RV Tangaroa Summary Voyages 2016/17

1 July 2016 to 30 June 2017

Tangaroa Reference Group

1 July 2016 to 31 June 2017

2016/17	Project	Lead	Mob	Demob	MBIE NIWA Contract	TR Group	Weather Downtime (Days)
NIWA	TAN1608: Canterbury Basin Survey	John Mitchell	2 Jul	20 Jul	19		18 Hours
GNS Science	TAN1611: Back Arc south Survey of Kermadec Sanctuary - Coleville III	Fabio Caratori Tontini (Cornel De Ronde)	26 Sep	16 Oct		21	0
University of Auckalnd/ Auckland Museum/ NIWA	TAN1612: Biodiversity patterns of benthic and mid water fauna of Kermadec Region	Malcolm Clark/Tom Trnski/ Rochelle Constantine	19 Oct	8 Nov		22	0
NIWA	TAN1613: Hikurangi Paleoseismology	Phil Barnes	9 Nov	22 Nov	14		0
MPI	TAN1701: Quantifying Benthic Biodiversity. Chatham Rise.	Dave Bowden	4 Jan	2 Feb		30	0
MBIE	TAN1702: Deployment of moorings and repeating CTD transects. Campbell Plateau.	Aitana Forcen	15 Mar	1 Apr	18		0
NIWA /Malta University	TAN1703: Freshwater Seep Survey. Christchurch.	Joshu Mountjoy	5 Apr	1 May	27		0
GNS Science	TAN1705: Hikurangi Seafloor Geodesy (HOBITSS IV).	Laura Wallace	24 Jun	5 Jul		7	0
Total 2016/17					78	80	

Summary of Voyages

TAN1608 Great South Basin and Southern Canterbury Shelf Survey
Date: July 2016
Lead Organisation: NIWA SSIF
Funding: NIWA SSIF
Voyage Leader: John Mitchell

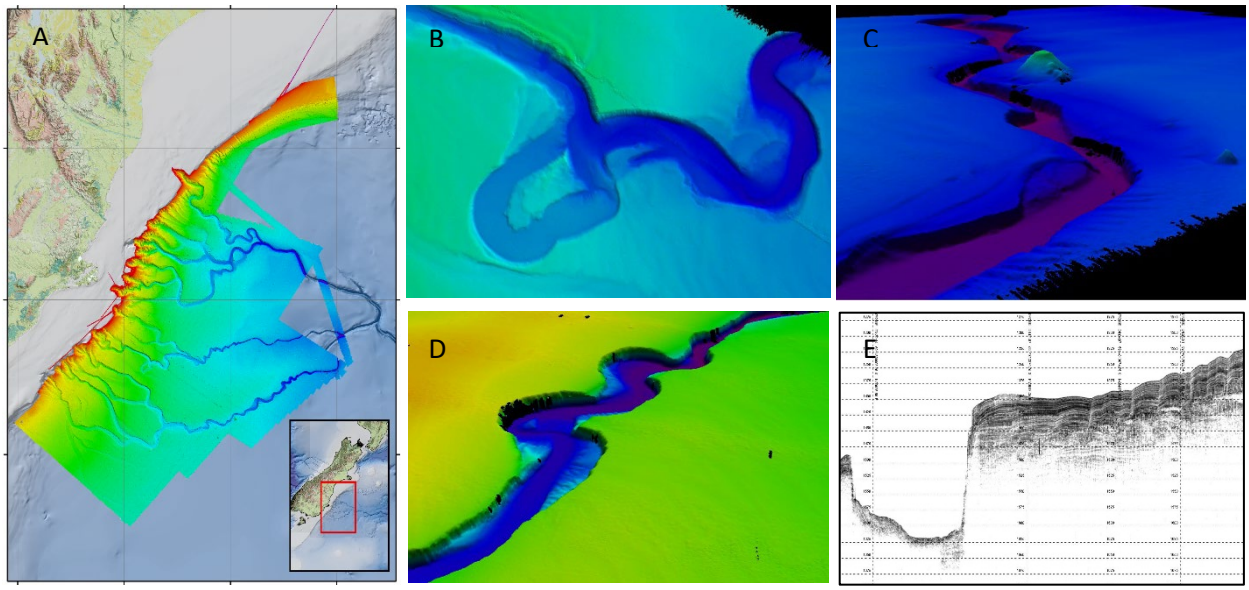
This survey was undertaken in the Great South Basin with the intention of completing the multi-beam echo sounder (MBES) survey across the head of the Bounty Trough and Otago Canyon Complex originally started in July 2012 (TAN1209). This compiled bathymetric coverage will act as a baseline dataset for future voyages to determine the physical habitats and biodiversity of the area, along with enabling an analysis of the detailed geomorphic expression of tectonic and sedimentary processes.

At the completion of the survey new multibeam data were acquired covering ~18,000 km^2. When combined with archive data the MBES coverage encompasses ~ 40,000 km^2. Coincident with the MBES data collection, a full set of sub-bottom profiles were collected using the newly installed TOPAS PS18 sub-bottom profiler.

The TAN1608 MBES data collected offshore of Otago includes upper-slope portions of the Otago Fan Complex, and Centre and South Channels - tributaries that merge to form the Bounty Channel and Fan system to the east. This network of canyon-fed channels has been previously documented, but the bathymetric mapping now afforded by MBES coverage enabled the features of interest to be defined for the very first time.

Some of the key geomorphic features documented during the survey include: the narrow v-shaped canyon heads of the Otago Fan complex progressing into broad U-shaped canyons; the entrenched (250 m deep) sinuous Centre and South Channels with asymmetrical convex levees and associated sediment wave fields, low relief mounds or terraces, outer bank and point bars, and gully erosion features; the occurrence of cut-off or abandoned meanders suggesting an active and evolving channel-levee system; pockmarks predominately on the northern levees up to 200 m across and exhibiting up to 20 m relief; and presence of previously unmapped “mud” volcanoes.

Combining these data with those collected during on previous NIWA voyages has resulted in a dataset mapping the structure of the Otago Fan Complex seaward of the shelf break, and North, Centre and South Channels which merge to form the Bounty Channel.



A: Combined multibeam coverage; B, C, D: Complex Channel structures including mud volcano (C); E: Sub-bottom profile over channel.

TAN1611: Colville III

Date: August 2016
Lead Organisation – GNS Science
Funding: GNS Science SSIF
Voyage leaders: Christian Timm and Fabio Caratori-Tontini (GNS Science)
Rationale
This survey is the most recent in a series of three voyages that are aimed to provide the first comprehensive map of the seafloor, together with geophysical maps of the Colville Ridge within New Zealand's extended Exclusive Economic Zone (EEZ) (see Figure 1 below for layout of the track lines). These data are intended to provide a framework that will underpin research on seafloor hydrothermal systems and mineralization processes, tectonic models and arc volcanism in the Kermadec back-arc region.

Bathymetric maps are important for defining the geometry and structure of the seafloor, while geophysical data provide information on the geology and structures on and below the seafloor. Prior to this voyage, no comprehensive bathymetry or geophysical data existed for the northern Colville Ridge area. Rock samples had never been recovered from the survey area, thus little is known about the seafloor composition of this large part of our sovereign estate.

Outcome
The Colville III survey was successful in providing the first comprehensive map of the seafloor together with geophysical grids of the north Colville Ridge area covering 21,815 km² (Figure 2). The weather was good most of the time and no mechanical breakdowns were experienced. As shown in the track lines, consistent wind speeds up to 50 knots forced us to change course over a c. 24-hour window to ensure the collection of good quality data.

Data collected on the Colville III voyage included bathymetry, backscatter, magnetics, gravity and rock samples. These data, combined with data collected from Colville I and Colville II voyages complete reconnaissance data collection for the Colville Ridge south of 31.5˚S within New Zealand's EEZ. The Colville III (TAN1611) data will be used to develop a fundamental understanding of the geology, elucidate the structure of the seafloor and underlying crust, and to assess whether and where ancient hydrothermal systems exist.

Seabed sampling undertaken during the Colville I, II and III voyages have recovered volcanic and sedimentary units, as well as the first hydrothermally altered rock samples from the Colville Ridge. The new samples have been added to the rock collection held at GNS Science.

Cruises with GEOMAR in 2017 will utilize the maps created during this voyage and previous Colville voyages to target areas of scientific interest for more select seabed sampling. The results from the surveys will be published as maps and papers in international journals as part of GNS Science SSIF science and will be publicly accessible online at GNS Science. A voyage report is being written and will be available in early February 2017. Proposed cruises with GEOMAR in 2017 will utilize the maps created during this voyage and previous Colville voyages to target areas of interest for more select seabed sampling.

Outreach activity
A GNS Science media release was published on the day of departure (26.09.2016). The media release can be found here: https://gns.cri.nz/Home/News-and-Events/Media-Releases/Colville.

As a further outreach initiative, an online blog was run by Jack Whattam, a student on-board the voyage. The blog recorded the major scientific objectives and various day-to-day activities that took place on-board. The aim of the blog was to communicate scientific research in the Colville Ridge region and the importance of the work. Each blog post focussed on one specific aspect of the science or general life on-board a research vessel and was accompanied with a series of photos to illustrate points. In total there were six blog posts covering research aims, sound velocity profiles, multi-beam bathymetry mapping, geophysical measurements, ship life on a research vessel, and seabed sampling using a rock dredge. Read the blog here: http://colville-ridge-marine-expedition.blogspot.co.nz/

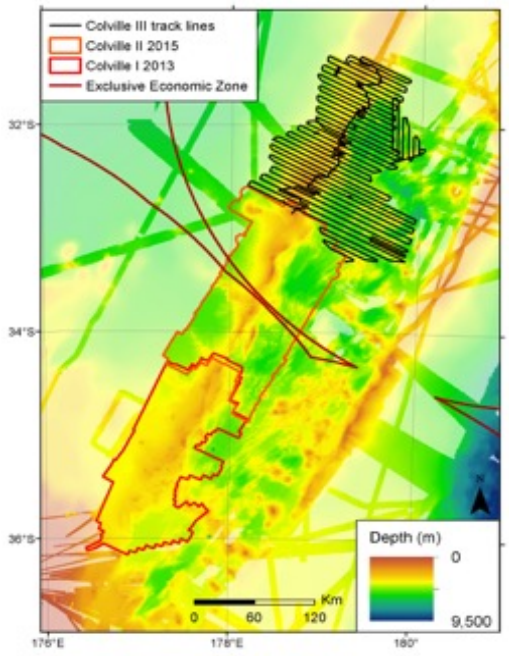


Fig 1: Map showing survey area and track lines.

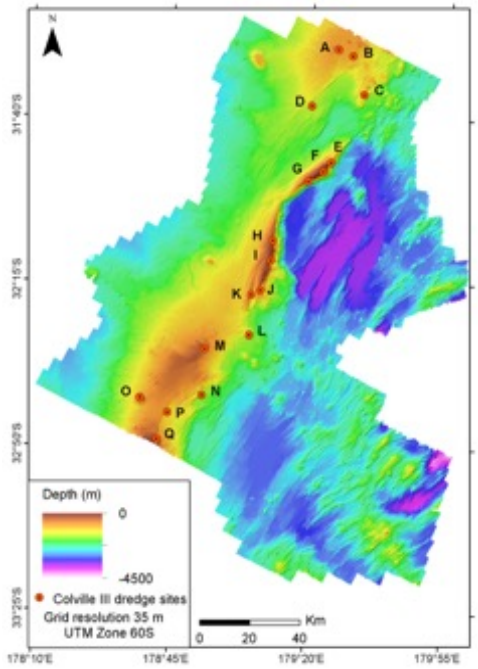


Fig 2: New multi-beam map of the survey area showing rock sampling locations

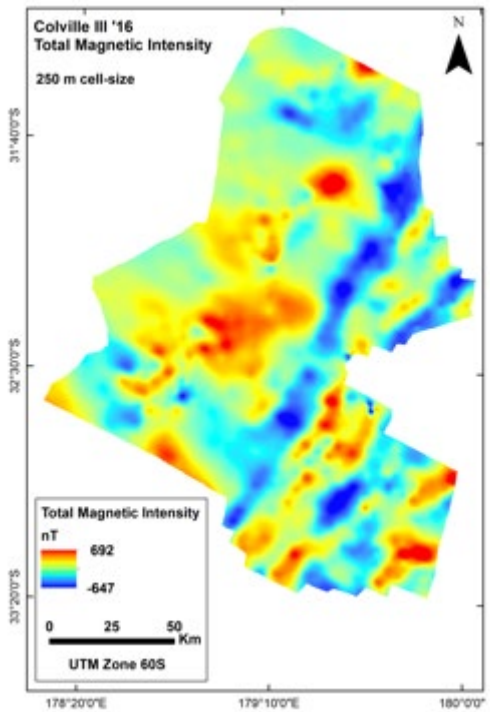


Fig 3: New magnetic map of the survey area

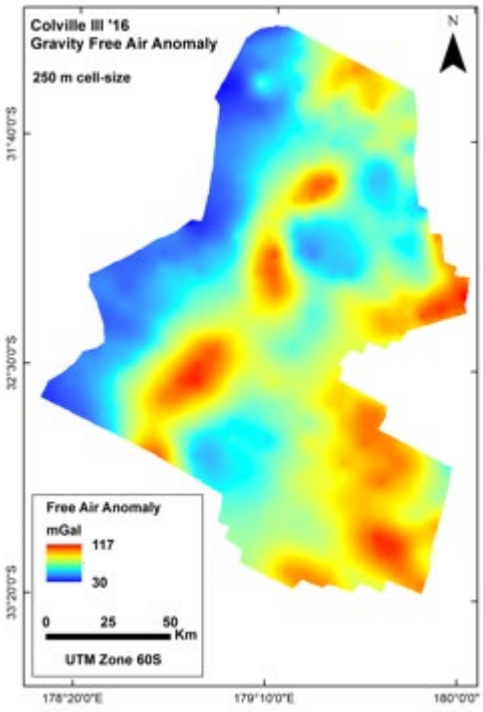


Fig 4: New gravity map of the survey area

TAN1612: Biodiversity of the Kermadec Islands and Kermadec Ridge
Date: October - November 2016
Lead Organisations: NIWA/TePapa/University of Auckland

Funding: NIWA SSIF/MfE/Auckland Museum/Te Papa/Auckland University

This survey was carried out to improve knowledge of coastal and offshore biodiversity in support of the proposed Kermadec-Rangitahua Ocean Sanctuary. Seven agencies collaborated in developing a multidisciplinary research plan that centred around objectives to describe and quantify the diversity of benthic invertebrate fauna and fish communities of the central Kermadec Islands and Ridge; to develop and expand marine mammal identification around the Kermadec Islands, and determine links to regional populations; and to characterise the demographic and genetic connectivity of coastal populations and quantify morphological adaptation in shallow reef communities.

Offshore sampling stations were distributed at depths from 50 to 3250 m, and included surface plankton, line fishing, vertical plankton, midwater and bottom trawl, deep-towed camera, epibenthic sled and beam trawl, fish trap, and CTD operations. These multiple gear types sampled a wide range of faunal types and sizes in different habitats, from the surface to the seafloor, and from shallow waters inshore to the abyssal plains. Combined with diving operations inshore, and marine mammal research around Raoul and Macauley Islands, there were 143 sampling events. These included 16 dive stations, 11 marine mammal small-boat trips, 36 deep-towed camera deployments, 27 epibenthic sled or beam trawl tows, and 19 plankton casts.

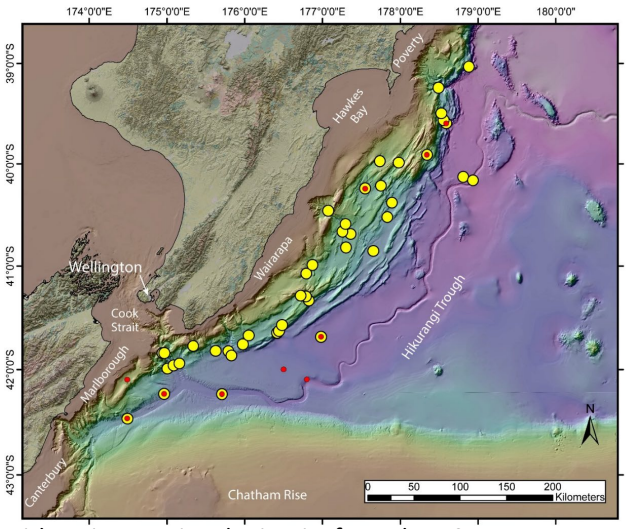
In total, 236 fish and 254 invertebrate species (or taxonomic groups) were provisionally identified. There are many new records for the region, and for the New Zealand EEZ, as well as undescribed new species. For fish, initial examination has 60 new records for the Kermadec Ridge, 20 new records for the EEZ, and at least 3 new species. New habitat-related discoveries were also made, such as the observation of extensive rhodolith beds at Macauley Island, L'Esperance Rock and the Star of Bengal Bank-the first time these have been recorded from the northern Kermadec Ridge.

Logistics were at times challenging, with combining the small boat and deep-sea sampling, and it was the first time *Tangaroa* had hosted a major diving operation. However, the various teams interacted well, and together with good weather a large amount of research was completed. The survey developed strong collaboration between the teams onboard, which will increase as the various data sets and samples get processed and analysed between the various agencies.

Media interest in the voyage was extremely high from the outset, with publicity about the release of a hawksbill turtle named Koha at Raoul Island. Koha helped raise the voyage profile and his departure was covered on TVNZ news and then live on Breakfast. Radio NZ featured one participant on Kim Hill's Saturday morning programme. The inclusion of a videographer on the voyage meant voyage components, such as the release of Koha, could be livestreamed and shared across all partner social media platforms. Similarly shared was a voyage blog, video and images, while the NIWA website hosted a voyage web page and a regular blog was hosted on the Auckland Museum website.

Daily images, of the general activities and different samples caught, were for sharing on social media, and 11 short video interviews with scientists on board were conducted. In February Pew Foundation organised a presentation of the expedition in parliament, which was well attended by a host of senior ministers. Pew and NIWA organised a successful media release around this event. One News, One Breakfast and Radio NZ broadcast elements of the expedition, with both Malcolm Clark and Tom Trnski being interviewed. https://www.tvnz.co.nz/one-news/new-zealand/might-look-like-flying-dragon-but-underwater-version-kiwi-scientists-believe-theyve-found-new-species-in-kermedecs.

TAN1613: Hikurangi Margin Paleoseismology
TAN1613: 10 November 2016
Lead Organisation: NIWA
Funding: NIWA SSIF



The primary objective of *Tangaroa* voyage TAN1613 was to recover sedimentary cores from the continental slope and Hikurangi Trough expected to deliver records of past earthquakes associated with the Hikurangi subduction zone. Two secondary objectives developed during the survey in response to the 14th November Mw 7.8 Kaikoura Earthquake. The first involved sediment coring specifically to investigate if a seismically-triggered turbidity current associated with submarine landslides had occurred as a result of strong ground shaking. The second involved seafloor mapping on the continental shelf of coastal Marlborough in search of evidence of co-seismic faulting. *Tangaroa* voyage TAN1613 was part of a large multi-institutional study, involving New Zealand scientists from NIWA, GNS Science, University of Auckland, University of Canterbury, and Victoria University of Wellington, together with an international scientist from the USA.

A total of 50 piston cores and 10 multicores were collected between eastern Marlborough and offshore of Poverty Bay, including those related to the Kaikoura earthquake response work. The cores are individually up to 5 m length, and collectively represent about 140 m of total core material. Each core was cut to 1 m sections, split, photographed, logged manually on a standard template description sheet developed for this survey, X-rayed, measured for magnetic susceptibility, and packaged for storage in the NIWA core repository.

The cores contain layers of gravel, sand, mud and volcanic ash. Many layers are “turbidites”, rapidly transported and deposited (within hours and days) from past turbidity currents resulting from landslides. Some cores contain up to 25 individual turbidite layers. Based on inferred sedimentation rates in the area, we suspect the longer cores probably span the last ~5000-10,000 years. The suite of cores will be analysed post-voyage to determine their origin and age. Many but not all of the turbidites may have been triggered by strong shaking associated with past earthquakes (subduction “megathrust” and other coastal faults). Collectively the suite of cores looks encouraging in terms of providing future paleoseismic records, following the shore-based analyses and associated modelling.

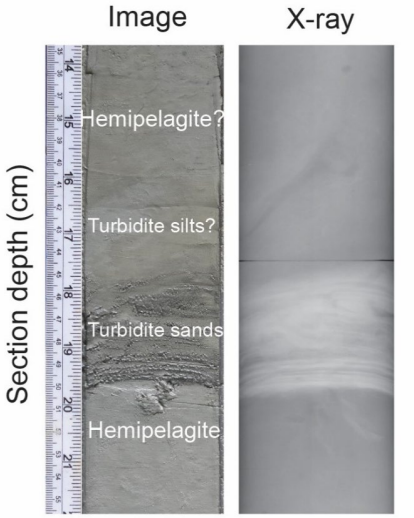
A series of multicores collected provide strong evidence that the 14th November Mw 7.8 Kaikoura earthquake triggered a turbidity current from submarine landslide sources near the earthquake. Unconsolidated turbidite silts and sands at the base of a muddy fluidised layer were observed in the Hikurangi Channel and on the basin floor east of Kaikoura, Cook Strait, and Wairarapa, approximately 300 km down-system from the likely source area in the Kaikoura Canyon region. The turbidity current potentially flowed at least 500 km from source to offshore of Hawkes Bay. Our preliminary interpretations will require post-cruise validation from detailed sedimentological analyses of the cores and from chronology established using short lived radioisotopes.

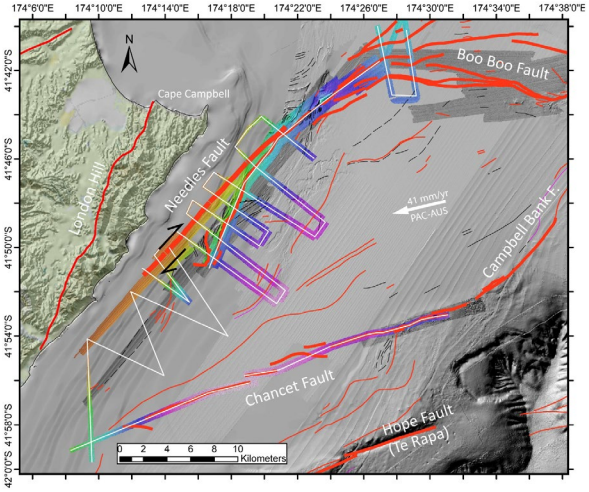
Seafloor mapping on the continental shelf of coastal Marlborough is consistent with surface rupture on the submarine Needles Fault during the November 14th Mw 7.8 Kaikoura earthquake. We mapped a fresh, almost continuous, 17 km along fault scarp and infer a total submarine rupture length of about 34 km. No evidence was seen for any co-seismic offset on the Chancet Fault or western end of the Boo Boo Fault, associated with this earthquake. This mapping will help to characterise the total network of faults that ruptured during the earthquake.

There was significant public outreach associated with the voyage. Our US colleague Dr Jay Patton maintained a daily blog at http://humboldt-jay.blogspot.co.nz/. A NIWA Media release was published online on the day of arrival in Wellington, and was supported by a Media Briefing held at NIWA Greta Point: NIWA Media Release, 22nd November 2016, Scientists detect huge fault rupture offshore from Kaikoura. https://www.niwa.co.nz/news/scientists-detect-huge-fault-rupture-offshore-from-kaikoura. This was followed by Radio NZ interviews, aired Thursday 1 December: http://www.eastcoastlab.org.nz/news/searching-for-past-earthquakes/. Preliminary results of the fault

mapping associated with the Kaikoura earthquake have since been incorporated into a journal paper by Ian Hamling et al., just accepted by *Science*.

Top: Map of piston corer yellow) and multicorer (red) sites at which cores were successfully collected. Below left: Example of a turbidite layer recovered in a logged (left) and X-rayed (right) core. Below Right: Map showing the location of fault surveying work undertaken in coastal Marlborough in response to the Kaikoura earthquake.





TAN1701: Quantifying Benthic Biodiversity Across Environmental Gradients
Date: January – February 2017
Lead Organisation: MPI
Funding: MPI/NIWA
Voyage Leader: David Bowden

The aim of this voyage was to collect seabed data that will reduce uncertainty in predictive models of the distributions of seabed habitats and fauna, and enable development of a benthic risk assessment framework for bottom dwelling organisms. Quantitative data on the distribution and abundance of benthic species are sparse in New Zealand waters.

This situation has resulted in high levels of uncertainty associated with predictive models of communities and species distributions, which in turn have resulted in precautionary management decisions in relation to proposed seabed resource use.

The survey (RV *Tangaroa*, TAN1701) was designed to acquire quantitative data about benthic habitats and fauna across Chatham Rise, an oceanic rise extending to the east of New Zealand's South Island, using a towed camera system with high-definition digital video and still image cameras, and a multicorer. Effort was concentrated in areas substantially under-sampled in previous comparable surveys of the area (primarily TAN0705), with the aim of generating data that would improve future predictive models of distributions. A secondary objective to collect seabed camera transects and sediment cores at the head of Kaikōura Canyon was included in the voyage programme in response to the November 2016 Kaikōura Earthquake.

Photographic transects, each of approximately 1 km seabed distance, were completed at 142 sites across Chatham Rise, in depths from 130 m to 1407 m. This effectively doubled the number of sites on Chatham Rise from which high-resolution seabed photographic data are available. Five additional sites were sampled in Kaikōura Canyon, with overall totals of 152 towed camera and 27 multicorer deployments completed successfully. The total seabed distance covered in photographic transects was 161.4 km (approximately 600,000 m^2 seabed area), with 152 hours of seabed video and 36,500 still images recorded, and more than 70,000 individual observations of fauna recorded to log files. Multicorer deployments yielded a total of 101 individual sediment cores, which will be processed for sediment properties (27 cores), macro-infauna (retained on 300µm sieve, 49 cores), and meiofauna/genetics (un-sieved, 24 cores). Multibeam echosounder data and CTD data were also collected routinely throughout the voyage.

The voyage was very successful in achieving both of its major objectives, exceeding the planned number of stations sampled and with no equipment malfunctions. Weather conditions were largely favourable, with only one period of enforced down-time lasting 36 h as a deep low-pressure system come through.

Sampling in Kaikoura Canyon in the aftermath of the November earthquake showed dramatic changes in seabed sediments and fauna. These findings created considerable media interest on *Tangaroa's* return to Wellington, with media interviews on TV and RNZ National news and current affairs programmes.

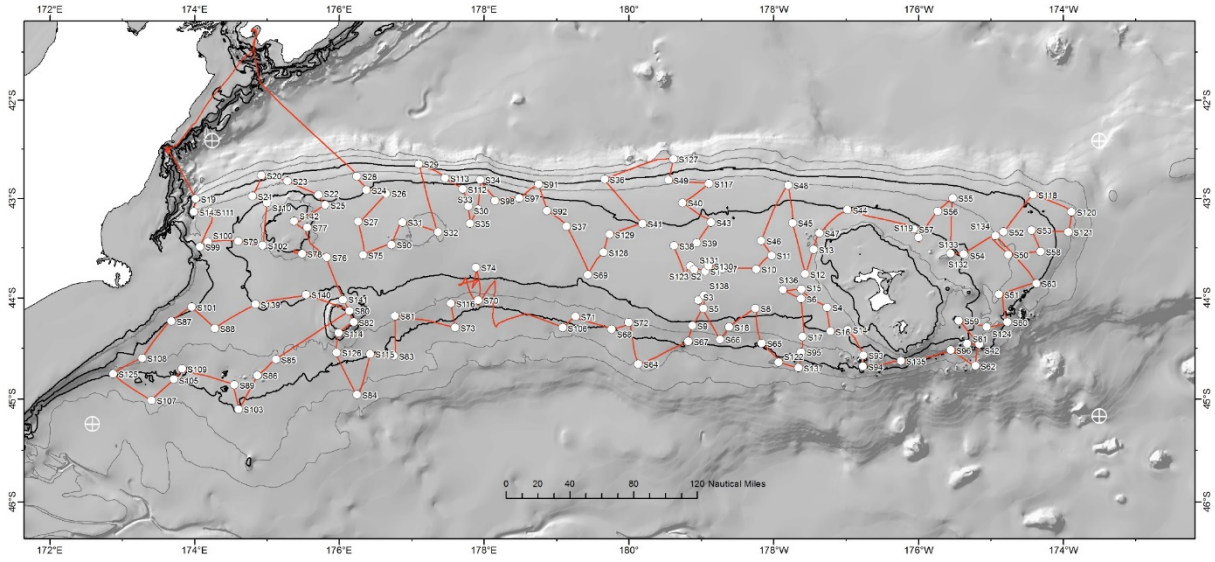


Figure 1: Sampling sites and track of RV *Tangaroa* during voyage TAN1701. Seven sites sampled in Kaikōura Canyon are not shown because they overlie each other at the scale of this map. A 1 km seabed photographic transect was completed at each site, and multicorer sediment samples were collected at a subset of 27 sites.

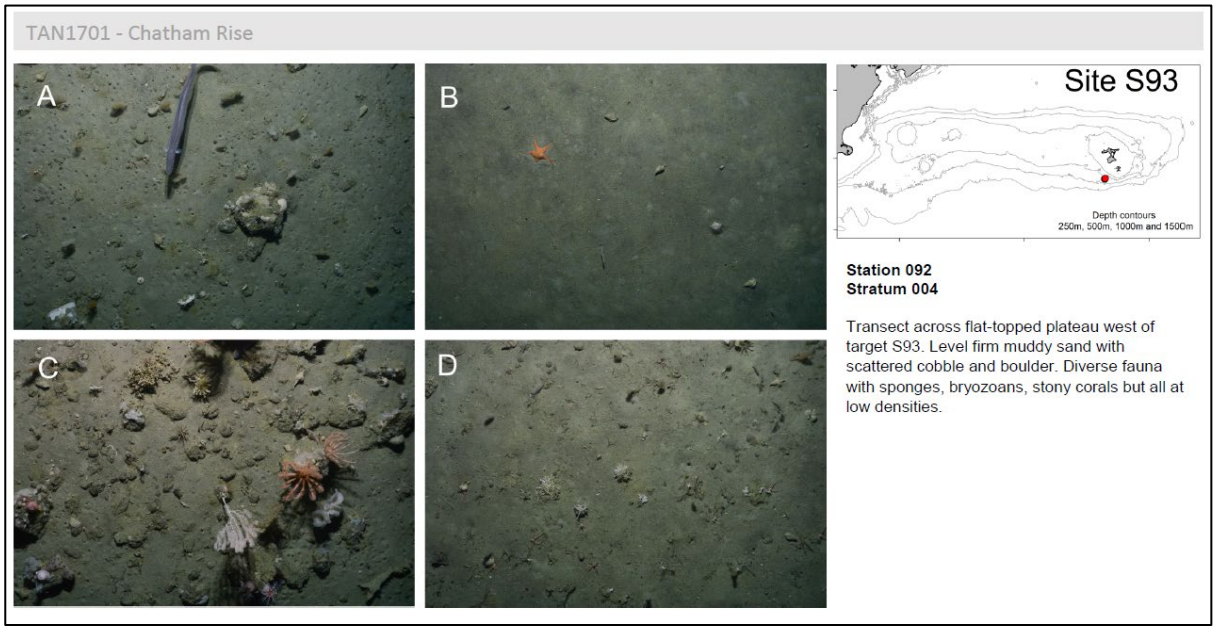


Figure 2: Seabed imagery example – Site S93 at 600 m depth south of the Chatham Islands.

TAN1703 MARCAN Canterbury Groundwater
Date: April 2017
Lead Organisation: University of Malta
Funding: European Research Council
Voyage Leader: Joshu Mountjoy

MARCAN is a new research project, led by Dr Aaron Micallef at the Marine Geology & Seafloor Surveying group of the University of Malta with partners at NIWA in New Zealand, GEOMAR in Germany, and the New Mexico Institute of Mining and Technology in the USA. It brings together the fields of geology, geomorphology, geochemistry, geophysics, hydrogeology and engineering to address the hypothesis that Topographically-driven meteoric recharge (TDM) groundwater plays a key role in the geomorphic development of passive continental margins. The objectives of MARCAN are to:

(1) Define the characteristics and dynamics of offshore TDM groundwater systems by determining their 3D geometry and evolution in response to sea level changes; and

(2) Assess whether TDM groundwater is an important geomorphic agent in continental margins by quantifying the rates and controls of groundwater weathering and erosion at the outcrop scale, and determining the conditions in which TDM groundwater can shape landscapes.

Two study areas provide a context for MARCAN: 1) the Canterbury Bight, off the eastern South Island of New Zealand - a type example of a sedimentary passive margin; 2) the north-eastern Maltese Islands, central Mediterranean Sea - an example of a carbonate bedrock margin. These study areas have been selected because they are representative of the

most prevalent continental margin types globally, and because they are comprehensively covered by good quality baseline data. (e.g. multibeam bathymetry, reflection seismic, well data).

New Zealand's Canterbury margin hosts one of the shallowest offshore groundwater reservoirs globally, which, combined with the availability of borehole data from IODP Expedition 317, makes it a unique site for investigating offshore groundwater systems in detail. We have collected a total length of ~300 km of marine controlled-source electromagnetic (CSEM) data during the 4-week long TAN1703 expedition on board *R/V Tangaroa* in April 2017 (Figure 1). We used a seafloor-towed electric dipole-dipole system to measure the sub-seafloor resistivity distribution, which can be related to porosity and pore water salinity changes. To further constrain the groundwater model, we collected a comprehensive grid of multibeam echosounder, sub-bottom profiles, and 2D multichannel seismic reflection data as the basis of a 3D geological model. CTD casts and a drop camera were used to locate and sample freshwater seeps, while piston coring was carried out to obtain pore water samples and measure the geologic and hydraulic properties of seafloor sediments.

Although MARCAN represents a unique opportunity to address long-standing and fundamental questions in continental margin geomorphology and hydrogeology, its outcomes also have a strong applied value. Offshore groundwater systems are clearly of interest as a source of drinking water, whilst sectors involving seafloor engineering, carbon dioxide sequestration, as well as mineral resource and petroleum exploration, have an interest in past fluid migration histories. MARCAN will contribute essential baseline data, scientific knowledge, observational tools and quantitative models that will assist the management of offshore natural resources and refine geohazard assessments.

Output: Micallef, A., J. J. Mountjoy, K. Schwalenberg, M. Jegen, B. Weymer, S. Woelz, P. Gerring, N. Luebben, D. Spatola, D. Otero and C. Mueller (2017). "The role of offshore groundwater in shaping the seafloor." EOS Project Update Accepted for Publication.

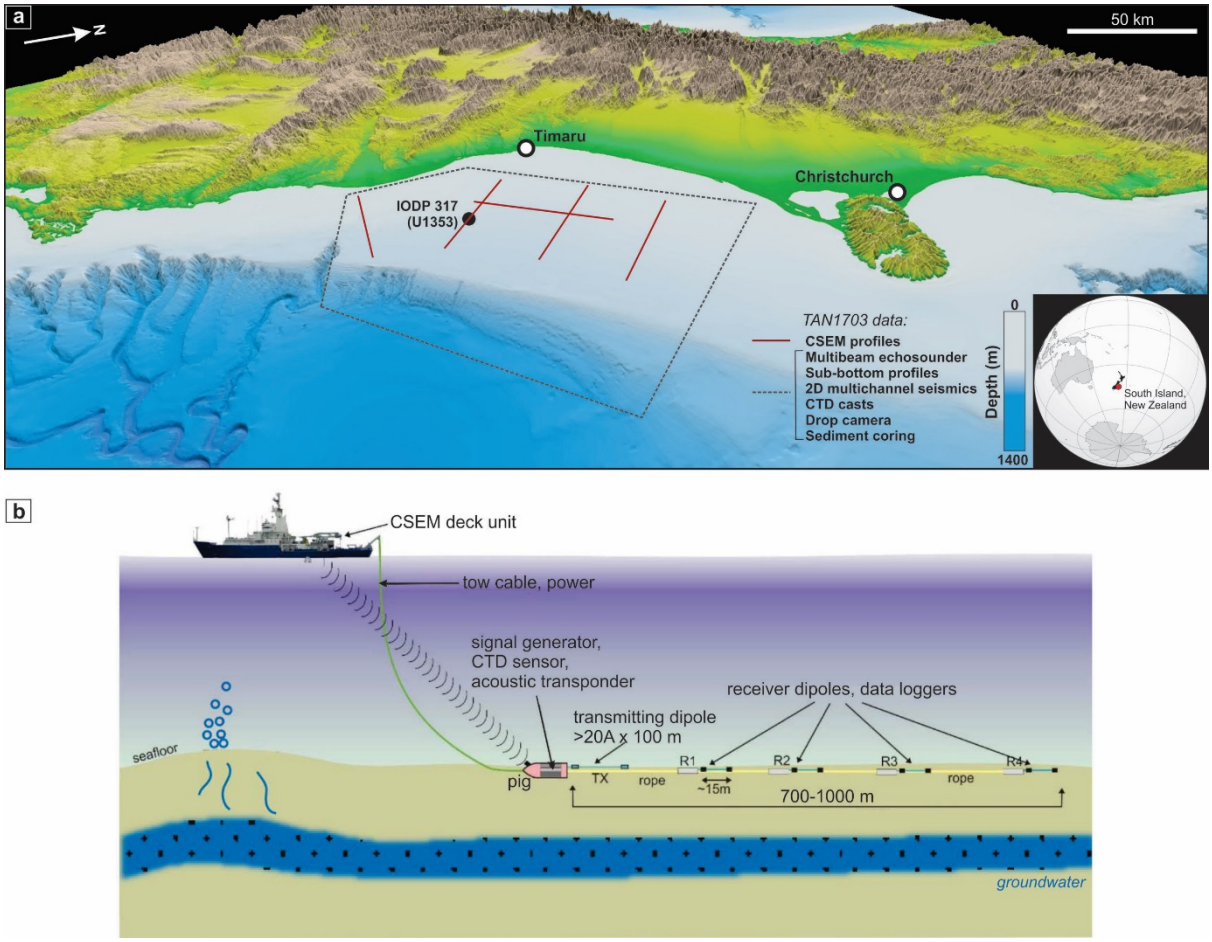


Figure 1: (a) Three-dimensional view of the South Island of New Zealand, compiled using data from NIWA and Land Information New Zealand, showing the location of site U1353 (IODP Exp. 317) and the data acquired during the TAN1703 oceanographic expedition (CSEM lines are represented by red lines, whereas the spatial coverage of multibeam echosounder data, sub-profiles, 2D multichannel seismics, CTD casts, drop camera and sediment coring are indicated by a dotted grey polygon). (b) Schematic of the seafloor-towed controlled-source electromagnetic (CSEM) system, which consists of a 100-m-long electrical transmitting dipole (TX) and four electrical receiving dipoles (R1-4) at offsets of 150 m, 275 m, 400 m and 650 m, respectively. The system is towed along the seafloor and is also equipped with a CTD (conductivity-temperature-depth) sensor measuring sea water electrical conductivity.

TAN1702: Campbell Plateau
Date: 16 March to 1 April 2017
Lead Organisation – NIWA
Funding: NIWA SSIF
Voyage Leaders: Aitana Forcen-Vazquez and Joanne O'Callaghan.

Rationale

This voyage was a physical oceanography study of the subantarctic region with special focus on Campbell Plateau. Hydrographic sections sampled the Subantarctic Front (SAF), the Subtropical Front (STF) and the Southland Front. Three moorings were deployed to collect the first year-long oceanographic dataset aiming to understand Subantarctic Mode Water (SAMW) formation. ADCP transects were completed for the duration of the voyage.
The primary objectives of the voyage were to:

- Research oceanographic processes in the New Zealand subantarctic region with special focus on Campbell Plateau, using a combination of CTD sections, deployment of oceanographic moorings and ADCP measurements.
- Determine the sources and fluxes of abyssal, intermediate, and surface waters influencing the area south of New Zealand through three natural 'gates' formed by bathymetry.
- Investigate the influences of the STF and SAF on the plateau and to evaluate the regional pattern of SAMW formation.
- Deploy moorings to understand the seasonal variability on Campbell Plateau.
- Reoccupy one oceanographic section to the east of Campbell Plateau crossing the SAF to address decadal changes.

Campbell Plateau has been postulated to be a region of SAMW formation, but this has never been confirmed largely because of a lack of wintertime data. A water mass is 'formed' when winter mixed layers are deep enough to create water sufficiently dense that it is subducted into the surrounding ocean. These subducted water masses have critical climate implications because the heat and CO2 they carry are sequestered in the deep ocean for up to thousands of years. Changes in water mass formation would have large impacts on regional and global climate.

Acoustic mapping, biological, chemical and atmospheric observations were also collected during the voyage to maximise benefit from a voyage to the Southern Ocean. The following additional opportunistic measurements were also made: Continuous Plankton Recorder, biological, chemical, atmospheric, multibeam and Topas.

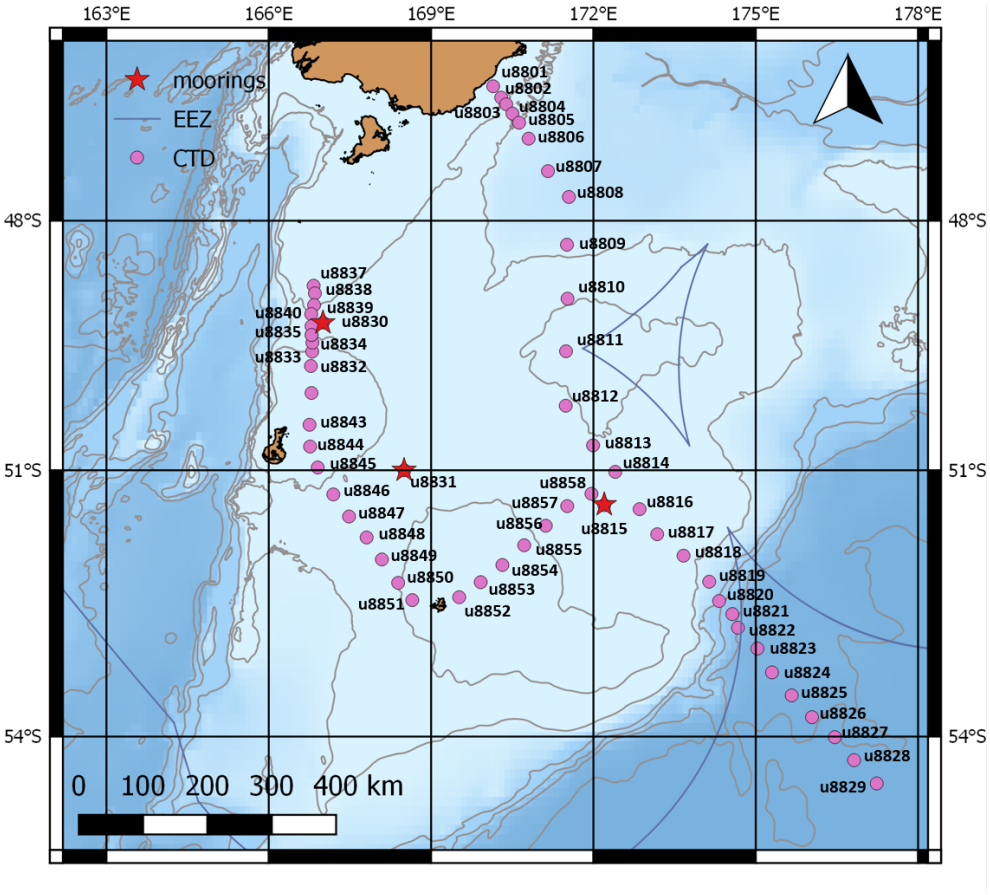
Background

The subantarctic around Campbell Plateau is oceanographically complex with three distinct oceanographic regions. North of the STF is warm and salty Subtropical Water; the subantarctic zone between the STF and the SAF is characterised by cooler and fresher Subantarctic Water; while south of the SAF there are colder and fresher polar waters.

The SAF is the northern boundary of the Antarctic Circumpolar Current and is steered by bathymetry in the New Zealand subantarctic region. Branches of the SAF are merged where the front is forced to pass south of Campbell Plateau.
SAMW is formed by deep winter mixing on the equatorward side of the SAF and occupies the surface and intermediate depths of the subantarctic zone. The global significance of Campbell Plateau as a formation site is an ongoing question. The mooring deployments on the plateau will provide the first year-round data to shed light on this question, in addition to the cycle of upper water column stability, winter convection and biotic responses.
The CTD survey will repeat two sections performed on previous voyages for intercomparisons, with additional profiles to complete the research aims of the voyage.

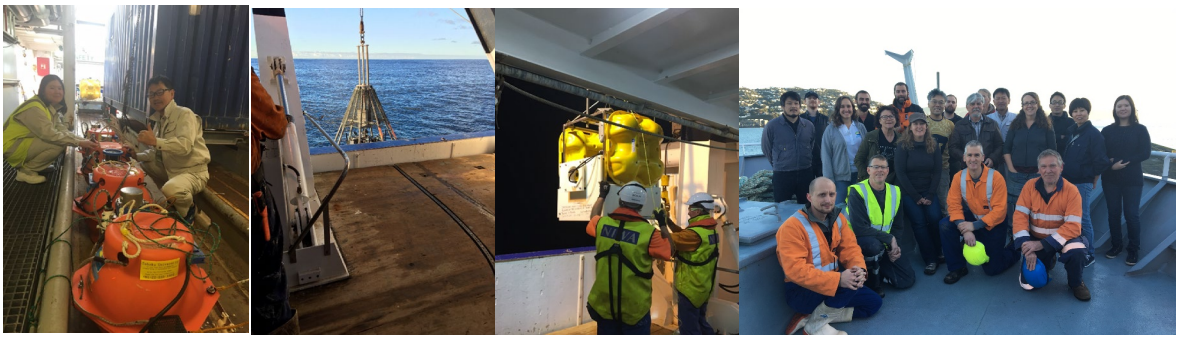
Outcomes/data collected

Physical oceanography: CTD sections completed, 3 Moorings deployed, ADCP transects.
Primary production and phytoplankton carbon fluxes through different functional groups in the Campbell Plateau
Phytoplankton physiology and primary production variability across the Campbell Plateau: comparing novel fluorometric and standard 14C-based approaches
Microbial diversity on Campbell Plateau
Microbial diversity, community structure and functional variability across the subtropical front
Underway sampling
Large eukaryotic plankton diversity in the mesopelagic region of Campbell Plateau
Free-living and particle-associated bacterioplankton community structure in relation to different water masses and topography
Continuous Plankton Recorder
Multibeam data
Topas
Geochemical water sampling
Aerosol Measurements



Voyage station and mooring locations

TAN1705: HOBITSS IV
Date: 24 June-5 July 2017
Lead Organisation: GNS Science
Funding: SSIF
Voyage leader: Laura Wallace, GNS Science



Rationale: Objectives of TAN1705 were to (1) undertake seafloor geodetic instrument deployments, recoveries, and surveys offshore Gisborne and Mahia, and (2) acquire mulitcores along the Hikurangi margin and offshore the

northeastern South Island to evaluate the extent of turbidite deposition following the Kaikōura earthquake. The seafloor geodetic aims involve using Bottom Pressure Recorder (BPRs) to determine the cm-level vertical movement (upward or downward) of the seafloor during slow slip events, as well as to survey an existing seafloor transponder array using GPS-Acoustic methods to track cm-level horizontal tectonic motion of the seafloor (Figure 1a, b). The offshore Gisborne and Mahia region are targeted due to the large and frequent slow slip events that occur there. The second phase of the voyage (commencing July 30th) involved multicore sample acquisition at 26 sites (Figure 2), spanning from offshore Hawke Bay to Pegasus Bay. The multicoring builds on results from an earlier piston coring and multicoring campaign last November that was interrupted by the Kaikōura earthquake. All voyage objectives underpin research funded by an MBIE Endeavour fund programme: "Diagnosing peril posed by the Hikurangi subduction zone: New Zealand's largest plate boundary fault."

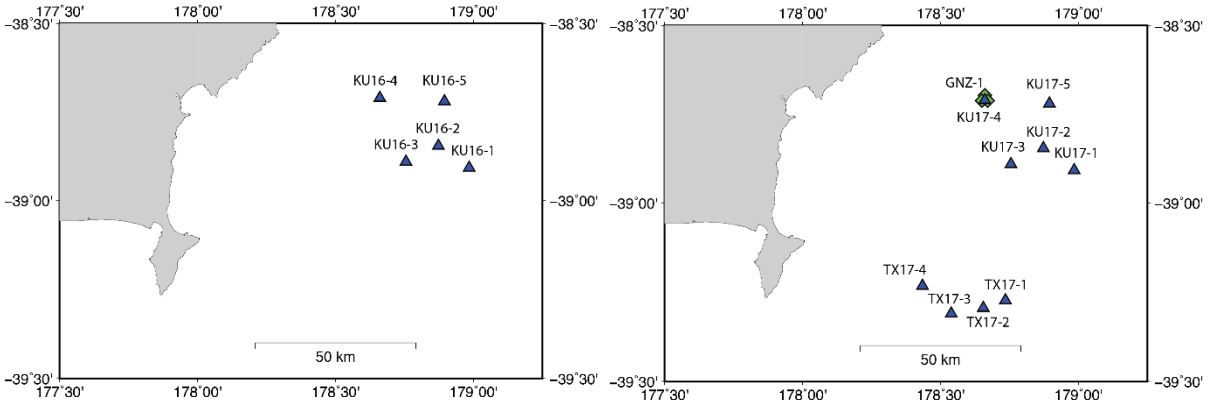
Outcomes: All of the planned objectives for TAN1705 were successfully achieved. 5 Bottom Pressure Recorders belonging to Tohoku University were recovered during the voyage (Fig. 1a). These BPRs were deployed in June 2016 (on TAN1607), and recorded data for one year. Immediate observations from the data include: vertical motion of the seafloor during passage of seismic waves from both the M7.8 Kaikōura (November 2016) and M7.1 Te Araroa (September 2016) earthquakes (Fig. 3), and passage of tsunami waves from both of those earthquakes. The duration of the Kaikōura earthquake seismic wave passage offshore Poverty Bay was several minutes—up to 30% longer than recorded at onshore stations, and gives important constraints on the ground shaking response of the offshore Hikurangi margin. TAN1705 scientists are in the process of analyzing the BPR data to determine if vertical deformation during the slow slip event following the Kaikōura earthquake is detectable in the BPR data. In addition, 5 BPRs belonging to Kyoto University, and 4 BPRs belonging to the University of Texas were deployed (for a total of 9 deployments) (Fig. 1b). The GPS-A survey of a transponder array (Fig. 1b) offshore Gisborne was undertaken for 30 hours, which will result in a position for the array to within a few cm.

Core was successfully retrieved from 26 different multicore sites (Fig. 3) and sampled on board for subsequent CT tomography, ^{210}Pb dating, sedimentology and faunal analysis. Evidence for recent tubidite emplaced associated with the Kaikōura earthquake was observed in multi-cores from along the Hikurangi channel system. These cores provide new geological evidence that the turbidity current triggered by the Kaikōura earthquake travelled at least 650 km north along the Hikurangi channel from the source region in the Kaikōura canyon, extending previous estimates by over 350 km. Further, multi-cores from margin perpendicular canyons that feed the Hikurangi channel also contain evidence of recent turbidite emplacement that may indicated triggering of turbidity currents by the Kaikōura earthquake was more widespread than originally anticipated. This hypothesis will be tested using by radioisotopic dating and detailed sedimentological analysis.

Outreach Activity: The voyage resulted in extensive outreach activity, led by voyage participant Kate Boersen of the East Coast LAB (www.eastcoastlab.org.nz). Kate kept a blog of the voyage on the East Coast Lab website, including 12 blog entries hosted on the East Coast LAB site. One of the voyage participants (Jennifer Granich) is a schoolteacher in the United States. She plans to incorporate some of her experiences and what she learned into lesson plans for her Earth Science students.

East Coast Lab issued two press releases, at the beginning and end of the voyage, which resulted in quite a bit of media coverage of the voyage and the results. Selected media coverage includes:
http://gisborneherald.co.nz/localnews/2868127-135/research-ship-explores-mega-quake-risk
http://www.nzherald.co.nz/hawkes-bay-today/news/article.cfm?c_id=1503462&objectid=11884458
http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11886692
http://www.radionz.co.nz/national/programmes/ninetonoon/audio/201850095/voyage-to-discovery-drilling-to-diagnose-slow-slip-earthquakes

Figure 1: Left: Bottom Pressure Recorder sites recovered during TAN1705. Right: BPR sites deployed and GPS-A sites surveyed during TAN1705.



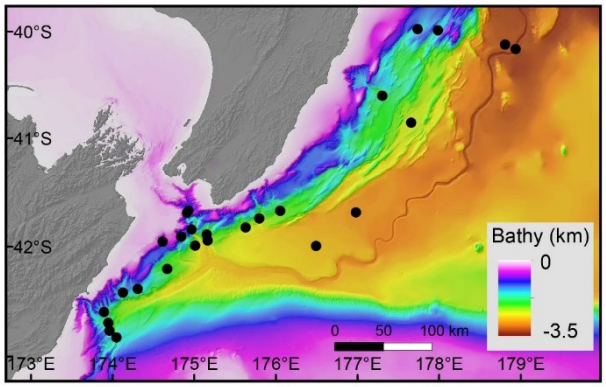


Figure 2: Left: Distribution of multi-core sites successfuly cored during the TAN1705 voyage.

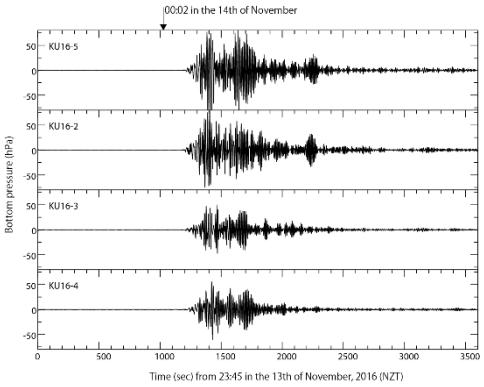


Figure 3: Seafloor pressure records of the passing seismic waves from the M7.8 Kaikōura earthquake at 4 BPR sites off Gisborne. The duration of the Kaikōura earthquake wave passage lasted up to 500 seconds, and following that period, several aftershocks of the earthquake are also visible.