatories monitor formation pressure at multiple depths (to use as a proxy for volumetric strain during SSEs) and temperature, while the more complex observatory through the fault zone at U1518 also measures fluid flow rates and samples fluids within the fault zone.

Overall, Expedition 375 was highly successful. All of the planned objectives were achieved, and there was sufficient time to acquire additional core material and data at some of the sites. One of the most surprising results was the sheer diversity of lithologies recovered from Sites U1520 and

U1526 on the subducting Pacific Plate, which are being transported into the SSE source region. This indicates that lithological and rheological heterogeneity may play an important role in the generation of SSEs. Cores of the active fault zone revealed co-existing brittle and ductile deformation in the fault zone rocks, suggesting a variety of deformation mechanisms accommodate plate motion on the fault. Successful installation of the two observatories was the most ambitious aspect of Expedition 375. The first post-expedition visit to the observatories was made in February 2019, and they appear to be functioning well thus far. We are planning for a follow-up data download visit to the observatories in late 2020 or early 2021.

The Proceedings for Hikurangi slow slip drilling on IODP Expeditions 372 and 375 was published in May, 2019 (Wallace et al., 2019). Post-expedition research by the ~60 combined science party members to use the coring and logging data to better understand the physical processes leading to SSEs is well underway. A post-expedition meeting for Expeditions 372 and 375 is being planned in Napier, New Zealand for March 2020.



Tectonic setting (upper left inset) and location of slow slip on the Hikurangi subduction zone in a September/October 2014 event captured by a seafloor geodetic network (black contours, labeled in 50 mm increments; Wallace et al., 2016) and the reflective properties of the subduction interface (Bell et al., 2010) at northern Hikurangi. Black dashed line shows the location of the drilling transect (see Figure 2); pink ellipses are the IODP Expedition 372 and 375 drill sites. Red stars are locations of two tsunamigenic subduction interface earthquakes (Mw 6.9–7.1) in March and May of 1947. Lower left inset shows the east component of the position time series for a continuously operating GPS site near Gisborne to demonstrate the repeatability of SSEs since they were first observed in 2002.

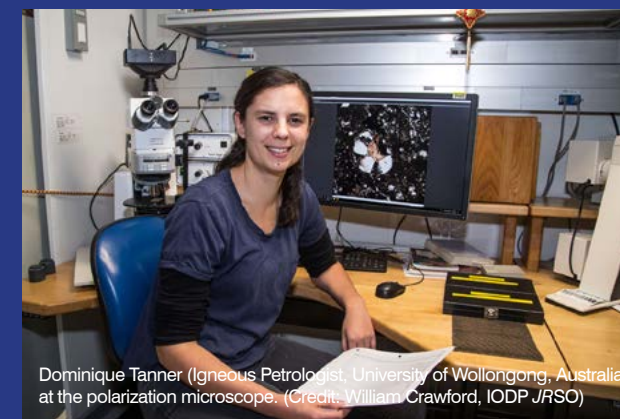


Demian Saffer (Co-Chief Scientist, Pennsylvania State University, USA) and Laura Wallace (Co-Chief Scientist, GNS Science, New Zealand) with the observatory wellheads. (Credit: Tim Fulton, IODP JRSO)



Expedition 376 investigated the fundamental, interrelated processes governing subseafloor hydrothermal activity at Brothers volcano, southern Kermadec arc (IODP proposal 818-Full2). The co-chief scientists were Cornel de Ronde, representing ANZIC from GNS Science, and Susan Humphries, from the Woodshole Oceanographic Institution, U.S.A. ANZIC representatives on board included: Fabio Caratori Tontini (Palaeomagnetist, GNS Science), Agnes Reyes and Cecile Massiot (Physical Properties and Downhole measurements, GNS Science), and Dominique Tanner (Igneous Petrologist, University of Wollongong). Perry Hyde was an Outreach Officer from Museum of New Zealand Te Papa Tongarewa.

The ultimate scientific goal of Expedition 376 was to discover the key processes that distinguish submarine arc-hosted hydrothermal systems from those linked to spreading centers, which results from the flux of magmatic fluid commonly being much higher in volcanic arcs.



Dominique Tanner (Igneous Petrologist, University of Wollongong, Australia) at the polarization microscope. (Credit: William Crawford, IODP JRSO)

IODP Expedition 376 set sail from Auckland, with only a short transit to reach the Brother's volcano, ~400 km northeast of New Zealand. The Brothers volcano is renowned as the most hydrothermally active volcano along the Kermadec Arc, offering scientists a rare opportunity to observe the natural processes operating in modern submarine hydrothermal systems. The expedition centred around two key sites: seawater-dominated hydrothermal systems around the caldera rim and magmatic-influenced hydrothermal systems emerging from the resurgent cone in the centre of the caldera.

The aims of the expedition were to:

- (1) characterise the subvolcano, magma chamber-derived volatile phase to test model-based predictions that this is either a single-phase gas or two-phase brine-vapor;
- (2) explore the subseafloor distribution of base and precious metals and metalloids and the reactions that have taken place along pathways to the seafloor;
- (3) quantify the mechanisms and extent of fluid-rock interaction and consequences for mass transfer of metals and metalloids into the ocean and the role of magmatically derived carbon and sulfur species in mediating these fluxes; and
- (4) assess the diversity, extent, and metabolic pathways of microbial life in an extreme, metal-toxic, and acidic volcanic environment.

While we struggled to recover core at the beginning, I was lucky enough to be on deck when the first submarine rocks from the Brothers volcano were recovered from the caldera rim.

The first rocks to "hit the deck" were unaltered, jet-black dacitic cobbles – but subsequent core barrels retrieved increasingly altered rocks. Some of the rocks beneath the volcanic cone were altered beyond recognition by multiple generations of fluid pathways. This made determining their protolith exceptionally difficult as an igneous petrologist! In total, 222.4 m of volcanoclastic rocks and lavas were recovered from the five sites drilled, which is exceptionally high recovery for altered volcanic rocks in a submarine environment.

As expected, drilling into a volcano certainly wasn't easy. The Brothers volcano challenged the exceptionally talented and seasoned team of drillers aboard the *JOIDES Resolution*. We even trialled a new drilling technique for coring hard rocks using a prototype turbine-driven coring system designed by the Center for Deep Earth Exploration at the Japan Agency for Marine-Earth Science and Technology. But the most memorable event was the culmination of the core through the centre of the resurgent cone. The very acidic (as low as pH 1.8) and relatively hot fluids ($\leq 236^\circ\text{C}$) beneath the volcano got the better of our equipment, spectacularly shearing right through the drill string!

A unique feature of our trip was the addition of an onboard fluid inclusion expert – Agnes Reyes from GNS Science. Preliminary onboard fluid inclusion data provide evidence for involvement of two distinct fluids beneath the resurgent cone within the caldera: a phase-separated (modified) seawater and a ~360°C hypersaline brine, which alters the volcanic rock and potentially transports metals in the system. This is an incredible finding, which has recently been published by the Expedition 376 Scientists in the high-impact journal *Geology*.



All hands on deck! Expedition 376 scientists are on the top deck as the ship departs Auckland. (Photo credit: William Crawford, IODP JRSO)

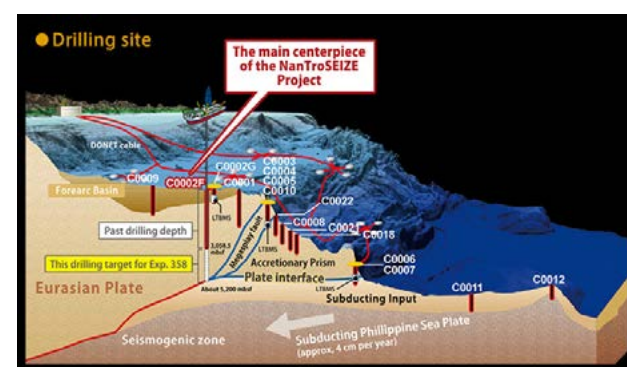
This trip was also remarkable for the strong contingent of researchers from ANZIC. Other ANZIC colleagues on board included co-chief scientist Cornel de Ronde from GNS Science, along with Fabio Caratori Tontini, Agnes Reyes and Cecile Massiot from GNS Science. We also had a fantastic outreach officer Perry Hyde from the Museum of New Zealand/Te Papa Tongarewa.

Our last night aboard the *JOIDES Resolution* coincided with Matariki – the traditional Maori celebration of the New Year. Our outreach officer Perry hosted a beautiful Matariki ceremony while we all huddled under the lifeboats and looked up at the stars. Despite the chilly wind, we stayed outside for quite a while, sharing our gratitude for those around us and our hopes for the new year.



The expedition goal was to deepen riser hole C0002F/N/P from 3000 mbsf to the primary megathrust fault target at ~5200 mbsf, using logging-while-drilling (LWD), downhole measurements, and drill cuttings analysis, in addition to drilling limited coring intervals. This expedition was the culmination of 10 years of IODP NanTroSEIZE deep drilling efforts to reach the plate interface fault system at seismogenic / slow slip depths.

The Scientific Leaders of this six-month long expedition included Takehiro Hirose (JAMSTEC), Kyuichi Kanagawa (Chiba University), Masataka Kinoshita (University of Tokyo), Demian Saffer (Pennsylvania State University), Asuke Yamaguchi (University of Tokyo), Matt Ikari (MARUM), Gaku Kimura (Tokyo University of Marine Science and Technology), Hiroko Kitajima (Texas A&M University) and Harold Tobin (University of Washington).



Starting in October 2018, 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 were 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. Material limitations in the operation left contingency activities, such as virgin hole attempts as infeasible. As a result, it was with great disappointment the team 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, logging while drilling (LWD) and drill logs. Real-time measurement while drilling (M-LWD) logs, monitoring of mud gas and cuttings was conducted and an enormous amount of drilling and operational data was collected, which is 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 the more benign of 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 of seven specialists from around the world providing monitoring, modelling and recommendations to the Chikyu drill ship 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 ANZICs involvement in these operations is centred on what we can learn for future campaigns so we can drill deeper into the unknown and continue to set new records for scientific offshore drilling around the world.



IODP Future Expeditions 2019-2021 & Proposals

Future Expeditions

Eleven RV JOIDES Resolution scheduled expeditions are shown below.

The Chikyu IODP Board (CIB) will be prioritising future riser drilling projects (CRISP #537, IBM #698, and Hikurangi #781), after the completion of the last NanTroSEIZE expedition. In parallel, the CIB has encouraged new Chikyu riser-based projects for consideration along with current active proposals for future implementation.

ECORD Facility Board (EFB) had scheduled for 2020 Expedition 866: Japan Trench Paleoseismology in collaboration with CDEX-JAMSTEC and Expedition 389: Hawaiian Drowned Reefs (now delayed until post 2020). Other Mission Specific Platform MSP expeditions have been endorsed: Expedition 386 based on Proposal, Expedition 377 Central Arctic Paleoclimatology (ArcOP) and Expedition 373 Antarctic Cenozoic Paleoclimate

New IODP Proposals

Sixteen new IODP proposals were submitted in 2018, including three derived from the 2017 Australasian IODP Regional Planning Workshop.

Active IODP Proposals

There are currently 89 active IODP proposals in the archives of the Science Support Office (as of 30 Jan, 2019).

Distribution across the Science Plan themes

- 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

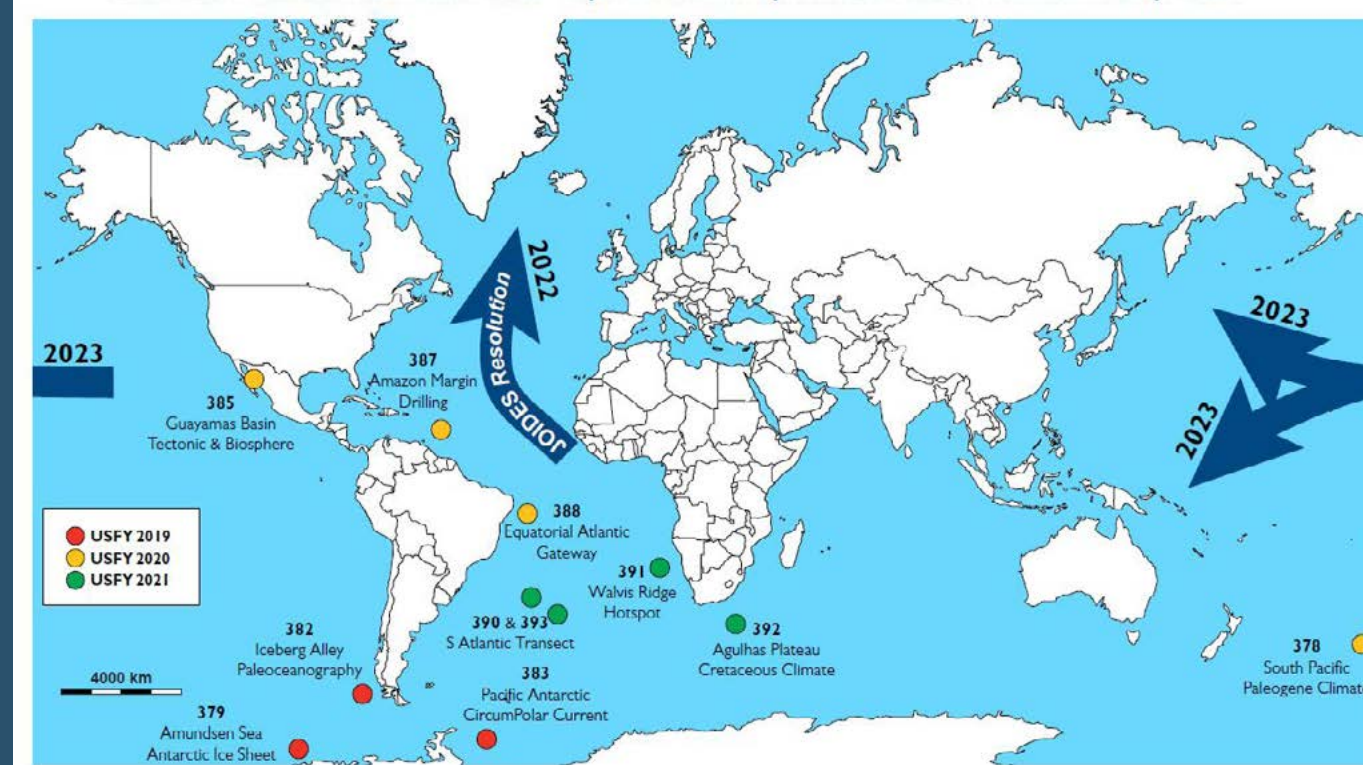


The distribution of the 89 active IODP proposals across the various IODP platforms

61 JR proposals (68.5%);
12 Chikyu proposals (13.5%);
10 MSP proposals (11.2%); and
6 multiple proposals (6.7%) involving the JR and the Chikyu

44 of these proposals are currently with the Facility Boards ready for selection for drilling (29 at JRFB, seven at the Chikyu IODP Board and six at the EFB).

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



IODP Future Expeditions



Exp 374 (Photo credit: William Crawford IODP JR50)

IODP Expedition 379 18 Jan - 20 March 2019

Amundsen Sea West Antarctic Ice Sheet History

Co-chief Scientists Karsten Gohl
Julia Wellner
ANZIC Scientists Joe Prebble, Palynologist (GNS Science)



IODP Expedition 379 will reconstruct the onset of glaciation in the greenhouse to icehouse transition, processes of dynamic ice sheet behavior during the Neogene and Quaternary, and ocean conditions associated with the glacial cycles in the Amundsen Sea Embayment. The five principal objectives of Expedition 379 are as follows: (1) To reconstruct the glacial history of West Antarctica from the Paleogene to recent times and the dynamic behavior of the WAIS during the Neogene and Quaternary, especially possible partial or full WAIS collapses, and the WAIS contribution to past sea level changes. Emphasis is placed in particular on studying the response of the WAIS at times when the pCO_2 in Earth's atmosphere exceeded 400 ppm and atmospheric and oceanic temperatures were higher than at present; (2) To correlate the WAIS-proximal records of ice sheet dynamics in the Amundsen Sea with global records of ice volume changes and proxy records for air and seawater temperatures; (3) To study the relationship between incursions of warm Circumpolar Deep Water (CDW) onto the continental shelf of the Amundsen Sea Embayment and the stability of marine-based ice sheet margins under warm water conditions; (4) To reconstruct the processes of major WAIS advances onto the middle and outer shelf that are likely to have occurred since the middle Miocene and compare their timing and processes to those of other Antarctic continental shelves; and (5) To identify the timing of the first ice sheet expansion onto the continental shelf of the ASE and its possible relationship to the uplift of Marie Byrd Land.

IODP Expedition 382 20 March - 20 May. 2019

Iceberg Alley and Subantarctic Ice and Ocean Dynamics

Co-chief Scientists Mike Weber
Maureen Raymo
ANZIC Scientists Linda Armbricht, Micropalaeontologist- Diatom (University of Adelaide)

IODP Expedition 382 will long-term climate history of Antarctica, seeking to understand how polar ice sheets responded to changes in atmospheric CO_2 in the past and how ice sheet evolution influenced global sea level. We will drill six sites in the Scotia Sea, east of the Antarctic Peninsula, providing the first deep drilling in this region of the Southern Ocean. We expect to recover >600 m of late Neogene sediment that will be used to reconstruct the past history and variability in Antarctic Ice Sheet (AIS) mass loss and associated changes in oceanic and atmospheric circulation.

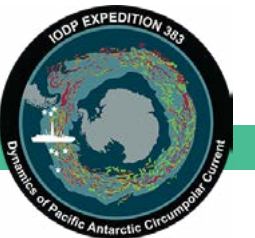


IODP Expedition 383 20 May - 20 July 2019

Dynamics of Pacific Antarctic Circumpolar Current

Co-chief Scientists Frank Lamy
Gisela Winckler
ANZIC Scientists Christina Riesselman, Micropalaeontologist- Diatom (University of Otago)
Chris Moy, Special Call - Sedimentologist (University of Otago)

IODP Expedition 383 will investigate the Pliocene-Pleistocene atmosphere-ocean-cryosphere dynamics of the Pacific Antarctic Circumpolar Current (ACC), and their role in regional and global climate and atmospheric CO_2 based on sediment records with the highest possible stratigraphic resolution. The expedition will test two major scientific hypotheses: (1) ACC dynamics and Drake Passage throughflow conditioned the global Meridional Overturning Circulation and high-low climate linkages on orbital and submillennial time-scales since the Pliocene. (2) Variations in the Pacific ACC determine the physical and biological characteristics of the oceanic carbon pump and atmospheric CO_2 .

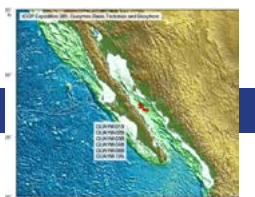


IODP Expedition 385 16 Sept. - 16 Nov. 2019

Guaymas Basin Tectonics and Biosphere

Co-chief Scientists Andres Teske
Daniel Lizarralde
ANZIC Scientist Not filled

IODP Expedition 385 will core and log a series of sites in the Guaymas Basin to investigate the relationship of tectonics, magmatism, sedimentation, carbon cycling, and microbial activity. The primary objectives are to: (1) explore the physical and chemical gradients along active and extinct fluid pathways associated with sill emplacement; (2) investigate subsurface microbial communities that are sustained by alteration products, in order to determine how efficiently they capture carbon-bearing alteration products; and (3) advance our understanding of the conditions that limit life in the deep biosphere.



IODP Expedition 389 Rescheduled

Hawaiian Drowned Reefs

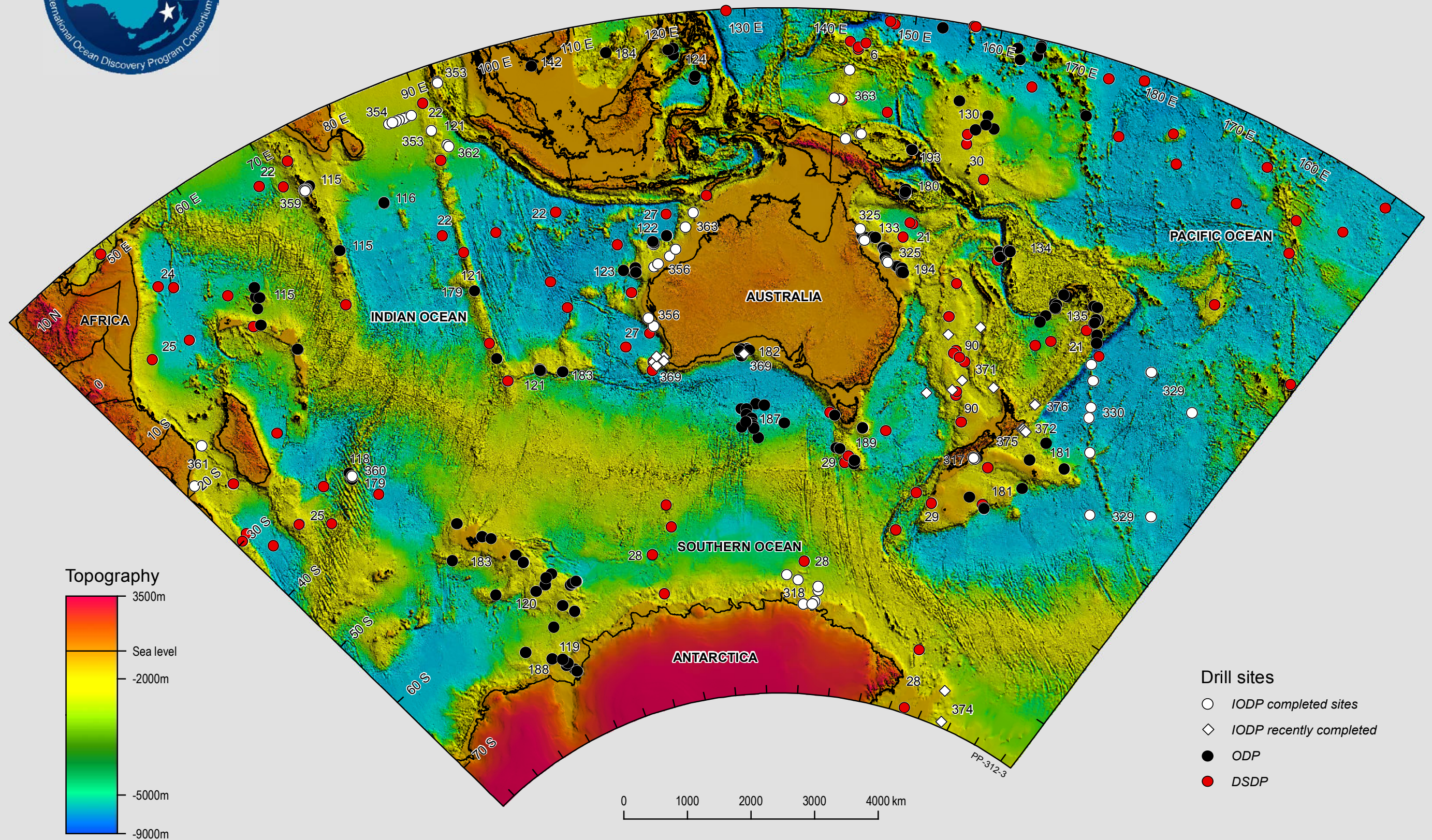
Co-chief Scientists Jody Webster (University of Sydney, Australia) ANZIC
Christina Ravelo (University of California, USA)

The overall goal of the drilling campaign is to sample a unique succession of drowned coral reefs around Hawaii now at -134 to -1155 m below sea level. As a direct result of Hawaii's rapid but nearly constant subsidence, a thick (100-200 m) expanded sequence of shallow coral reef dominated facies is preserved within the reefs. These reefs span important periods in Earth climate history, either not available or highly condensed on stable (Great Barrier Reef, Tahiti) and uplifted margins (Papua New Guinea, Barbados) due to a lack of accommodation space and/or unfavourable shelf morphology. Specifically, these data show that the reefs grew into, during and out of the majority of the last five to six glacial cycles. Scientific drilling through these reefs will generate a new record of sea-level and associated climate variability during several controversial and poorly understood periods over the last 500 kyr.





AUSTRALASIAN SCIENTIFIC OCEAN DRILLING: 1968 - 2018



Commonwealth of Australia (Geoscience Australia 2016)



IODP New Decadal Science Plan 2024-2034

Ocean Planet Workshop

Developing the new IODP Strategic Plan 2024 – 2034 14-16th 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, analyse, theorise, 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. IODP also builds intellectual capacity through the promotion of international collaboration, education, and training.

The Science Plan for the International Ocean Discovery Program, Illuminating Earth's Past, Present, and Future, is intended to guide multidisciplinary international collaboration on scientific ocean drilling during the period 2013-2023.

As part of the worldwide effort to develop the next decadal plan for scientific ocean drilling, the ANZIC has planned a three day workshop, Ocean Planet, to bring together Australian and New Zealand experts in marine geoscience and geomicrobiology relevant to drilling who wish to help formulate a new 2024-2034 science plan for ANZIC and international partners.

The workshop located at the Australian National University encourages early to mid career researchers, to attend and to define new themes and new challenges. We hope the ANZIC community will provide fresh and innovative ideas and approaches that will generate the framework for a new science plan, emphasising research interests and expertise focused on Oceania and Antarctica for the next decade.

Participants will deliberate new research frontiers, gaps in the current IODP Science Plan (<https://www.iodp.org/about-iodp/iodp-science-plan-2013-2023>), and improved engineering, technological, drilling, logging, and observing capabilities. The workshop report will form the basis of Australia's and New Zealand's input into the next global decadal plan.

ANZIC Ocean Planet Workshop will produce a report that will be presented at the international decadal plan workshop in Osaka in September, bringing together the input and results from all 23 IODP member nations to finalise the globally agreed next science plan for international scientific ocean drilling.

Once completed and initiated the new science plan 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.

Australia and New Zealand's continued involvement in the IODP is vital and ANZIC needs to continue its engagement and extensive leadership with the IODP. The IODP is the largest and longest running international scientific research program in the ocean and Earth sciences and focus on the Oceania region should be a matter of importance and that our scientists remain involved in this program.

Through our involvement with IODP and these international collaborations we have unearthed our seventh continent - Zealandia, we are helping to protect the Great Barrier Reef, and by reading the past we have transformed our understanding of our planet to better predict the future.

IODP expeditions in our region have increased our participation and focused international attention on our scientific research issues, and through ANZIC's engagement we have developed the next generation of research scientists through participation, mentoring, and training.

ANZIC is funded through to the end of 2020 by the Australian Research Council and a consortium of 16 universities and four publicly funded research agencies. The ANZIC community is seeking renewed funding support from the Australian and New Zealand governments to continue the essential work of ANZIC as a full member of IODP from 2020.

Summary of Outputs by ANZIC Participants

ANZIC scientists contribute significant knowledge to advance our global understanding of the Earth’s geology, climatic evolution, geohazards and biosphere. We are an active community having provided 16% of the total publications within IODP in our current funding phase (2016-2018).

Since the inception of the ocean drilling program in 1968, through to our current International Ocean Discovery Program in 2018, ANZIC scientists have contributed over 4,000 publications, representing 11.7% of the 36,000+ publications globally produced over the last 50 years of scientific ocean drilling (Table 5). 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 that are supported by ANZIC, or through the unique ANZIC Legacy analytical grant support program. The 2018 record of ANZIC contributions are extracted from the Scientific Ocean Drilling Bibliographic Database, compiled annually by the *JOIDES Resolution* Support Office (JRSO).

The Scientific Ocean Drilling Bibliographic Database is a subset of American Geosciences Institute (AGI) GeoRef database. To generate the GeoRef database, AGI indexes and records bibliographic data from approximately 3,800 domestic and international publications. AGI produces the Scientific Ocean Drilling Bibliographic Database in collaboration with IODP. AGI uses a series of keywords to extract bibliographic records related to Program research from the GeoRef database. The database resides on the AGI server (<http://iodp.americangeosciences.org/vufind>) and is updated weekly. Metadata associated with each record can be saved to a personalised list, texted or emailed, or exported into common bibliographic software. The database also generates references in several formats.

Depending on the source, from which AGI acquires its information, there may be a significant delay after publication before a record is included in the GeoRef database and later in the Scientific Ocean Drilling Bibliographic Database. There is no guarantee that all publication venues for Program research are included in GeoRef or the Scientific Ocean Drilling Bibliographic Database, but scientific publications throughout the world are represented.

Australia and New Zealand have been members of the various phases of the scientific ocean drilling program over the last 50 years, either directly (as affiliated members) or indirectly (non-funded periods) (Table 5). In the current phase of direct funding, from the Australian Research Council under the Linkage Infrastructure, Equipment and Facilities scheme (LE160100067 2016-2020) and our co-investment consortium members, ANZIC scientists have contributed a substantial 16.0% of the global output attributed to IODP, with Australian and New Zealand scientists involved in 12.4% and 4.5%, respectively, of the total output. It is anticipated that by the end of the current phase of ANZIC’s affiliation to IODP in 2020, ANZIC scientists will have exceeded their previous major contribution to the global scientific output previously achieved between 1988-2003.

In terms of peer-reviewed outputs in top tier publications, ANZIC scientists have nearly doubled the last two years’ of outputs in the top twenty Earth Science journals, whereby Australian scientists have now contributed 7.1%, and New Zealand Scientists 3.0%, of the global IODP total top 20 Earth Sciences publications since 2016 (Table 6).

Table 5. Scientific ocean discovery publications* including authors representing Australia or New Zealand compared to all scientific ocean discovery publications produced internationally.

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
1968–1987	223	181	290	9,084	3.2
1988–2003	2,191	150	2,308	13,784	16.7
2004–2007	330	87	385	3,771	10.2
2008–2013	384	239	585	5,375	10.9
2014–2015	227	103	289	1,943	14.9
2016–2018†	281	103	364	2,274	16.0
Total	3,636	863	4,221	36,231	11.7

Notes: This table was prepared in September 2019 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 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), and 2016–2018 = 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 2018 only reflect citations that were added to the database by June 2019 and may not represent a complete total of 2018 publications.

(Photo credit: IODP JRSO)

Table 6. Peer-reviewed scientific ocean discovery 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 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	2	0	416	33	1,990
1988–2003	18	1	181	52	15	1,440	221	4,050
2004–2007	3	1	72	36	22	592	108	1,553
2008–2013	8	5	107	41	22	893	140	2,099
2014–2015	8	1	30	19	11	333	66	787
2016–2018‡	2	2	22	33	14	464	90	965
Total	41	13	588	183	84	4,138	658	11,444

Notes: This table was prepared in September 2019 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), 2016–2018 = IODP ANZIC Phase 3 (direct). * = Top three science journals (based on Thompson/Reuters impact factor) = Nature, Science, and Nature Geoscience. † = Top twenty Earth science journals (determined by impact factor of journals in ISI Web of Knowledge categories related to Earth science) = Proceedings of the National Academy of Sciences of the United States of America; Earth-Science Reviews; Geology; Quaternary Science Reviews; Earth and Planetary Science Letters; Geophysical Research Letters; Geochimica et Cosmochimica Acta; Global and Planetary Change; Geological Society of America Bulletin; Chemical Geology; Journal of Geophysical Research; Marine and Petroleum Geology; Climate of the Past; Journal of Petrology; Marine Geology; Sedimentary Geology; Sedimentology; Contributions to Mineralogy and Petrology; Organic Geochemistry; and Paleoceanography and Paleoclimatology. 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 2018 only reflect citations that were added to the database by June 2019 and may not represent a

The following section provides excerpts from the new annual IODP bibliographic report to IODP members. As of June 2018, the Scientific Ocean Drilling Bibliographic Database contained 3,301 records containing metadata from publications published from 2014 to 2018 (representing our current and previous ARC LIEF funding periods). Of these publications, 439 are authored, or co-authored, by researchers from the Australian and New Zealand IODP Consortium (ANZIC) (Figure 1). These ANZIC-authored publications include ~54% IODP program records (e.g., publications produced and published by IODP) and ~47% non-Program records (e.g., Program-related scientific research published in the open literature) (Figure 2). The IODP portion of the serial entries includes records from both phases of the Integrated Ocean Drilling Program and International Ocean Discovery Program

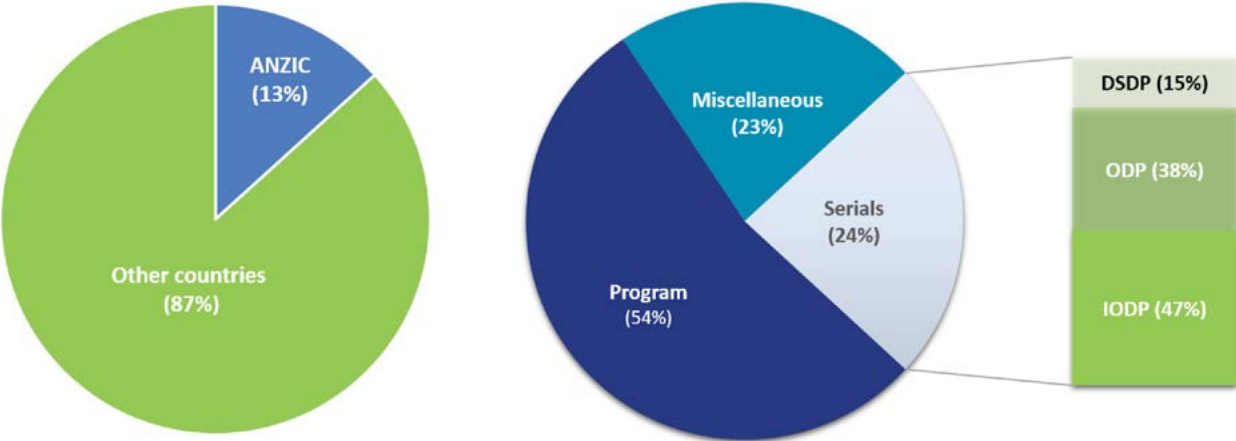


Figure 1. Percentage of Scientific Ocean Bibliographic Database records with ANZIC contributors, 2014–2018 (total = 491). This figure was prepared in July 2018 by IODP Publication Services.

Figure 2. Overview of ANZIC records in the Scientific Ocean Bibliographic Database, 2014–2018 (total = 491). This figure was prepared in July 2018 by IODP Publication Services.

ANZICs serial contributions in comparison to the three IODP platform providers and other program members are listed in Table 7. Overall, ANZIC just places fourth in terms of IODP contributing countries behind the three platform providers and 20 papers in front of China, and fifth in terms of first-authored to other small affiliate members. Our contributions given our 0.5 affiliate level in IODP clearly indicate ANZIC scientists hit well above expectations and comparisons. Our Legacy grant program is considered one of the reasons that our success is transformed in this way.

Table 7. ANZICs serial contributions in comparison to the three IODP platform providers and other program members

Platform Provider Country/ Consortium	First authors of serials	Serial contribution by country	Serial contributions by author	Total contributions
United States of America	3,923	3,253	5,942	9,865
Japan	696	817	1,829	2,525
ECORD	4,073	5,239	6,691	10,764
Program Member Country/ Consortium	First authors of serials	Serial contribution by country	Serial contributions by author	Total contributions
ANZIC	310	453	558	868
(Australia)	(180)	(300)	(347)	(527)
(New Zealand)	(130)	(153)	(211)	(341)
Brazil	23	30	32	55
China	420	326	427	847
India	173	95	106	279
Republic of Korea	50	81	93	143
Total Papers	9,668			25,346

An overview of publications in terms of overall IODP outputs since 2003 are presented in Figure 3. Here, the Program (Expedition Reports, post-expedition research data reports, and Scientific Drilling papers in dark blue) and non-Program serial publications (light blue) for all completed Integrated Ocean Drilling Program and IODP expeditions whose Expedition Reports volumes are published before the end of June 2018 (Expeditions 301–366 and 370) are shown. Note that the publication tail for post-cruise expedition research in both Program and serial publications extends for several years after the end of the expedition; hence, more recent expeditions have fewer publications credited to them, as illustrated in the figure.

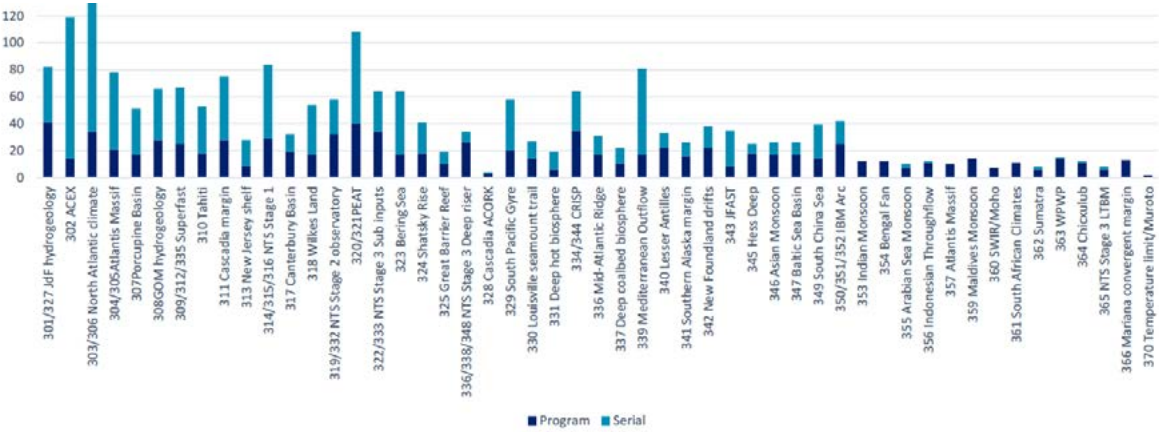


Figure 3. Publication Record for Expeditions 301–366 and 370 (2003–2018). This figure was prepared in July 2018 by IODP Publication Services based on cited-by data through Google Scholar.

As indexing and interconnectivity of scientific research results increase, IODP is better able to illustrate through “cited-by” data how often scientific publications are cited in other research articles. Cited-by data, in the form of number of times an article has been cited, can be accrued through several venues: Science Direct, SCOPUS, CrossRef, Web of Science, Web of Knowledge, and others. Comprehensive cited-by results are unavailable at this time, as not all publishers utilise cited-by data compilers. For this first annual IODP publication report, the IODP Publication Services collected cited-by data in July 2018 through Google Scholar. Review of these cited-by data shows that Program publications and non-Program serial publications containing research results from the Integrated Ocean Drilling Program and IODP expeditions have been cited in other research articles more than 34,900 times between 2003 and 2018. Figure 4 includes available cited-by counts for Expeditions 301–352.

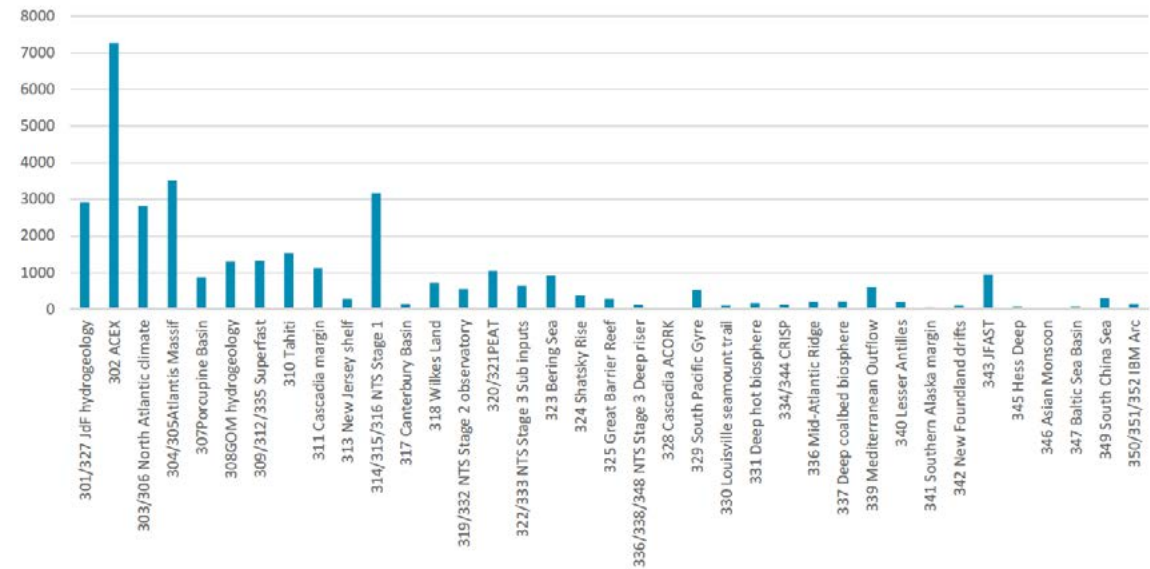


Figure 4. Number of times Program or non-Program serial publications from the Integrated Ocean Drilling Program and IODP expeditions were cited by other research articles (2003–2018). This figure was prepared in June 2018 by IODP Publication Services based on data in the Scientific Ocean Drilling Bibliographic Database, a subset of GeoRef hosted by the American Geosciences Institute.



2018 Publications Authored by ANZIC Members

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 2019 that were published in 2018, with ANZIC members highlighted in bold type.

Armbricht, L.H., Lowe, V., Escutia, C., Iwai, M., **McKay, R.**, and **Armand, L.K.**, 2018. Variability in diatom and silicoflagellate assemblages during mid-Pliocene glacial-interglacial cycles determined in Hole U1361A of IODP Expedition 318, Antarctic Wilkes Land Margin. *Marine Micropaleontology*, 139:28–41. <https://doi.org/10.1016/j.marmicro.2017.10.008>

Carter, S.C., Griffith, E.M., Scher, H.D., and the Expedition 355 Scientists (including **S. Bratenkov**), 2017. Data report: 87Sr/86Sr in pore fluids from IODP Expedition 355 Arabian Sea Monsoon. In Pandey, D.K., Clift, P.D., Kulhanek, D.K., and the Expedition 355 Scientists, Arabian Sea Monsoon. Proceedings of the International Ocean Discovery Program, 355: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.355.201.2017>

Durand, A., Chase, Z., Noble, T.L., Bostock, H., Jaccard, S.L., Townsend, A.T., Bindoff, N.L., Neil, H., and **Jacobsen, G.**, 2018. Reduced oxygenation at intermediate depths of the southwest Pacific during the last glacial maximum. *Earth and Planetary Science Letters*, 491:48–57. <https://doi.org/10.1016/j.epsl.2018.03.036>

Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists (including **E.A. Frery**), 2018. Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College

Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.2018>

Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists (including **E.A. Frery**), 2018. Supplementary material, <https://doi.org/10.14379/iodp.proc.366supp.2018>. Supplement to Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.2018>

Fryer, P., Wheat, C.G., Williams, T., Albers, E., Bekins, B., Debreit, B.P.R., Deng, J., Dong, Y., Eickenbusch, P., **Frery, E.A.**, Ichiyama, Y., Johnson, K., Johnston, R.M., Kevorkian, R.T., Kurz, W., Magalhaes, V., Mantovanelli, S.S., Menapace, W., Menzies, C.D., Michibayashi, K., Moyer, C.L., Mullane, K.K., Park, J.-W., Price, R.E., Ryan, J.G., Shervais, J.W., Sissmann, O.J., Suzuki, S., Takai, K., Walter, B., and Zhang, R., 2018. Expedition 366 summary. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.101.2018>

Fryer, P., Wheat, C.G., Williams, T., Albers, E., Bekins, B., Debret, B.P.R., Deng, J., Dong, Y., Eickenbusch, P., **Frery, E.A.**, Ichiyama, Y., Johnson, K., Johnston, R.M., Kevorkian, R.T., Kurz, W., Magalhaes, V., Mantovanelli, S.S., Menapace, W., Menzies, C.D., Michibayashi, K., Moyer, C.L., Mullane, K.K., Park, J.-W., Price, R.E., Ryan, J.G., Shervais, J.W., Sissmann, O.J., Suzuki, S., Takai, K., Walter, B., and Zhang, R., 2018. Expedition 366 methods. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.102.2018>

Fryer, P., Wheat, C.G., Williams, T., Albers, E., Bekins, B., Debret, B.P.R., Deng, J., Dong, Y., Eickenbusch, P., **Frery, E.A.**, Ichiyama, Y., Johnson, K., Johnston, R.M., Kevorkian, R.T., Kurz, W., Magalhaes, V., Mantovanelli, S.S., Menapace, W., Menzies, C.D., Michibayashi, K., Moyer, C.L., Mullane, K.K., Park, J.-W., Price, R.E., Ryan, J.G., Shervais, J.W., Sissmann, O.J., Suzuki, S., Takai, K., Walter, B., and Zhang, R., 2018. Site 1200. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.103.2018>

Fryer, P., Wheat, C.G., Williams, T., Albers, E., Bekins, B., Debret, B.P.R., Deng, J., Dong, Y., Eickenbusch, P., **Frery, E.A.**, Ichiyama, Y., Johnson, K., Johnston, R.M., Kevorkian, R.T., Kurz, W., Magalhaes, V., Mantovanelli, S.S., Menapace, W., Menzies, C.D., Michibayashi, K., Moyer, C.L., Mullane, K.K., Park, J.-W., Price, R.E., Ryan, J.G., Shervais, J.W., Sissmann, O.J., Suzuki, S., Takai, K., Walter, B., and Zhang, R., 2018. Site U1491. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.104.2018>

Fryer, P., Wheat, C.G., Williams, T., Albers, E., Bekins, B., Debret, B.P.R., Deng, J., Dong, Y., Eickenbusch, P., **Frery, E.A.**, Ichiyama, Y., Johnson, K., Johnston, R.M., Kevorkian, R.T., Kurz, W., Magalhaes, V., Mantovanelli, S.S., Menapace, W., Menzies, C.D., Michibayashi, K., Moyer, C.L., Mullane, K.K., Park, J.-W., Price, R.E., Ryan, J.G., Shervais, J.W., Sissmann, O.J., Suzuki, S., Takai, K., Walter, B., and Zhang, R., 2018. Site U1492. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.105.2018>

Fryer, P., Wheat, C.G., Williams, T., Albers, E., Bekins, B., Debret, B.P.R., Deng, J., Dong, Y., Eickenbusch, P., **Frery, E.A.**, Ichiyama, Y., Johnson, K., Johnston, R.M., Kevorkian, R.T., Kurz, W., Magalhaes, V., Mantovanelli, S.S., Menapace, W., Menzies, C.D., Michibayashi, K., Moyer, C.L., Mullane, K.K., Park, J.-W., Price, R.E., Ryan, J.G., Shervais, J.W., Sissmann, O.J., Suzuki, S., Takai, K., Walter, B., and Zhang, R., 2018. Sites U1493, U1494, and U1495. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.106.2018>

Fryer, P., Wheat, C.G., Williams, T., Albers, E., Bekins, B., Debret, B.P.R., Deng, J., Dong, Y., Eickenbusch, P., **Frery,**

E.A., Ichiyama, Y., Johnson, K., Johnston, R.M., Kevorkian, R.T., Kurz, W., Magalhaes, V., Mantovanelli, S.S., Menapace, W., Menzies, C.D., Michibayashi, K., Moyer, C.L., Mullane, K.K., Park, J.-W., Price, R.E., Ryan, J.G., Shervais, J.W., Sissmann, O.J., Suzuki, S., Takai, K., Walter, B., and Zhang, R., 2018. Site U1496. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.107.2018>

Fryer, P., Wheat, C.G., Williams, T., Albers, E., Bekins, B., Debret, B.P.R., Deng, J., Dong, Y., Eickenbusch, P., **Frery, E.A.**, Ichiyama, Y., Johnson, K., Johnston, R.M., Kevorkian, R.T., Kurz, W., Magalhaes, V., Mantovanelli, S.S., Menapace, W., Menzies, C.D., Michibayashi, K., Moyer, C.L., Mullane, K.K., Park, J.-W., Price, R.E., Ryan, J.G., Shervais, J.W., Sissmann, O.J., Suzuki, S., Takai, K., Walter, B., and Zhang, R., 2018. Site U1497. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.108.2018>

Fryer, P., Wheat, C.G., Williams, T., Albers, E., Bekins, B., Debret, B.P.R., Deng, J., Dong, Y., Eickenbusch, P., **Frery, E.A.**, Ichiyama, Y., Johnson, K., Johnston, R.M., Kevorkian, R.T., Kurz, W., Magalhaes, V., Mantovanelli, S.S., Menapace, W., Menzies, C.D., Michibayashi, K., Moyer, C.L., Mullane, K.K., Park, J.-W., Price, R.E., Ryan, J.G., Shervais, J.W., Sissmann, O.J., Suzuki, S., Takai, K., Walter, B., and Zhang, R., 2018. Site U1498. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.109.2018>

Hagino, K., and the Expedition 370 Scientists (including **M.J. Raudsepp**), 2018. Data report: calcareous nannofossils from the middle Miocene to Pleistocene, IODP Expedition 370 Site C0023. In Heuer, V.B., Inagaki, F., Morono, Y., Kubo, Y., Maeda, L., and the Expedition 370 Scientists, Temperature Limit of the Deep Biosphere off Muroto. Proceedings of the International Ocean Discovery Program, 370: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.370.201.2018>

Huber, B.T., Hobbs, R.W., Bogus, K.A., and the Expedition 369 Scientists (including **A. Maritati, C.C. Wainman, and L.T. White**), 2018. Expedition 369 Preliminary Report: Australia Cretaceous Climate and Tectonics. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.pr.369.2018>

Jian, Z., Larsen, H.C., Alvarez Zarikian, C.A., and the Expedition 368 Scientists (including **K.A. Dadd**), 2018. Expedition 368 Preliminary Report: South China Sea Rifted Margin. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.pr.368.2018>

Jian, Z., Larsen, H.C., Alvarez Zarikian, C.A., Sun, Z., Stock, J.M., Klaus, A., Boaga, J., Bowden, S.A., Briaes, A., Chen, Y., Cukur, D., **Dadd, K.A.**, Ding, W., Dorais, M.J., Ferré, E.C., Ferreira, F., Furusawa, A., Gewecke, A.J., Hinojosa, J.L., Höfig, T.W., Hsiung, K.-H., Huang, B., Huang, E., Huang, X.-L., Jiang, S., Jin, H., Johnson, B.G., Kurzaewski, R.M., Lei, C., Li, B., Li, L., Li, Y., Lin, J., Liu, C., Liu, Z., Luna, A., Lupi, C., McCarthy, A.J., Mohn, G., Ningthoujam, L.S., Nirrengarten, M., Osono, N., Peate, D.W., Persaud, P., Qui, N., Robinson, C.M., Satolli, S., **Sauermilch, I.**, Schindlbeck, J.C., Skinner,

S.M., Straub, S.M., Su, X., Tian, L., van der Zwan, F.M., Wan, S., Wu, H., Xiang, R., Yadav, R., Yi, L., Zhang, C., Zhang, J., Zhang, Y., Zhao, N., Zhong, G., and Zhong, L., 2018. Site U1505. In Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarikian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.109.2018>

Johnston, R.M., Ryan, J.G., and the Expedition 366 Scientists (including **E.A. Frery**), 2018. pXRF and ICP-AES characterization of shipboard rocks and sediments: protocols and strategies. In Fryer, P., Wheat, C.G., Williams, T., and the Expedition 366 Scientists, Mariana Convergent Margin and South Chamorro Seamount. Proceedings of the International Ocean Discovery Program, 366: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.366.110.2018>

Larsen, H.C., Mohn, G., Nirrengarten, M., Sun, Z., Stock, J., Jian, Z., Klaus, A., et al. (including **I. Sauermilch** and **K. Dadd**), 2018. Rapid transition from continental breakup to igneous oceanic crust in the South China Sea. Nature Geoscience, 11:782–789. <https://doi.org/10.1038/s41561-018-0198-1>

Larsen, H.C., Jian, Z., Alvarez Zarikian, C.A., Sun, Z., Stock, J.M., Klaus, A., Boaga, J., Bowden, S.A., Briaes, A., Chen, Y., Cukur, D., **Dadd, K.A.**, Ding, W., Dorais, M.J., Ferré, E.C., Ferreira, F., Furusawa, A., Gewecke, A.J., Hinojosa, J.L., Höfig, T.W., Hsiung, K.-H., Huang, B., Huang, E., Huang, X.-L., Jiang, S., Jin, H., Johnson, B.G., Kurzaewski, R.M., Lei, C., Li, B., Li, L., Li, Y., Lin, J., Liu, C., Liu, C., Liu, Z., Luna, A., Lupi, C., McCarthy, A.J., Mohn, G., Ningthoujam, L.S., Nirrengarten, M., Osono, N., Peate, D.W., Persaud, P., Qui, N., Robinson, C.M., Satolli, S., **Sauermilch, I.**, Schindlbeck, J.C., Skinner, S.M., Straub, S.M., Su, X., Tian, L., van der Zwan, F.M., Wan, S., Wu, H., Xiang, R., Yadav, R., Yi, L., Zhang, C., Zhang, J., Zhang, Y., Zhao, N., Zhong, G., and Zhong, L., 2018. Site U1501. In Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarikian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.105.2018>

Larsen, H.C., Jian, Z., Alvarez Zarikian, C.A., Sun, Z., Stock, J.M., Klaus, A., Boaga, J., Bowden, S.A., Briaes, A., Chen, Y., Cukur, D., **Dadd, K.A.**, Ding, W., Dorais, M.J., Ferré, E.C., Ferreira, F., Furusawa, A., Gewecke, A.J., Hinojosa, J.L., Höfig, T.W., Hsiung, K.-H., Huang, B., Huang, E., Huang, X.-L., Jiang, S., Jin, H., Johnson, B.G., Kurzaewski, R.M., Lei, C., Li, B., Li, L., Li, Y., Lin, J., Liu, C., Liu, C., Liu, Z., Luna, A., Lupi, C., McCarthy, A.J., Mohn, G., Ningthoujam, L.S., Nirrengarten, M., Osono, N., Peate, D.W., Persaud, P., Qui, N., Robinson, C.M., Satolli, S., **Sauermilch, I.**, Schindlbeck, J.C., Skinner, S.M., Straub, S.M., Su, X., Tian, L., van der Zwan, F.M., Wan, S., Wu, H., Xiang, R., Yadav, R., Yi, L., Zhang, C., Zhang, J., Zhang, Y., Zhao, N., Zhong, G., and Zhong, L., 2018. Site U1502. In Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarikian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.106.2018>

Larsen, H.C., Jian, Z., Alvarez Zarikian, C.A., Sun, Z., Stock, J.M., Klaus, A., Boaga, J., Bowden, S.A., Briaes, A., Chen, Y., Cukur, D., **Dadd, K.A.**, Ding, W., Dorais, M.J., Ferré, E.C., Ferreira, F., Furusawa, A., Gewecke, A.J., Hinojosa, J.L., Höfig, T.W., Hsiung, K.-H., Huang, B., Huang, E., Huang, X.-L., Jiang, S., Jin, H., Johnson, B.G., Kurzaewski, R.M., Lei, C., Li, B., Li, L.,

Li, Y., Lin, J., Liu, C., Liu, C., Liu, Z., Luna, A., Lupi, C., McCarthy, A.J., Mohn, G., Ningthoujam, L.S., Nirrengarten, M., Osono, N., Peate, D.W., Persaud, P., Qui, N., Robinson, C.M., Satolli, S., **Sauermilch, I.**, Schindlbeck, J.C., Skinner, S.M., Straub, S.M., Su, X., Tian, L., van der Zwan, F.M., Wan, S., Wu, H., Xiang, R., Yadav, R., Yi, L., Zhang, C., Zhang, J., Zhang, Y., Zhao, N., Zhong, G., and Zhong, L., 2018. Site U1503. In Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarikian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.107.2018>

Larsen, H.C., Jian, Z., Alvarez Zarikian, C.A., Sun, Z., Stock, J.M., Klaus, A., Boaga, J., Bowden, S.A., Briaes, A., Chen, Y., Cukur, D., **Dadd, K.A.**, Ding, W., Dorais, M.J., Ferré, E.C., Ferreira, F., Furusawa, A., Gewecke, A.J., Hinojosa, J.L., Höfig, T.W., Hsiung, K.-H., Huang, B., Huang, E., Huang, X.-L., Jiang, S., Jin, H., Johnson, B.G., Kurzaewski, R.M., Lei, C., Li, B., Li, L., Li, Y., Lin, J., Liu, C., Liu, C., Liu, Z., Luna, A., Lupi, C., McCarthy, A.J., Mohn, G., Ningthoujam, L.S., Nirrengarten, M., Osono, N., Peate, D.W., Persaud, P., Qui, N., Robinson, C.M., Satolli, S., **Sauermilch, I.**, Schindlbeck, J.C., Skinner, S.M., Straub, S.M., Su, X., Tian, L., van der Zwan, F.M., Wan, S., Wu, H., Xiang, R., Yadav, R., Yi, L., Zhang, C., Zhang, J., Zhang, Y., Zhao, N., Zhong, G., and Zhong, L., 2018. Site U1504. In Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarikian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.108.2018>

Larsen, H.C., Sun, Z., Stock, J.M., Jian, Z., Alvarez Zarikian, C.A., Klaus, A., Boaga, J., Bowden, S.A., Briaes, A., Chen, Y., Cukur, D., **Dadd, K.A.**, Ding, W., Dorais, M.J., Ferré, E.C., Ferreira, F., Furusawa, A., Gewecke, A.J., Hinojosa, J.L., Höfig, T.W., Hsiung, K.-H., Huang, B., Huang, E., Huang, X.-L., Jiang, S., Jin, H., Johnson, B.G., Kurzaewski, R.M., Lei, C., Li, B., Li, L., Li, Y., Lin, J., Liu, C., Liu, C., Liu, Z., Luna, A., Lupi, C., McCarthy, A.J., Mohn, G., Ningthoujam, L.S., Nirrengarten, M., Osono, N., Peate, D.W., Persaud, P., Qui, N., Robinson, C.M., Satolli, S., **Sauermilch, I.**, Schindlbeck, J.C., Skinner, S.M., Straub, S.M., Su, X., Tian, L., van der Zwan, F.M., Wan, S., Wu, H., Xiang, R., Yadav, R., Yi, L., Zhang, C., Zhang, J., Zhang, Y., Zhao, N., Zhong, G., and Zhong, L., 2018. Expedition 367/368 summary. In Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarikian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.101.2018>

McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists (including **G. Cortese**), 2018. Expedition 374 Preliminary Report: Ross Sea West Antarctic Ice Sheet History. International Ocean Discovery Program, 374. <https://doi.org/10.14379/iodp.pr.374.2018>

Pearson, P.N., and the IODP Expedition 363 Shipboard Scientific Party Scientists (including **B.N. Opdyke** and **J.B. Wurtzel**), 2018. A deep-sea agglutinated foraminifer tube constructed with planktonic foraminifer shells of a single species. Journal of Micropaleontology, 37:97–104. <https://doi.org/10.5194/jm-37-97-2018>

Pecher, I.A., Barnes, P.M., LeVay, L.J., and the Expedition 372 Scientists (including **M.B. Clenell** and **J.B. Mountjoy**), 2018. Expedition 372 Preliminary Report: Creeping Gas Hydrate Slides and Hikurangi LWD. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.pr.372.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists (including **B.N. Opdyke** and **J.B. Wurtzel**), 2018. Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Expedition 363 summary. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.101.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Expedition 363 methods. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.102.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Site U1482. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.103.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Site U1483. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.104.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Site U1484. In Rosenthal, Y.,

Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.105.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Site U1485. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.106.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Site U1486. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.107.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Site U1487. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.103.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Site U1488. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.109.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Site U1489. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.110.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., Aiello, I.W., Babila, T.L., Bayon, G., Beaufort, L., Bova, S.C., Chun, J.-H., Dang, H., Drury, A.J., Dunkley Jones, T., Eichler, P.P.B., Fernando, A.G.S., Gibson, K.A., Hatfield, R.G., Johnson, D.L., Kumagai, Y., Li, T., Linsley, B.K., Meinicke, N., Mountain, G.S., **Opdyke, B.N.**, Pearson, P.N., Poole, C.R., Ravelo, A.C., Sagawa, T., Schmitt, A., **Wurtzel, J.B.**, Xu, J., Yamamoto, M., and Zhang, Y.G., 2018. Site U1490. In Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.111.2018>

Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists (including **B.N. Opdyke** and **J.B. Wurtzel**), 2018. Supplementary material, <https://doi.org/10.14379/iodp.proc.363supp.2018>. Supplement to Rosenthal, Y., Holbourn, A.E., Kulhanek, D.K., and the Expedition 363 Scientists, Western Pacific Warm Pool. Proceedings of the International Ocean Discovery Program, 363: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.363.2018>

Saffer, D.M., **Wallace, L.M.**, Petronotis, K., and the Expedition 375 Scientists (including **P.M. Barnes**, **M.P. Crundwell**, and **C.L. Shepherd**), 2018. Expedition 375 Preliminary Report: Hikurangi Subduction Margin Coring and Observatories. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.pr.375.2018>

Shaanan, U., Rosenbaum, G., Hoy, D., and Mortimer, N., 2018. Late Paleozoic geology of the Queensland Plateau (offshore northeastern Australia). Australian Journal of Earth Sciences, 65(3):357–366. <https://doi.org/10.1080/08120099.2018.1426041>

Sun, Z., Stock, J., Klaus, A., and the Expedition 367 Scientists (including **I. Sauermilch** and **Dadd, K.A.**), 2018. Expedition 367 Preliminary Report: South China Sea Rifted Margin. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.pr.367.2018>

Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarkian, C.A., and the Expedition 367/368 Scientists (including **K.A. Dadd** and **I. Sauermilch**), 2018. South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.2018>

Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarkian, C.A., and the Expedition 367/368 Scientists (including **K.A. Dadd** and **I. Sauermilch**), 2018. Supplementary material, <https://doi.org/10.14379/iodp.proc.367368supp.2018>. Supplement to Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarkian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.2018>

Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarkian, C.A., Boaga, J., Bowden, S.A., Briais, A., Chen, Y., Cukur, D., **Dadd, K.A.**, Ding, W., Dorais, M.J., Ferré, E.C., Ferreira, F., Furusawa, A., Gewecke, A.J., Hinojosa, J.L., Höfig, T.W., Hsiung, K.-H., Huang, B., Huang, E., Huang, X.-L., Jiang, S., Jin, H., Johnson, B.G., Kurzawski, R.M., Lei, C., Li, B., Li, L., Li, Y., Lin, J., Liu, C., Liu, C., Liu, Z., Luna, A., Lupi, C., McCarthy, A.J., Mohn, G., Ningthoujam, L.S., Nirrengarten, M., Osono, N., Peate, D.W., Persaud, P., Qui, N., Robinson,

C.M., Satolli, S., **Sauermilch, I.**, Schindlbeck, J.C., Skinner, S.M., Straub, S.M., Su, X., Tian, L., van der Zwan, F.M., Wan, S., Wu, H., Xiang, R., Yadav, R., Yi, L., Zhang, C., Zhang, J., Zhang, Y., Zhao, N., Zhong, G., and Zhong, L., 2018. Expedition 367/368 methods. In Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarkian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.102.2018>

Sun, Z., Stock, J.M., Klaus, A., Larsen, H.C., Jian, Z., Alvarez Zarkian, C.A., Boaga, J., Bowden, S.A., Briais, A., Chen, Y., Cukur, D., **Dadd, K.A.**, Ding, W., Dorais, M.J., Ferré, E.C., Ferreira, F., Furusawa, A., Gewecke, A.J., Hinojosa, J.L., Höfig, T.W., Hsiung, K.-H., Huang, B., Huang, E., Huang, X.-L., Jiang, S., Jin, H., Johnson, B.G., Kurzawski, R.M., Lei, C., Li, B., Li, L., Li, Y., Lin, J., Liu, C., Liu, C., Liu, Z., Luna, A., Lupi, C., McCarthy, A.J., Mohn, G., Ningthoujam, L.S., Nirrengarten, M., Osono, N., Peate, D.W., Persaud, P., Qui, N., Robinson, C.M., Satolli, S., **Sauermilch, I.**, Schindlbeck, J.C., Skinner, S.M., Straub, S.M., Su, X., Tian, L., van der Zwan, F.M., Wan, S., Wu, H., Xiang, R., Yadav, R., Yi, L., Zhang, C., Zhang, J., Zhang, Y., Zhao, N., Zhong, G., and Zhong, L., 2018. Site U1499. In Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarkian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.103.2018>

Sutherland, R., Dickens, G.R., Blum, P., and the Expedition 371 Scientists (including **K.M. Pascher** and **W.R. Stratford**), 2018. Expedition 371 Preliminary Report: Tasman Frontier Subduction Initiation and Paleogene Climate. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.pr.371.2018>

Stock, J.M., Sun, Z., Klaus, A., Larsen, H.C., Jian, Z., Alvarez Zarkian, C.A., Boaga, J., Bowden, S.A., Briais, A., Chen, Y., Cukur, D., **Dadd, K.A.**, Ding, W., Dorais, M.J., Ferré, E.C., Ferreira, F., Furusawa, A., Gewecke, A.J., Hinojosa, J.L., Höfig, T.W., Hsiung, K.-H., Huang, B., Huang, E., Huang, X.-L., Jiang, S., Jin, H., Johnson, B.G., Kurzawski, R.M., Lei, C., Li, B., Li, L., Li, Y., Lin, J., Liu, C., Liu, C., Liu, Z., Luna, A., Lupi, C., McCarthy, A.J., Mohn, G., Ningthoujam, L.S., Nirrengarten, M., Osono, N., Peate, D.W., Persaud, P., Qui, N., Robinson, C.M., Satolli, S., **Sauermilch, I.**, Schindlbeck, J.C., Skinner, S.M., Straub, S.M., Su, X., Tian, L., van der Zwan, F.M., Wan, S., Wu, H., Xiang, R., Yadav, R., Yi, L., Zhang, C., Zhang, J., Zhang, Y., Zhao, N., Zhong, G., and Zhong, L., 2018. Site U1500. In Sun, Z., Jian, Z., Stock, J.M., Larsen, H.C., Klaus, A., Alvarez Zarkian, C.A., and the Expedition 367/368 Scientists, South China Sea Rifted Margin. Proceedings of the International Ocean Discovery Program, 367/368: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.367368.104.2018>

Williams, H.N., Li, N., and the Expedition 349 Scientists (including **K.A. Dadd** and **I. Sauermilch**), 2018. Data report: exploring the presence of Bdellovibrio and like organisms in deep-sea sediment by culture-independent and culture-dependent methods. In Li, C.-F., Lin, J., Kulhanek, D.K., and the Expedition 349 Scientists, South China Sea Tectonics. Proceedings of the International Ocean Discovery Program, 349: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.349.202.2018>



Exp 368 Sunset. (Photo credit: Guangfa Zhong & IOBP)



**Australian and New Zealand
IODP Consortium**

Exploring the Earth under the Sea

T: +61 2 6125 7999 E: iodp.administrator@anu.edu.au W: iodp.org.au
Jaeger 4 Building, Australian National University, 142 Mills Rd, Acton ACT 2601, AUSTRALIA