# The IODP opportunity and value proposition

The International Ocean Discovery Program (IODP) is a multinational research programme that addresses fundamental questions about Earth processes by drilling beneath the seafloor to collect and analyse sediment, rock and biological samples and to install apparatus for subseafloor monitoring. It is the largest international collaboration in geoscience, involving 24 nations and with an annual budget of USD$67M[[1]](#footnote-1). Scientific drilling is the best means to access the subsurface archive of Earth dynamic processes and changes over geological timescales. IODP expeditions are developed from hypothesis-driven science proposals aligned with the program's Science Plan[[2]](#footnote-2) “*Illuminating Earth's Past, Present, and Future*”, which addresses a wide range of societally relevant research questions, ranging from geological hazards and climate change to the nature of life in extreme environments.

IODP research aims to provide underpinning data and knowledge that will improve forecasts of future geohazards events, better inform responses to climate change, contribute to the stewardship of resources, and broaden research capability in marine geoscience. IODP membership underpins the substantial interdependencies between global science priorities, funding agencies, national and international marine scientists and their institutions, and New Zealand major trading partners.

New Zealand participates in the program in consortium with Australia (the Australian and New Zealand IODP Consortium -ANZIC). Our formal entry into scientific ocean drilling in 2008 has brought together GNS Science, NIWA and three of our leading universities. We have taken full advantage of six IODP expeditions in our region over 2017 and 2018 to lead research of global significance, in partnership with scientists from more than 20 other countries. For an annual investment of USD$300,000 per year since 2008, New Zealand has leveraged over USD$80M of international funding for these expeditions.

IODP utilises facilities funded by three platform providers: US funds the research vessel *JOIDES Resolution;* Japan funds the research vessel *Chikyu*, and a European consortium funds a range of *mission-specific drilling platform*s. New Zealand’s membership level allows us to send one participant on an expedition per year, to submit proposals to lead expeditions, attend workshops, and access core archives. All direct costs are covered by the membership fee; these include operation of the drilling vessels, travel and accommodation related to expeditions, workshops and meetings, curation of cores and freight of samples.

# The Proposal

ANZIC and IODP agreements are established till September 2020 but continued IODP membership relies on funding applications to Australian funding agencies through infrastructure grant support mechanisms and continued long term commitment by science institutions in New Zealand. Given the unprecedented level of leveraging of science investment provided by New Zealand’s membership in IODP, it is essential that our membership be continued beyond 2020.

The New Zealand Earth science community seeks long-term and enhanced commitment from the New Zealand government to support IODP research. We propose to double our current commitment be contributing an annual fee of USD$600,000. This will allow New Zealand to increase our berth entitlements and increase our leverage over the future direction of the programme. Doubling berth entitlements will open up IODP research to a wider range of local scientists. Direct government funding may allow us to offer these opportunities to all New Zealand-based scientists. A potential mechanism to support this initiative is the MBIE Strategic Science Investment Fund - Infrastructure component. The commitment to double New Zealand’s involvement is in line with our Australian partners objective of also doubling the requested amount in their 2019 funding application, from USD$1.5M to USD$3M

There is an ongoing expectation that New Zealand CRI members (GNS Science and NIWA) and university partners will continue to contribute to the costs of membership and participation in IODP. The appropriate level of these contributions needs discussion and negotiation.

# New Zealand Participation in IODP 2008 - 2018

Since 2008, New Zealand participation in IODP has been coordinated by a team based at GNS Science and managed by a national committee. Participation is open to staff and students of those universities and research institutes that pay an annual membership fee. Current members include GNS Science, NIWA, University of Otago, Victoria University of Wellington, and University of Auckland.

Participation in *JOIDES Resolution* Voyages

In the decade since 2008, 29 New Zealand shipboard scientists, spanning all the member institutions, have participated in 12 *JR* voyages and one has sailed on the *Chikyu* (Table 1). This number far exceeds the official quota. Six of the scientists were Co-Chiefs on expeditions in the New Zealand EEZ and, on expedition 372, both Co-Chiefs were New Zealanders. Some of these participants are early career researchers that have gone on to the lead proposals and one has achieved the position of Co-Chief. In addition, six New Zealanders will have sailed on the *JR* as Education and Outreach officers by the end of 2018. Other scientists have been involved in writing proposals and many will be shore-based researchers, who will join the expedition science teams in follow-up research.

IODP serves as a technical and scientific training ground providing opportunities for graduate students to work alongside international teams of scientists. Since 2008, 15 graduate students have studied material recovered from IODP drilling legs in New Zealand and Southern Ocean waters (Table 2). Many have provided important and valuable preparatory work for the recent and upcoming expeditions and have filled specialist positions onboard or as shore-based scientists, based directly from PhD specialisation.

Complementary Research Voyages

Since 2011 the New Zealand earth science community have completed 29 marine research voyages using the *RV Tangaroa*, and French, USA, Japanese, German, Korean, and Australian research ships, completing IODP complementary and ancillary science projects and building towards *JR* drilling (Table 3). Collectively these voyages amount to co-funding of >$70M.

In support of the two IODP expeditions on the Hikurangi margin (Legs 372 and 375) 17 voyages (10 using *RV Tangaroa* and 7 international) have been completed and 3 others will take place early in 2019. These voyages were underpinned by a decade of seismological, geodetic, and geological data acquired onshore and offshore. In the Tasman Sea 6 research voyages have been completed including back-to-back cruises of the French research flag ship *R/V L'Atalante*. However, those voyages build on a legacy of over 182,000-line km from 1855 seismic lines compiled in preparation for Leg 371. Much of that data comprises open file industry-acquired seismic profiles lodged with the NZ Government. Four research voyages were completed along the Kermadec arc since 2011 (supporting Leg 376), that have added to more than a decade of detailed mapping and sampling Brothers submarine volcano that included ROV and submersible AUV dives. Two voyages have been completed in the Ross Sea with the objective of finalising site selection for Leg 374. These surveys add to the Antarctic Seismic Data Library holding of many 10000s of km of open-file data that New Zealand has contributed to.

Research Proposals

To support the science that underpinned our successful IODP expedition proposals, 36 New Zealand and international research programs from the US, UK, France, Germany, Italy, Australia, and Japan, have been funded in the last 7 years, including 9 Marsden Funded proposals and 2 MBIE Endeavour projects (Table 4). In addition, Strategic Science Investment Funds to GNS and NIWA have paid IODP membership, resourced proposals to scheduling, and provide limited support for Co-Chief Scientist responsibilities and on-going expedition data analysis.

Education and Outreach

Port visits in 2009, 2010 and 2018 have provided opportunities for tours of the *JR* by school students, university students and staff, the general public, media and VIPs in Auckland, Wellington, Lyttelton and Timaru. Expedition-based outreach has included live ship-to-shore links to schools, museums and university classes throughout the country. For the past two years, New Zealand has hosted the ANZIC Masterclass, a two-week intensive course on marine geoscience for undergraduate students from participating universities in Australia and New Zealand. We will host the Masterclass again in December 2018.

In 2018 we will also host the IODP School of Rock, a 9-day introduction to marine geoscience for teachers and science communicators open to all IODP member countries. School of Rock 2018 – Te Kura Kōhatu – is based in Auckland and will involve 6 participants from New Zealand, 5 from Australia and 7 from the United States.

IODP Science Diplomacy

New Zealand IODP membership has been coordinated by participation in writing the IODP Science Plan and having 10 New Zealand scientists selected on IODP panels and committees. Moreover, IODP research themes incorporate shared interests with other national and international research programs including GeoPRISMS, where New Zealand has been selected as one of the three US National Science Foundation global focus sites[[3]](#footnote-3). Other complementary programmes focus on land (e.g., International Continental Scientific Drilling Program), ice (Antarctic Geological Drilling), climate (e.g., International Geosphere-Biosphere Programme, Past Global Changes project, European Project on Ocean Acidification), or the deep biosphere (e.g., Deep Carbon Observatory). In addition, leading New Zealand institutions have recently formally established MoUs with JAMSTEC, Geoscience Australia, Woods Hole Oceanographic Institute, and Geological Survey of New Caledonia. We regularly brief French and German Embassies in Wellington. The “reach” of the New Zealand-led proposals includes most of New Zealand’s major trading partners.

# Future IODP Proposals in New Zealand Region

IODP missions are proposal driven and the body of active proposals, and the flow of new proposals will sustain IODP through to its next phase (post 2023). To meet the challenge of continuing to address global science questions that can be uniquely addressed in the South West Pacific, ANZIC convened the IODP Australasian Regional Workshop in June 2017 with the aim of building the next generation of proposals[[4]](#footnote-4). In the New Zealand region, two existing proposals were show-cased including:

**Proposal 781B-Full**: Hikurangi Subduction Margin Riser. This is proposal for a *Chikyu* deep hole into the subduction plate boundary fault. 3D seismic reflection data acquisition was completed over proposed sites in Jan 2018. Post analysis of Expeditions 372 and 375 samples and processing of 3D seismic the case for deep drilling will be reviewed with a decision to either proceed with the *Chikyu* option that could piggy back on 871-CPP (below) or, alternatively, another *JR* proposal be submitted.

**Proposal 871-CPP** Lord Howe Rise. In Australian EEZ and the focus of a number of voyages of the *RV Investigator* and Japanese research vessels.

Out of the IODP Australasian Regional Workshop in June 2017 innovative ideas were developed and one submitted as a preproposal in Oct 2017. These include:

1. Episodic fluid flow driven by slow slip and its impact on gas hydrate systems (Porangahau Ridge, eastern North Island).
2. Hikurangi Plateau Large Igneous Provenance and Subduction Inputs.
3. Testing Geodynamic models for subduction initiation: Puysegur Trench.
4. **Pre- Proposal 924** Accumulation and Release of Carbon Dioxide from Geologic Sources in the South Pacific: Chatham Rise, New Zealand” has been invited to develop a Full Proposal.
5. Eruptive processes and transport in submarine volcanic environments.
6. Offshore freshwater resources in the Canterbury Basin.
7. Southeast Chatham Rise margin: tectonics, dynamics and paleoceanography.
8. From Leg 374 (Ross Sea) sites U1524 and RSCR-19A kept in the scheduling pool for JRFB. Proponents to submit a mini-leg proposal to SEP to drill additional new sites near the Ross Ice Shelf by October 2018 to bring it up to a full expedition.

# Current ANZIC Governance

Our national and international networks are also governed by negotiated contracts for IODP membership with Australia (ANZIC), MoUs and Implementing Agreements with our major science partners.

1. The Australian National University (ANU) is the lead funding agency for ANZIC. On behalf of all Australia/New Zealand funding entities, the ANU signed the principal MoU between the Australian Research Council (ARC) and the US National Science Foundation (NSF)[[5]](#footnote-5) in late 2013 to be updated 2018.
2. GNS Science (GNS) is the lead agency for New Zealand ANZIC membership (NZ IODP) and signatory to the MoU with ANU[[6]](#footnote-6) – signed 2016 and expires September 2020.
3. NZ IODP membership is governed in turn by a Multiparty Institutional Agreement between GNS and NIWA, Victoria University, Otago University, and Auckland University[[7]](#footnote-7).

In the current arrangement GNS Science holds the NZ IODP Secretariat and retains a permanent seat on the ANZIC Governing Council.

In any future negotiations with the US National Science Foundation, and countries in the Asia Pacific region, ANZIC may be widened to include Korea and Singapore.

# Summary

The positive impacts for New Zealand IODP membership include improved understanding of the Earth’s climate and oceans and how they will respond to rapid environmental changes in the coming decades. The completed expeditions and planned proposals on the Hikurangi margin will provide improved assessment of earthquake and tsunami hazards and establishment of a long-term borehole observatory to monitor tectonic plate behaviour off the East Coast of the North Island. Scientific drilling has established the framework and understanding for the development of seafloor metal deposits, and the role of microbial communities in generating and biodegrading hydrocarbons and affords access to samples and analysis of geological processes in New Zealand’s marine territory that can be acquired in no other way. In addition, membership delivers invaluable training opportunities for the next generation of New Zealand scientists and engineers plus unrivalled opportunities for students, teachers, and the public to engage with marine science. Finally, IODP and ANZIC enhances New Zealand science diplomacy and leverages international connections that benefit the broader science system and New Zealand.

**Table 1**: New Zealand ANZIC Participants on IODP Expeditions 2008 till 2018. All expeditions using *JOIDES Resolution* unless specified otherwise.

|  |  |  |
| --- | --- | --- |
| **IODP Expedition** | **Date** | **NZ Participants** |
| 320: PEAT 1:  Eastern Pacific paleoceanography | March 5-May 5, 2009 | Christian Ohneiser (Otago), paleomagnetism |
| 317: Canterbury Basin: sea level fluctuations in last 20 million years | Nov. 4, 2009-Jan. 4, 2010 | Greg Browne and Martin Crundwell (GNS), Kirsty Tinto (Otago) |
| 318: Wilkes Land: climate and ocean change at the Antarctic margin over the past 50 million years | Jan 4- March 9, 2010 | Robt McKay (Victoria University) |
| 340: Lesser Antilles volcanism and landslides | Mar 3 – April 17, 2012 | Martin Jutzeler (Otago), structural geology |
| 343: Japan Trench Fast Drilling Project: (*Chikyu*) | April 1 - May 21, 2012 | Virginia Toy (Otago), structural geology |
| 342: Paleogene Newfoundland sediment drifts | June 2 – Aug. 11, 2012 | Chris Hollis (GNS), micropaleontology |
| 341: Southern Alaska Margin tectonics, climate and sedimentation | May 29 – July 29, 2013 | Chris Moy (Otago), Carol Larson (NZ National Aquarium, Napier), Education and Outreach |
| 361: Southern African Climates and Agulhas Current Density Profile | Jan. 30-March 31, 2016 | John Rolison (Otago), inorganic chemist |
| 371: Tasman Frontier Subduction and Climate (Lord Howe Rise) (838) | July 27 –Sept. 26, 2017 | Co-Chief Scientist Rupert Sutherland, Victoria; Wanda Stratford (GNS) physical properties; Kristina Pascher (GNS), micropaleontology; Hugh Morgans (GNS) micropaleontology |
| 372: Gas Hydrates & Hikurangi Subduction Margin LWD (781B & 841) | Nov. 26, 2017 – Jan. 4, 2018 | Co-Chief Scientists Ingo Pecher (Auckland) gas hydrates and Philip Barnes (NIWA) Hikurangi Subduction Margin; Joshu Mountjoy (NIWA), sedimentologist; Erin Todd (Otago) Education and Outreach. |
| 374: Ross Sea West Antarctic Ice Shelf (751) | Jan. 24-March 8, 2018 | Co-Chief Scientist Rob McKay (VUW); Giuseppe Cortese (GNS), micropaleontology; Rosa Hughes-Currie (Waitakere College), Education and Outreach |
| 375: Hikurangi Subduction margin (781A) | March 8 –May 5, 2018 | Co-Chief Scientist Laura Wallace (GNS); Philip Barnes (NIWA), core log and seismic integration; Martin Crundwell (GNS), micropaleontology; Annika Greve (VUW), paleomagnetism; Claire Shepherd (GNS), micropaleontology; Aliki Weststrate (Outer Reaches) (NZ), Education and Outreach |
| 376: Brothers Arc Flux (818) | May 5 – July 5 2018 | Co-Chief Scientist Cornel de Ronde (GNS); Fabio Caratori-Tontini (GNS), paleomagnetics; Agnes Reyes (GNS), downhole specialist; Cécile Massiot Geothermal Geologist; Perry Hyde (Te Papa), Education and Outreach |
| 378: South Pacific Paleogene Climate | Oct. 14 – Dec.14, 2018 | Chris Hollis (GNS) micropaleontology |
| 379: Amundsen Sea West Antarctic Ice Sheet History | Jan. 18 - March 20, 2019 | Joe Prebble (GNS) micropaleontology |

**Table 2:** New Zealand graduate students whose research is related to current and past IODP, ODP, and DSDP Expeditions

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **IODP Expedition 371** | | | | | | | | |
| **Institution** | **Degree** | **Supervisor** | **Student** | | **Year** | **IODP Leg** | **Thesis** | **Comment** |
| Victoria University of Wellington | PhD | Chris Hollis/Rob McKay | Kristina Pascher | | 2017 | Multiple DSDP and ODP drill sites in NZ region | Paleobiogeography of Eocene Radiolarians in the Southwest Pacific ﻿ | Provided important preparatory work for Expedition 371 and Expedition 378. She sailed on Expedition 371 as a non-quota specialist call based directly on her PhD specialisation. |
| Victoria University of Wellington | MSc | Rupert Sutherland | Callum Skinner | | 2018- | 371 | New Caledonia Trough (U1509) to Taranaki |  |
| Victoria University of Wellington | MSc | Rupert Sutherland | Damian Orr | | 2018 - | 371 | Reinga/Northland (U1508, TAN1312) |  |
| University of Canterbury | PhD | Philip Barnes/Andy Nicol/Jarg Pettinga | Sam Davidson | | 2018 | 372/375 | Impacts of rough-crust subduction, North Hikurangi | Seismic interpretation linked to site U1520 |
| **IODP Expedition 372 and 375** | | | | | | | | |
| **Institution** | **Degree** | **Supervisor** | **Student** | | **Year** | **IOD Leg** | **Thesis** | **Comment** |
| University of Auckland | PhD | Ingo Pecher | Adnan Dieffal | | 2017-current | 372 |  | Using logs from Exp. 372 to calibrate seismic data related to gas hydrates |
| Victoria University of Wellington | PhD | Chris Hollis/James Crampton | Claire Shepherd | | 2017 | Multiple DSDP and ODP drill sites in NZ region | Early to middle Eocene calcareous nannofossils of the SW Pacific: paleobiogeography and paleoclimate | Provided important preparatory work for Expedition 371 and Expedition 378. Sailed on Expedition 375 as a non-quota specialist based directly on her PhD specialisation |
| **IODP Expeditions 374 and past IODP/ODP expeditions to Antarctica** | | | | | | | | |
| **Institution** | **Degree** | **Supervisor** | **Student** | | **Year** | **IODP Leg** | **Thesis** | **Comment** |
| Victoria University of Wellington | PhD | Rob McKay | Molly Patterson | | 2014 | 2010 IODP 318 Wilkes Land, Antarctica | The response of Antarctic ice volume, global sea-level and southwest Pacific Ocean circulation to orbital variations during the Pliocene to Early Pleistocene ﻿ | PhD on IODP Expedition 318 (Wilkes Land, Antarctica). She is now an Assistant Professor at Binghampton University in USA, and was a shipboard participant on Expedition 374 (Ross Sea). |
| Victoria University of Wellington | PhD | Rob McKay | Bella Duncan | | 2017 | DSDP leg 28 | Cenozoic Antarctic climate evolution based on molecular and isotopic biomarker reconstructions from geological archives in the Ross Sea region ﻿ | Worked on DSDP leg 28, and other Ross Sea cores and preparatory work for IODP Expedition 374 (pilot studies on proxies). She is now a shore-based researcher on Expedition 374 (post doc) |
|  |  |  |  | |  |  |  |  |
| Victoria University of Wellington | MSc | Rob McKay | Georgia Grant | | 2012 | 318 Wilkes Land, Antarctica | Pliocene-Pleistocene Orbital Cyclostratigraphy and Glacial Evolution of the East Antarctic Ice Sheet from Continental Rise IODP Site U1361, Wilkes Land Margin, East Antarctica |  |
| Victoria University of Wellington | MSc | Rob McKay | Anna Albot | | 2017 | 318 Wilkes Land, Antarctica | Holocene sediment transport and climate variability of offshore Adélie Land, East Antarctica |  |
| Victoria University of Wellington | MSc | Rob McKay | Olga Al’bot | | 2016 |  | Pleistocene cyclostratigraphy on the continental rise and abyssal plain of the western Ross Sea, Antarctica | Sailed on KOPRI cruise and completed MSc on site survey cores relevant to choosing final sites for IODP Leg 374 (Ross Sea). |
| Victoria University of Wellington | MSc | Rob McKay | Christoph Kraus | | 2016 | DSDP site 270 | Oligocene to early Miocene glacimarine sedimentation of the central Ross Sea, and implications for the evolution of the West Antarctic Ice Sheet ﻿ | Worked DSDP site 270. This was direct preparatory work for IODP Leg 374 (Ross Sea), as this core is key to stratigraphic framework. |
| Victoria University of Wellington | PhD | Rob McKay | Katelyn Johnson | | 2018 - | 318 Wilkes Land, Antarctica |  |  |
| Victoria University of Wellington | MSc | Rob McKay | Rebbeca Pretty | | 2018 - | 318 Wilkes Land, Antarctica |  |  |
| Victoria University of Wellington | MSc | Rob McKay | Nikita Thurton | | 2018 - | 318 Wilkes Land, Antarctica |  |  |
| **Post Doc IODP Expeditions** | | | | | | | | |
| **Institution** | | **Funding** | **Researcher** | **year** | | **IOD Leg** | | **Comment** |
| Victoria University of Wellington | | Foundation for Research, Science and Technology (FRST) Postdoctoral Research Fellowship ($260K). | Rob McKay | | 2008-2012 | 318 Wilkes Land, Antarctica | | Research related to IODP Expedition 318 (Wilkes land) and support him as a shipboard participant. Now Associate Professor at VUW. |
| Victoria University of Wellington | | Prime Minister’s MacDiarmid Emerging Scientist, for New Zealand’s top emerging researcher (across all disciplines) ($NZ200k) | Rob McKay | | 2011 | 318 Wilkes Land, Antarctica | |  |

**Table 3**: Marine research voyages since 2011 to advance and complement IODP Expeditions.

| Marine voyages since 2011 to advance and complement IODP Expeditions 372 and 375. |
| --- |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **SURVEY** | **Activity** | **Geographic Area** | **Vessel** | **Voyage Leader (s)** | **YEAR** | **Estimated cost (total voyage)** |
| **TAN1114** | Seismic reflection site survey | Hikurangi margin, Offshore Gisborne | R/V Tangaroa | Philip Barnes (NIWA) and Stuart Henrys (GNS) | 2011 | $1,083,000 |
| **SSLOBS** | Deployment of Ocean Bottom Seismographs | East Coast of North Island | M/V Ocean Pioneer | Stuart Henrys, Kimihiro Mochizuki | 2012 | $72,000 |
| **SLOPS** | Geophysical - OBS recovery, pressure sensor deployment | Hikurangi margin | M/V Amaltal Mariner | Stuart Henrys (GNS), Shuichi Suzuki and Yoshihiro Ito (UoT) | 2013 | $130,000 |
| **TAN1404** | Tuaheni Landslide Complex, 3D seismic imaging project | Tuaheni (offshore Poverty Bay) | R/V Tangaroa | Joshu Mountjoy (NIWA), Sebastian Krastel (Kiel University) | 2014 | $1,200,000 |
| **TAN1405** | OBS, OPB instruments deployed | Hikurangi margin, Offshore Gisborne | R/V Tangaroa | Stuart Henrys (GNS) | 2014 | $1,030,000 |
| **TAN1508** | Gas hydrates and seep reconnaissance survey | Northern East Coast Basin | R/V Tangaroa | Joshu Mountjoy (NIWA), Gareth Crutchley, Ingo Pecher (Auckland Uni.) | 2015 | $1,320,000 |
| **RR1508** | Heat flow and thermal regime of the Hikurangi Subduction Zone and seismic data | Hikurangi margin | R/V Roger Revelle | Harris (OSU), Trehu (OSU, Henrys (GNS Science), Gorman (OU) | 2015 | $4,000,000 |
| **RR1509** | OBS and OBP deployment and Recovery Cruise | Hikurangi margin | R/V Roger Revelle | Laura Wallace | 2015 | $1,200,000 |
| **SO247** | MBEO Coring | Hikurangi margin, Offshore Gisborne and Hawke’s Bay | R/V Sonne | Katrin Huhn (Marum), Nina Kukowski (U. of Jena) | 2016 | $5,000,000 |
| **TAN1607** | OBS, OBP retrieval/deployment, GPS acoustic array survey | Hikurangi Margin | R/V Tangaroa | Stuart Henrys | 2016 | $769,000 |
| **TAN1613** | Piston coring, swath mapping, sub-bottom profiler | Hikurangi Margin | R/V Tangaroa | Philip Barnes | 2017 | $800,000 |
| **TAN1705** | Seafloor geodetic instrument recovery, deployments, GPS-Acoustic surveys. Multicoring. | Offshore east coast North Island and NE coast of South | R/V Tangaroa | Laura Wallace | 2017 | $718,000 |
| **IODP372** | Drilling 4 sites with coring and logging | East Coast, offshore Gisborne | DV *JOIDES Resolution* | Ingo Pecher (Auckland U.) and Philip Barnes (NIWA) | 2017 |  |
| **TAN1710** | OBS deployment and recovery | East Coast, Hikurangi Trench and Bay of Plenty | R/V Tangaroa | Dan Barker | 2017 | $1,600,000 |
| **TAN1712** | OBS deployment | Hikurangi margin, Offshore Gisborne | R/V Tangaroa | Richard Kellett | 2017 | $360,000 |
| **MGL1708** | 2D seismic | East Coast, Hikurangi Trench and Bay of Plenty | R/V Marcus Langseth | Nathan Bangs | 2017 | $6,500,000 |
| **MGL1801** | 3D seismic | Offshore Gisborne | R/V Marcus Langseth | Nathan Bangs | 2018 | $6,500,000 |
| **IODP 375** | Drilling 4 sites with coring and establish 2 ocean bottom observatories | East Coast | DV *JOIDES Resolution* | Demian Saffer (Penn State U., USA) and Laura Wallace (GNS) | 2018 |  |
| **TAN1803** | OBS retrieval | East Coast | R/V Tangaroa | Dan Bassett | 2018 | $600,000 |

| Marine voyages since 2011 to advance and complement IODP Expeditions 371. | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **SURVEY** | **Activity** | **Geographic Area** | **Vessel** | **Voyage Leader (s)** | **YEAR** | **Estimated cost (total voyage)** |
| **ECOSAT I** | Rock dredging collection of underway bathymetry, gravity and magnetic data | Coral Sea | R/V Southern Surveyor | Maria Seton, Simon Williams (U. of Sydney), Nick Mortimer (GNS) | 2012 |  |
| **TAN1312** | Multibeam, gravity, magnetic survey and dredging in the Reinga Basin | Tasman Sea | R/V Tangaroa | Francois Bache, Rupert Sutherland (GNS) | 2013 | $1,384,000 |
| **TAN1409** | IODP SIPC proposal site survey: multichannel seismic, multibeam | Tasman Sea | R/V Tangaroa | Rupert Sutherland, Stuart Henrys (GNS), and Julian Collot Geological Survey New Caledonia) | 2014 | $1,475,000 |
| **VESPA** | Seismic reflection survey and rock dredging | Tasman Sea | R/V L'Atalante | Martin Patriat (Ifremer). Nick Mortimer (GNS) | 2015 | $5,000,000 |
| **TECTA** | Seismic reflection survey, sub-bottom profiling and multibeam swath survey | Tasman Sea | R/V L'Atalante | Rupert Sutherland, (GNS), and Julian Collot Geological Survey New Caledonia) | 2015 | $5,000,000 |
| **IN2016\_T01 (ECOSAT II)** | Rock dredging | Tasman Sea | R/V Investigator | Simon Williams (U. of Sydney), Nick Mortimer (GNS) | 2016 | $1,000,000 |
| **IODP 371** | Drilling 6 sites with coring, | Tasman Sea | DV *JOIDES resolution* | Rupert Sutherland (VUW) and Jerry Dickens (Rice University, USA | 2017 |  |
| Marine research voyages since 2011 to advance and complement IODP Expeditions 374. | | | | | | |
| **SURVEY** | **Activity** | **Geographic Area** | **Vessel** | **Voyage Leader (s)** | **YEAR** | **Estimated cost (total voyage)** |
| **EUROFLEETS** | Seismic reflection site survey | Ross Sea | R/V Explora |  | 2017 | >$1,000,000 |
| **KLL-14-64** | Seismic reflection site survey | Ross Sea | R/V Araon | Joohan Lee and Hyung Jun Kim (Korea Polar Research Institute) | 2015 | >$2,000,000 |
| **IODP 374** | Six drill holes were planned, but 5 drilled. | Ross Sea | DV *JOIDES resolution* | Rob McKay (VUW) and Laura De Santis (Istituto nazionale di oceanografia e di geofisica sperimentale, Italy) | 2018 |  |
| Marine voyages since 2011 to advance and complement IODP Expeditions 376. | | | | | | |
| **SURVEY** | **Activity** | **Geographic Area** | **Vessel** | **Voyage Leader (s)** | **YEAR** | **Estimated cost (total voyage)** |
| **SO253** | ROV (*Quest 4000*) voyage to select volcanoes of the Kermadec arc; vent fluids, chimneys, microbes, heat flow, regional gravity, magnetics and bathymetry | Kermadec arc | R/V *Sonne* | Andrea Koschinsky, Wolfgang Bach, Christian Borowski (U. of Bremen), Cornel de Ronde (GNS) | 2016-17 | $3,500,000 |
| **Navy15** | Mid-Kermadec arc voyage using the AUV *Sentry*, in collaboration with the New Zealand Navy | Kermadec arc | HMNZS *Wellington* | Cornel de Ronde (GNS), Carl Kaiser (WHOI) | 2015 | $1,000,000 |
| **QUELLE** | Submersible *Shinkai 6500* dives | Kermadec arc | R/V *Yokosuka* | JAMSTEC Scientists and Cornel de Ronde (GNS) | 2013 | $8,000,000 |
| **TAN1104** | AUV *Sentry* and *TowCam* mapping Kermadec arc volcanoes | Kermadec arc | R/V *Tangaroa* | Cornel de Ronde (GNS) and Malcom Clark (NIWA) | 2011 | $2,324,000 |
| **IODP 376** | Six drill holes were planned, but 5 drilled. | Brothers Volcano | DV *JOIDES resolution* | Cornel de Ronde (GNS) and Susan Humphris (WHOI). | 2018 |  |

**Table 4:** Proposals and funded national and international projects in support and complementary to IODP Expeditions

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IODP Proposals and funded national and international projects in support and complementary to IODP Expedition 371 Tasman Sea | | | | | | | | |
| **Title** | **Agency** | **Institution** | **Lead PI** | | **Status** | **Planned** | **Comment** | |
| **IODP Proposals** |  |  |  | |  |  |  | |
| Submitted 2013 Subduction Initiation and Paleogene Climate in the Tasman Frontier, Southwest Pacific | IODP | GNS Science | R. Sutherland | | Exp 371 Current | 27 July to 26 September 2017 |  | |
| **Australia** |  |  |  | |  |  |  | |
| Continuity of Australian terranes into Zealandia: towards a geological map of the east Gondwana margin | Marine National Facility | U. of Sydney | Maria Seton | | Funded | 2016 |  | |
| **France** |  |  |  | |  |  |  | |
| TECTA: Tectonic Event of Cenozoic in the Tasman  Area | Flotte Océanographique Française | Geological Survey of New Caledonia | J. Collot | | Funded | 2015-2018 | TECTA and VESPA are complementary voyages to address the question of how subduction zones initiate. | |
| VESPA: Volcanic Evolution of South Pacific Arcs | Flotte Océanographique Française | Ifremer | M. Patriat | | Funded | 2015-2018 |  | |
| **New Zealand** |  |  |  | |  |  |  | |
| The unbearable warmness of surviving in the Eocene ocean | Marsden | GNS Science | C. Hollis | | Completed | 2014-2017 | Funded two PhDs (Pascher, Shepherd) who undertook paleontological studies of related DSDP sites 206, 207, 283, 592. Both subsequently sailed on IODP expeditions (371, 375). Also funded proponents Dickens and Huber to attend NZ workshops | |
| IODP Proposals and funded national and international projects on the Hikurangi margin in support and complementary to IODP Expedition 374 | | | | | | | | |
| **Title** | **Agency** | **Institution** | **Lead PI** | **Status** | | **Planned** | **Comment** |
| **IODP Proposals** |  |  |  |  | |  |  |
| Ocean-ice sheet interactions and West Antarctic Ice Sheet vulnerability: clues from the Neogene and  Quaternary record of the outer Ross Sea continental margin | IODP | Victoria U. of Wellington | R. McKay | Exp 374 Completed | | 4 January to 8 March 2018 | 751-Full |
| **New Zealand** |  |  |  |  | |  |  |
| Develop and undertake IODP Expedition 374 (Ross Sea) | Rutherford Discovery Fellowship | Victoria U. of Wellington | R. McKay | Completed | | 2008-2012 |  |
| Predicting a Sea Change: Antarctic ice-ocean interactions in a warming world | Marsden | Victoria U. of Wellington | A/Prof N. Bertler and R McKay | Current | | 2015-2018 |  |
| Southern Ocean and Antarctic climate response to high atmospheric CO2 forcing | New Zealand Antarctic Research Institute grant | Victoria U. of Wellington and GNS Science | R Levy and R McKay. | Completed | | 2013 |  |
| IODP Proposals and funded national and international projects on the Hikurangi margin in support and complementary to IODP Expeditions 372 and 375 | | | | | | | |
| **Title** | **Agency** | **Institution** | **Lead PI** | **Status** | | **Planned** | **Comment** |
| **IODP Proposals** |  |  |  |  | |  |  |
| Submitted 2011: Multiphase Drilling Project: Unlocking the secrets of slow slip by drilling at the northern Hikurangi subduction margin, New Zealand | IODP | GNS Science/UTIG | L. Wallace | This is the umbrella proposal for 781A and 781B | |  | 781 |
| Submitted 2011: Unlocking the secrets of slow slip by drilling at the northern Hikurangi subduction margin, New Zealand | IODP | Penn State | D. Saffer | Exp 375 Completed | | Nov 26, 2017-Jan 4, 2018 and Mar 8-May 5, 2018 | 781A: Riserless Drill Ship Proposal to drill 4 holes offshore Gisborne. JOIDES Resolution Facilities Board has now time-tabled this for USA FY18 (Oct 2017-Oct 2018) |
| Submitted 2013: Unlocking the secrets of slow slip by drilling at the northern Hikurangi subduction margin, New Zealand: Riser drilling to intersect the plate interface | IODP | GNS Science/ UTIG | L Wallace | Chikyu IODP Facility Board | | 2020-2025 | 781B: Riser Drill Ship Proposal to drill ~6km to plate interface |
| Submitted 2013: Creeping Gas Hydrate Slides: Slow Deformation of Submarine Landslides on the Hikurangi Margin | IODP | University of Auckland | I Pecher | Exp 372 Completed | | Nov 26, 2017-Jan 4, 2018 | APL 841: Ancillary Riserless Drill Ship Proposal to 781A-FULL |
| **United States** |  |  |  |  | |  |  |
| HOBITSS: Hikurangi Ocean Bottom Investigation of Tremor and Slow Slip | NSF | UTIG | L. Wallace | Completed | | 2014-2016 | Marine deployment of seafloor observatory: complimentary science to IODP 781A-FULL |
| Unlocking the secrets of slow slip at the Northern Hikurangi Subduction margin, New Zealand: CORK observatory development and installation | NSF | UTIG | L. Wallace | Current | | 2016-2018 | Borehole observatory: complimentary science to IODP proposals |
| The Thermal Regime of the Hikurangi Subduction Zone and Shallow Slow Slip Events, New Zealand. | NSF | Oregon State University | R. Harris | Completed | | June 2015 | Marine seafloor observations and seismic surveys: complimentary science to IODP 781A-Full |
| A community 3D seismic investigation of fault property controls on slow-slip along the Hikurangi megathrust | NSF | UTIG | N. Bangs | Current | | Jan 2018 | Complimentary science to IODP 781A-Full and 781B-FULL |
| Collaborative Research: Controls on along-strike variations in locked  and creeping megathrust behavior at the Hikurangi convergent margin (SHIRE) | NSF | UTIG | K. McIntosh | Current | | 2018 | Marine and land geophysical surveys: complimentary science to IODP 781A-Full and 781B-FULL |
| 3D variations in Hikurangi margin along-strike and down-dip electrical structure | NSF | Columbia University (LDEO) | K. Key | Funded | | 2019 | Marine MT and CSEM along the Hikurangi margin and includes 30+ days of ship days |
| Hikurangi margin seabed fluid flow and tectonics | NSF | U. of Washington | E. Solomon | Funded | | 2020 | Seabed fluid sampling |
| Along-strike variation in shallow, offshore strain accumulation and slow slip at Hikurangi subduction margin, NZ | NSF | Scripps | D. Chadwell | Funded | | 2018-2021 | Seafloor geodetic deployments to track vertical and horizontal tectonic deformation at offshore Hikurangi |
| **Germany** |  |  |  |  | |  |  |
| SlamZ -Slide activity on the Hikurangi margin, New Zealand | BMBF | U. of Bremmen | K. Kuhn | Current | | March 2016 | Marine MeBo shallow drilling related to IODP 841-APL |
| **UK** |  |  |  |  | |  |  |
| Unlocking the secrets of slow slip with IODP drilling and next-generation seismic experiments | NERC | Imperial College London | R. Bell | Current | | 2017-2018 | Deploy 60 seismometers from SeisUK instrument pool to assist with the wide-angle SHIRE (NSF) study |
| **Japan** |  |  |  |  | |  |  |
| Science of Slow Earthquakes | Japan Funding Agency | U. of Tokyo | K. Obara | Current | | 2016-2020 | Includes 6 main projects including understanding the mechanisms involved in the occurrence of slow Earthquakes |
| Earthquake and Volcano Hazards Observation and Research Program | MEXT | U. of Tokyo | K. Mochizuki | Current | | 2014-2018 | Japan-NZ-USA international collaborative research on fault slip mechanisms along the plate interface during Slow-slip events |
| Observation and modelling for slow slip event in the Hikurangi subduction zone | Earthquake Research Institute U. of Tokyo | U. of Tokyo | Y. Ito | Completed | | 2013-2015 | Ocean Bottom Pressure Gauge deployments offshore Gisborne |
| Modeling relative motion along the plate interface around the slow-slip region in the Hikurangi subduction zone | Japan Funding Agency | Tohoku U. | M. Kido | Completed | | 2016-2017 | Acquisition of acoustic GPS measurements offshore Gisborne |
| **New Zealand** |  |  |  |  | |  |  |
| Subductions Slippery Slope | Marsden | GNS Science | S. Henrys | Completed | | 2009-2013 |  |
| How do tectonic plates lock together? | Marsden | GNS Science | M. Reyners | Completed | | 2009-2013 | Recently completed, with published results |
| Uncorking the Hydrate Bottle | Marsden | University of Auckland | I. Pecher | Completed | | 2010-2014 |  |
| Sticky or Creepy? What causes abrupt variations in seismic behaviour along subduction margins | Marsden | GNS Science | S. Ellis | Completed | | 2013-2016 | Testing the idea that fluid pressure variations along the subduction margin control sticking vs. creeping behaviour, by combining estimates for fluid sources and sinks with rock mechanics in a coupled fluid-mechanical model |
| Capturing the gurgling and chatter from slow slip deformation: Unlocking the role of fluids with magnetotellurics and seismology. | Marsden | GNS Science | S. Bannister and G. Caldwell | Completed | | 2012-2015 | Onshore broadband seismic array and broadband MT array, targeting shallow tremor & LFEs associated with SSEs, recording from Nov 2011 to Nov 2014. Marsden now completed. |
| Does the southern edge of the Hikurangi Plateau control Otago tectonics? | Marsden | GNS Science | M. Reyners | Completed | | 2013-2016 | Seismic tomography of southern Canterbury-Otago region |
| Can slow subduction zone deformation rapidly increase stress on nearby faults | Marsden | GNS Science | B. Fry | Current | | 2016-2019 | Apply seismic methods to HOBITSS data map and identify changes in physical  properties (i.e. stress) across a cycle of slow-slip deformation in the northern Hikurangi subduction |
| HSM: Hikurangi subduction earthquakes and slip behaviour | MBIE Endeavour | GNS Science | L. Wallace | Current | | 2017-2022 | Diagnosing peril posed by the Hikurangi subduction zone: New Zealand’s largest plate boundary fault |
| GHR: Harnessing New Zealand Gas Hydrate Resources | MBIE Contestable | GNS Science | G. Crutchley | Completed | | 2012-2018 | Fundamental research on NZ gas hydrate systems |
| HYDEE: Gas hydrates: opportunities and implications | MBIE Endeavour | GNS Science | G. Crutchley | Current | | 2018-2023 | Economic opportunities and environmental implications of energy extraction from gas hydrates |
| Great Megathrust earthquake hazard in New Zealand | NHRP | Geomarine Research | B. Hayward | Completed | | 2013-14 | Assessing evidence for a margin-wide subduction earthquake ~600 years BP |
| Landslide generated tsunami model for Cook Strait | NHRP | NIWA/GNS Science | J. Mountjoy/W. Power | Completed | | 2010-2014 | Development of a probabilistic model for landslide generated tsunami based on the Cook Strait Canyons |
| Eastern Marlborough Fault System | NHRP | NIWA/UoC | P. Barnes | Completed | | 2015-17 | Identification of structure, slip rate, and earthquake source characteristics of major strike-slip faults (including Hope, Chancet, Needles and Boo Boo faults), upper Marlborough continental margin |
| Weaving Earth’s Weak Seams: Manifestations and mechanical consequences of rock fabric development in active faults and shear zones | Rutherford Discovery Fellowship | UoO | V. Toy | In progress | | 2017-2021 | Includes further analysis of composition and mechanical properties of Japan Trench samples and development of computational methods that will be applied to analysis of Hikurangi Margin (exp 372 and 375) datasets. |
| IODP Proposals and funded national and international projects in support and complementary to IODP Expedition 376 on Brothers Volcano | | | | | | | |
| **Title** | **Agency** | **Institution** | **Lead PI** | | **Status** | **Planned** | **Comment** | |
| **IODP Proposals** |  |  |  | |  |  |  | |
| Submitted 2012 and accepted 2017: Brothers Arc Flux: Gateway to the Subarc mantle: volatile flux, metal transport, and conditions for early life. | IODP | GNS Science | C. de Ronde | | Exp 376 Current | May 5 – July 5, 2018 | First drilling of a hydrothermally active submarine arc volcano by IODP | |
| **United States** |  |  |  | |  |  |  | |
| Hydrothermal and Microbiological Investigations of the Active Brothers Volcano in the Kermadec Arc | NSF | WHOI | S. Humphris | | Funded | 2018 | AUV Jason survey of Brothers volcano for heat flux, vent fluids, microbes and stratigraphy | |
| **Germany** |  |  |  | |  |  |  | |
|  | DFG | U. Bremen | W. Bach | | Funded | Not yet scheduled | Drilling with MeBO the upper parts of Brothers volcano that were cased during IODP Exp 376 | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| IODP Proposals and funded national and international projects in support and complementary to IODP Expedition 343 JFAST | | | | | | |
| Searching for slippery nanopowders in earthquake-generating megathrust faults | UoO Research Grants | UoO | V. Toy | Completed | 2016-2017 | Coupled electron microscopic and synchrotron-CT analyses of principal slip zone materials from the Alpine Fault and the Japan Trench Subduction Thrust. Supported acquisition of data reported in PhD Thesis of Martina Kirilova and two resultant papers. | |
| Searching for slippery nanopowders in earthquake-generating megathrust faults [IODP expedition 343] | ANZIC Legacy Funding | UoO | K. Gessner, N. Timms, V. Toy | In progress | 2015-2018 | Coupled electron microscopic and synchrotron-CT analyses of principal slip zone materials from the Alpine Fault and the Japan Trench Subduction Thrust. Data are being prepared for publication at present. | |
| How does particle arrangement in Fault Rocks affect the earthquakes they generate? | Spring8 synchrotron | UoO | V. Toy | Completed | 2017 | Supported acquisition of further synchrotron-CT data from Japan Trench Subduction Thrust and Alpine Fault samples, as well as from Japan’s Median Tectonic Line. | |
| Weaving Earth’s Weak Seams: Manifestations and mechanical consequences of rock fabric development in active faults and shear zones | Rutherford Discovery Fellowship | UoO | V. Toy | In progress | 2017-2021 | Includes further analysis of composition and mechanical properties of Japan Trench samples and development of computational methods that will be applied to analysis of Hikurangi Margin (exp 372 and 375) datasets. | |

1. http://iodp.tamu.edu/publications/PP/IODP\_JRSO\_FY18\_APP.pdf [↑](#footnote-ref-1)
2. https://www.iodp.org/about-iodp/iodp-science-plan-2013-2023 [↑](#footnote-ref-2)
3. <http://geoprisms.org/initiatives-sites/scd/new-zealand> [↑](#footnote-ref-3)
4. https://www.iodp.org/australasian-workshop-report-june-2017/file Proposals [↑](#footnote-ref-4)
5. ANZIC has committed to total membership contribution of US$7.5 million to NSF, representing a commitment to IODP of 50% of a full membership for 5 years from 2016 to 2020 (US$1.5M per year). ANZIC membership to IODP MoU with the US will change mid-2019 to reflect increases in cost to the running of the RV JOIDES Resolution. ANZIC will most likely reduce membership to 37.5% or attempt continuation at 50% affiliation, however, the latter option would end membership earlier than the end of 2020. [↑](#footnote-ref-5)
6. GNS and the other New Zealand participants currently make a $US300,000 per annum commitment to IODP membership. This represents a New Zealand:Australia quota of 1:6. [↑](#footnote-ref-6)
7. The MIA was signed Aug 2016 and expires September 2020. The MIA also includes the annual International Continental Scientific Drilling Program (ICDP) membership fee of $US50,000. The annual contribution from these parties is $35,000 for IODP and $10,000 for ICDP. Institutions are invoiced annually and GNS makes up the difference from SDF, which is currently $320,000 per year [↑](#footnote-ref-7)