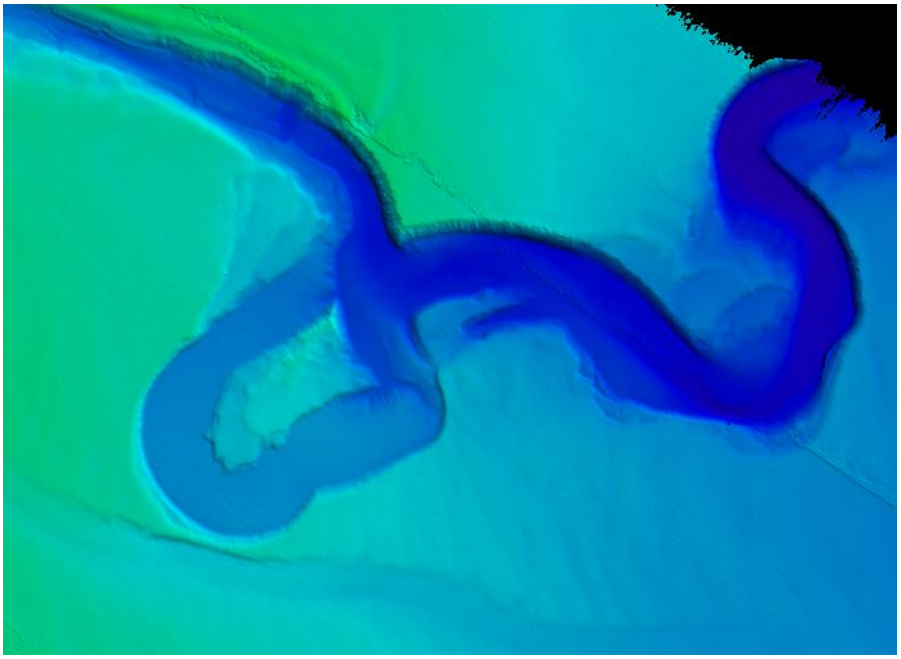
NIWA
Taihoro Nukurangi

# TAN1608 Voyage Report

## Otago Multibeam 2: Great South Basin and Southern Canterbury Shelf

*August 2016*



Prepared by:
John Mitchell
Arne Pallentin
Tim Kane

For any information regarding this report please contact:

John Mitchell
Marine Geology
Ocean Sediments
+64-4-386 0374
John.mitchell@niwa.co.nz

National Institute of Water & Atmospheric Research Ltd
Private Bag 14901
Kilbirnie
Wellington 6241

Phone +64 4 386 0300

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| Quality Assurance Statement | | |
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| | Reviewed by: | Alan Orpin |
| | Formatting checked by: | |
| | Approved for release by: | Alan Orpin |

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# Executive summary

This survey was undertaken in the Great South Basin with the intention of completing a multi-beam echo sounder (MBES) survey across the head of the Bounty Trough and Otago Canyons 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.

Funding for the *Tangaroa* sea days for this project were allocated from MBIE core vessel days and the funds for the science personnel, equipment and data processing were made available out of NIWA's core science funds.

At the completion of the survey new data were acquired over the planned area covering ~18,000 km$^2$. When combined with archive data the MBES coverage encompasses ~ 40,000 km$^2$

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 in general terms, but the bathymetric detail now afforded by MBES coverage was hitherto unknown.

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.
- presence of previously up mapped "mud" volcanoes

Combining these data with those collected during 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.

An additional MBES dataset was collected across the southern Canterbury uppermost slope to aid in the planning for an EU co-funded University of Malta/NIWA voyage scheduled for April 2017.

# 1 Introduction

The overall purpose of the Canterbury shelf and Great South Basins cruise was to continue the high resolution multi-beam echo sounder (MBES) mapping of the head of the Bounty Trough and the Otago Canyons as started in 2012 with the OS2020 voyage, TAN1209. This area in part of the Otago Fan Complex, and Centre and South Channels – tributaries that merge to form the Bounty Channel and Fan system to the east. These survey data will act as baseline bathymetry information to aid in the determination of the physical habitats and biodiversity of the area and to analyse the detailed geomorphic expression of tectonic and sedimentary processes.

Apart from the area covered during TAN1209, the Otago Fan Complex and Bounty Channel system of the Great South Basin has not been extensively surveyed using MBES technology. The seafloor in the area has very rarely been directly (using corers, sleds, dredges etc.) or indirectly sampled (using drop or towed cameras). The vast majority of sampling has occurred on the shelf and the shallow canyons heads, with very few sampling stations located on the deeper slope and trough. Very little is known about the biodiversity of the area or the physical characteristics of the predominant deep-sea habitat (canyon-incised slope at the head of a large ocean trough).

Data from this MBES survey will provide environmental base data, bathymetry which can be used to describe seafloor topography and backscatter which is indicative of sediment type, which can be used to generate a classification of the seafloor environment.

The government has encouraged oil exploration and investment in New Zealand's frontier basins, and NZPM has already provided significant capital to support seismic surveys of this area for hydrocarbons. Several blocks have been permitted for exploration in the area, with a large surrounding area under block offer in the 2016/2017 year. The acquisition of MBES data and production of a high resolution bathymetric coverage will provide a physical context for any planned exploratory oil drilling in the future, inform planning of possible oil platform installations, and provide environmental information.

# 2 Voyage Plan

The voyage plan had the following objectives:

- To complete full coverage, high resolution, MBES bathymetric map of the head area of the Bounty Channel;
- Collect MBES and TOPAS data from Canterbury shelf to aid in forward planning for University of Malta/NIWA voyage in April 2017;
- Continue the mapping of the mid-slope canyon features;
- Collect TOPAS seismic reflection data on all ship tracks.

Prior to departure three areas were prioritised. The total area of these exceeded the expected coverage for the voyage but gave the survey team options to move to different locations if the environmental conditions precluded any one area being completed (Figure 1).

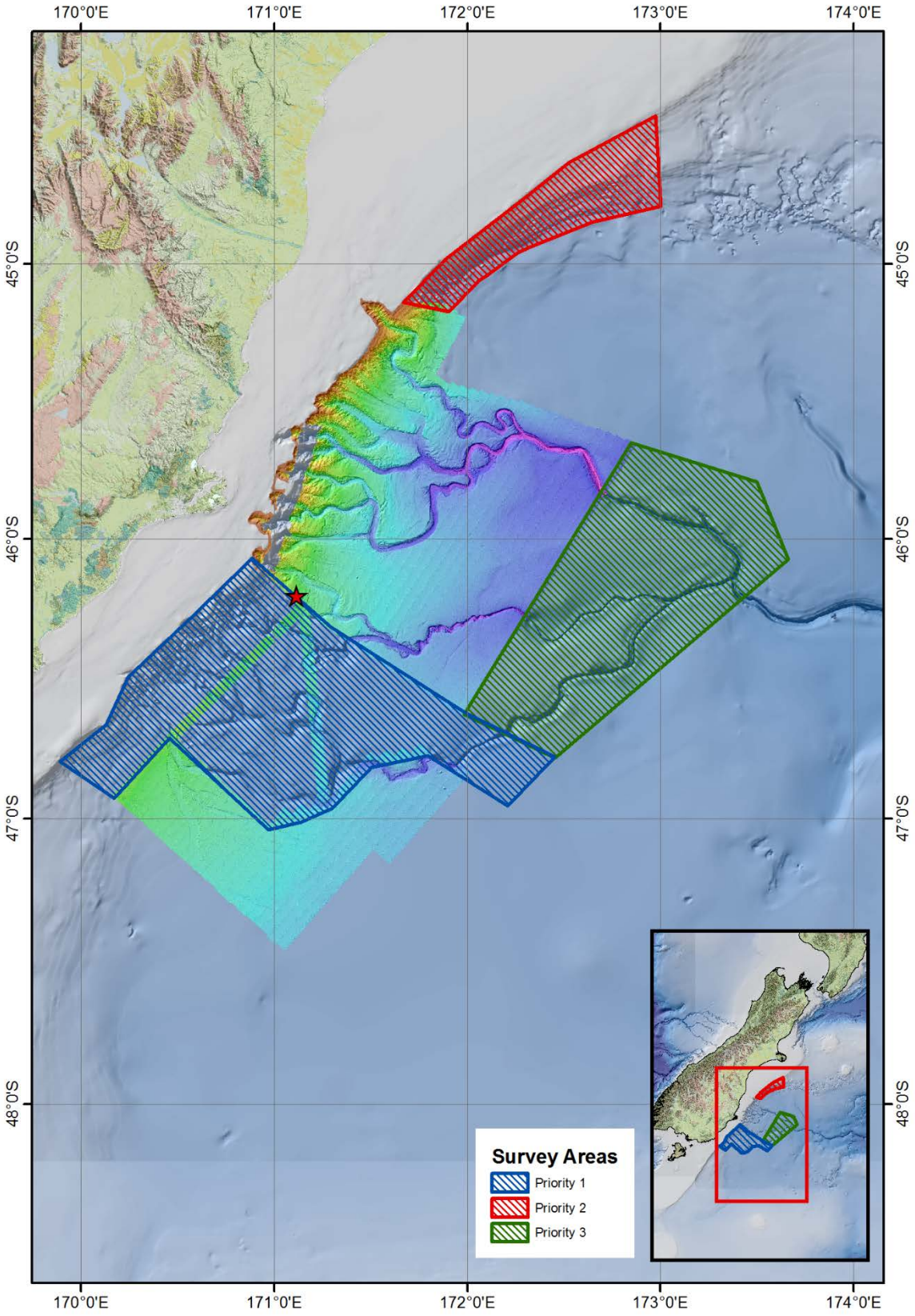


**Figure 1: Planned survey areas and priority for TAN1608 in the Great South Basin and Canterbury Shelf. Red star shows planned start location.**

# 3 Equipment

The following equipment and software was mobilised for this survey

- Kongsberg EM302 multibeam
- Kongsberg TOPAS PS18 parametric sub-bottom profiler
- AML Minos-X SVP probe
- CARIS HIPS&SIPS V9.1 for bathymetry processing
- QPS Geocoder for backscatter processing
- QPS FM-Midwater for water column processing

# 4 Voyage Narrative

| | | |
|---|---|---|
| Voyage Number | TAN1608 | |
| Voyage Name | Otago Multibeam 2 | |
| Project Number | COPR1704 | |
| Area | Great South Basin and Canterbury shelf | |
| Vessel | RV *Tangaroa* | |
| Duration | 19 days | |
| Depart Wellington | 1700 1 July 2016 | |
| Return Wellington | 1400 20 July 2016 | |
| Survey Personnel | John Mitchell | Voyage Leader |
| | Arne Pallentin | |
| | Tim Kane | |
| | Marine Guntz | Student Intern |

TAN1608 was mobilised and readied for departure on 1st July 2016. Minimal mobilisation was required as all equipment is permanently installed on RV *Tangaora*. Equipment checks were completed in the morning along with initial project set-up. Safety inductions were completed at 1300. A short pre-departure meeting was held at 1530 and the vessel readied for departure at 1700. Safety drills were held in the harbour immediately post departure and the vessels left for the survey site, passing the Wellington Heads outer buoy at 1830.

Vessel arrived on site at 0030 3rd July where an SVP profile was obtained and the first line in priority Area 1 commenced at 0148. The first survey line was started in ~900 m water depth and run shore parallel (Red star, Figure 1) with subsequent lines moving progressively inshore until they reached the shelf break. This part of the survey was completed by 0800 7th July. The survey then continued offshore in Area 1. Line direction was altered to shore perpendicular due to a change in the prevailing wind and swell direction. Good data could be obtained by running side on to the swell and wind, reducing bubble sheeting. Priority Area 1 was completed by 0620 11th July and the survey of Area 3 commenced.

The decision was made to survey Area 3 before Area 2 due to the time (in excess of 24 hours) that would be lost transiting and return.

Surveying in Area 3 continued until 0400 14th July when the vessel then transited to Area 2 on the southern Canterbury Shelf. At the completion of the 14 hour transit Area 2 surveying commenced at 1745 14th July. Survey lines in this area were shore parallel with the block divided into roughly half, with the western half surveyed first. Surveying continued until 1340 19th July when the vessel commenced the return transit to Wellington.

On arrival outside Wellington Harbour Entrance the vessel conducted DP and thruster trials for approximately 2 hours. This was followed by a short MBES survey over the area where two articulated trailers and a tugger unit had been lost from a Cook Strait ferry during a storm two days previous. This recognisance survey was run to identify any potential targets and search locations for a detailed follow-up survey using NIWA's high-resolution EM2040 MBES system. Three potential locations were identified.

The RV *Tangaroa* then proceeded into port and berthed alongside at 1400 20th July. The science team demobilised personal and science gear and departing the wharf by 1440.

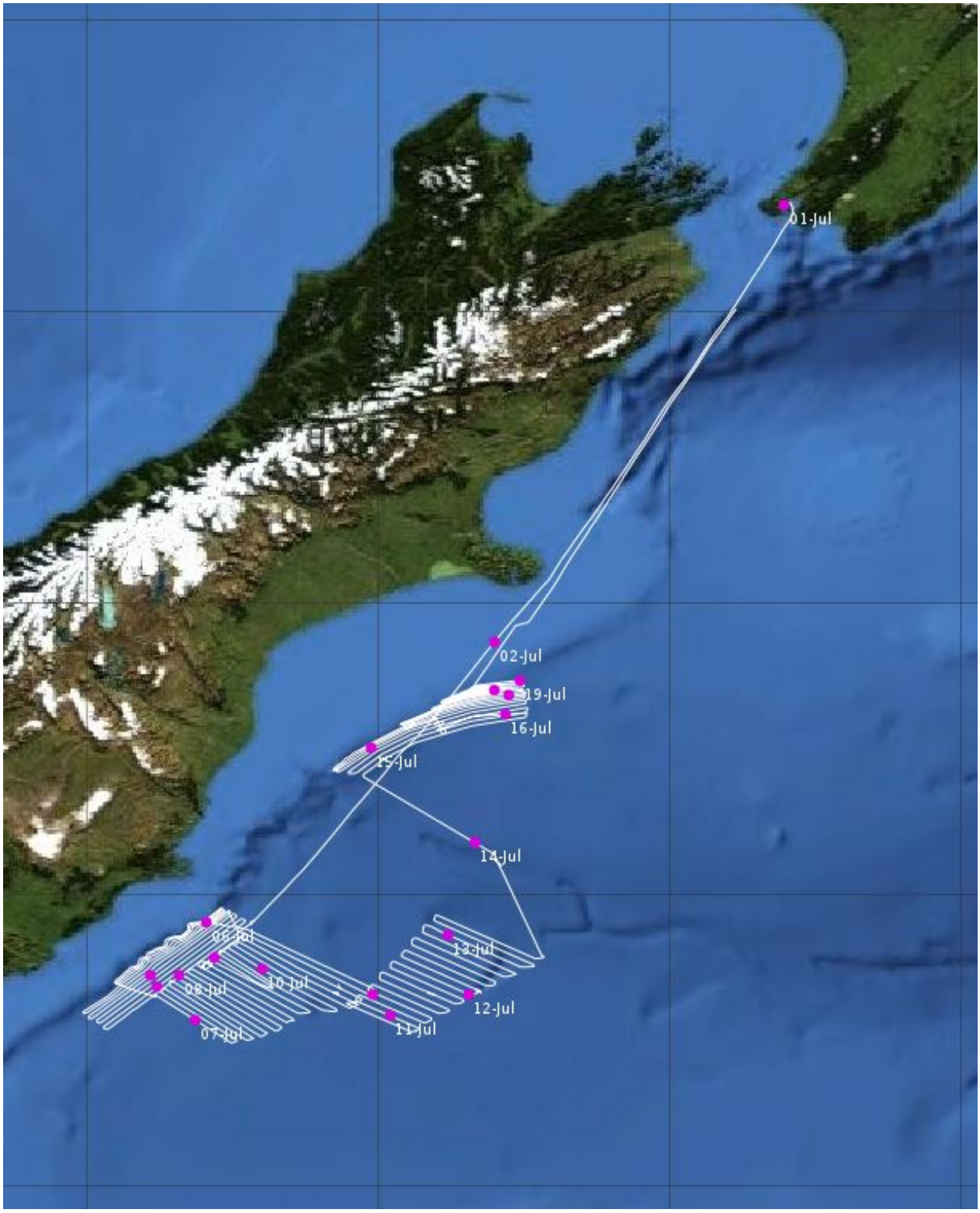


**Figure 2: Survey track for TAN1608.**

# 5 Environmental Conditions

Surveying in the austral winter is always problematic and can have significant impact on MBES surveys as high winds and the resulting seas produce conditions whereby bubble-sheeting degrades data quality. TAN1608 was exposed to a series of rapidly moving weather systems, which were typified by rapid increases in wind speed as fronts moved through, followed by equally rapid decreases in wind speed until the next front arrived. Wind direction was similarly changeable with periods of NW/NE following be strong S/SW winds. The effects of the wind and sea conditions were mitigated whenever possible by running survey lines perpendicular to the wind direction. This resulted in acceptable data quality but less than comfortable conditions for those on board with the ship pitching less but having a 10° lean (heel). Some lines could not be run perpendicular to the wind and resulted in short stoppages waiting for the wind and swell to ease, or alternatively dead steaming to the up-wind end of the line and surveying downwind only. Approximately 18-24 hours in total were lost to weather.

Wind speed for the voyage ranged from calm up to 60 knots (2 minute average) with sustained periods of 25–35 knots (Figure 3). Average wind speed was 20 knots but this does not accurately reflect the weather regime the voyage experienced.

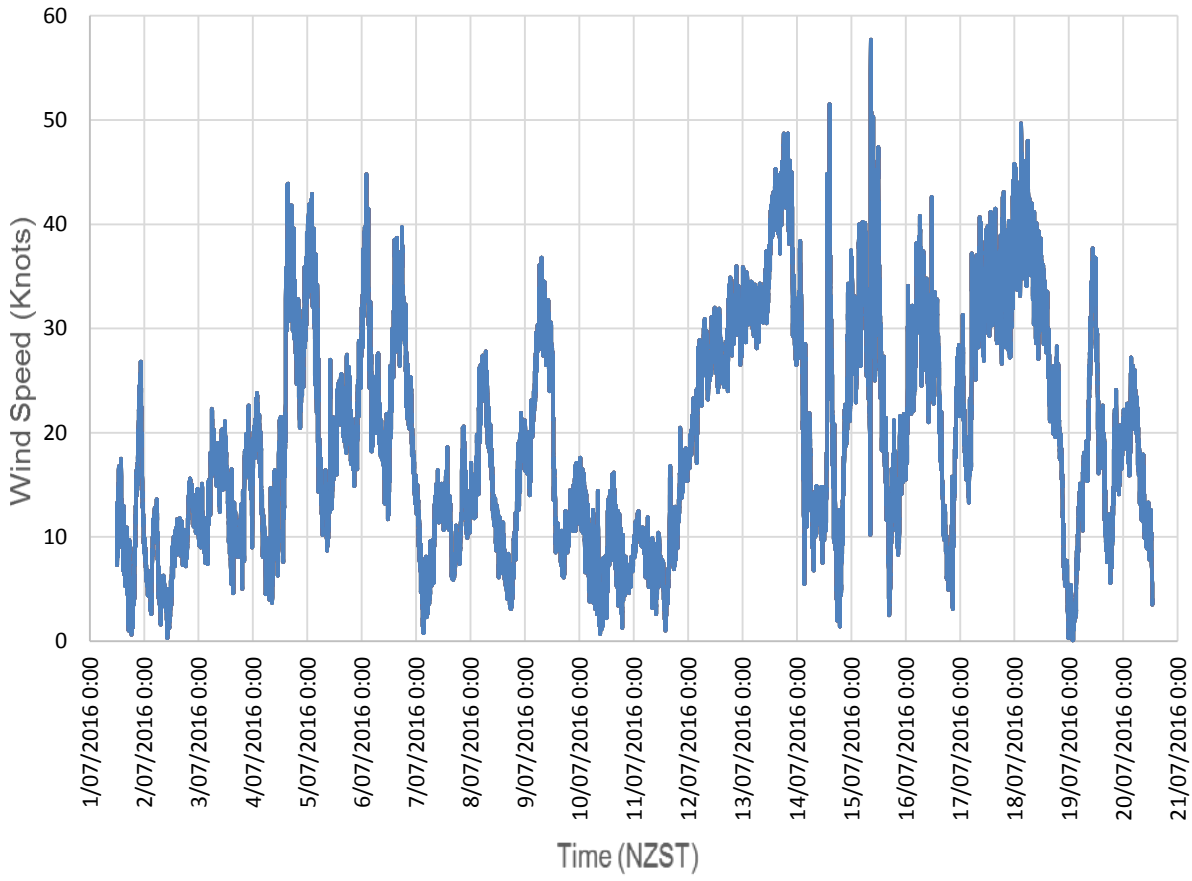


**Figure 3: Wind speed (2 minute average) measured during voyage.**

# 6 Results

All bathymetry data collected during this voyage were processed through the normal CARIS processing chain and new coverages were produced (Figure 4). At the end of the survey a combined coverage of all data collected from the region (including previous voyages) was produced to give a integrated dataset (Figure 5). TOPAS data showed good penetration (up to 80 m) and detailed sub-seafloor structures over the survey area (Figure 6 & 7).

No data analysis has been done at this stage but points of interest noted during the voyage were

- Canyon and channel locations different to existing maps
- Extensive pockmark fields between 500 and 700 m water depth (Figure 8 & 9)
- Well-developed oxbows in the channel structure on the mid-slope (Figure 10)
- Sinuous and rapidly changing structure to the lower reaches of the canyons (Figure 11)
- Newly discovered “mud” volcano, 200 m high and 2 km across (Figure 12)

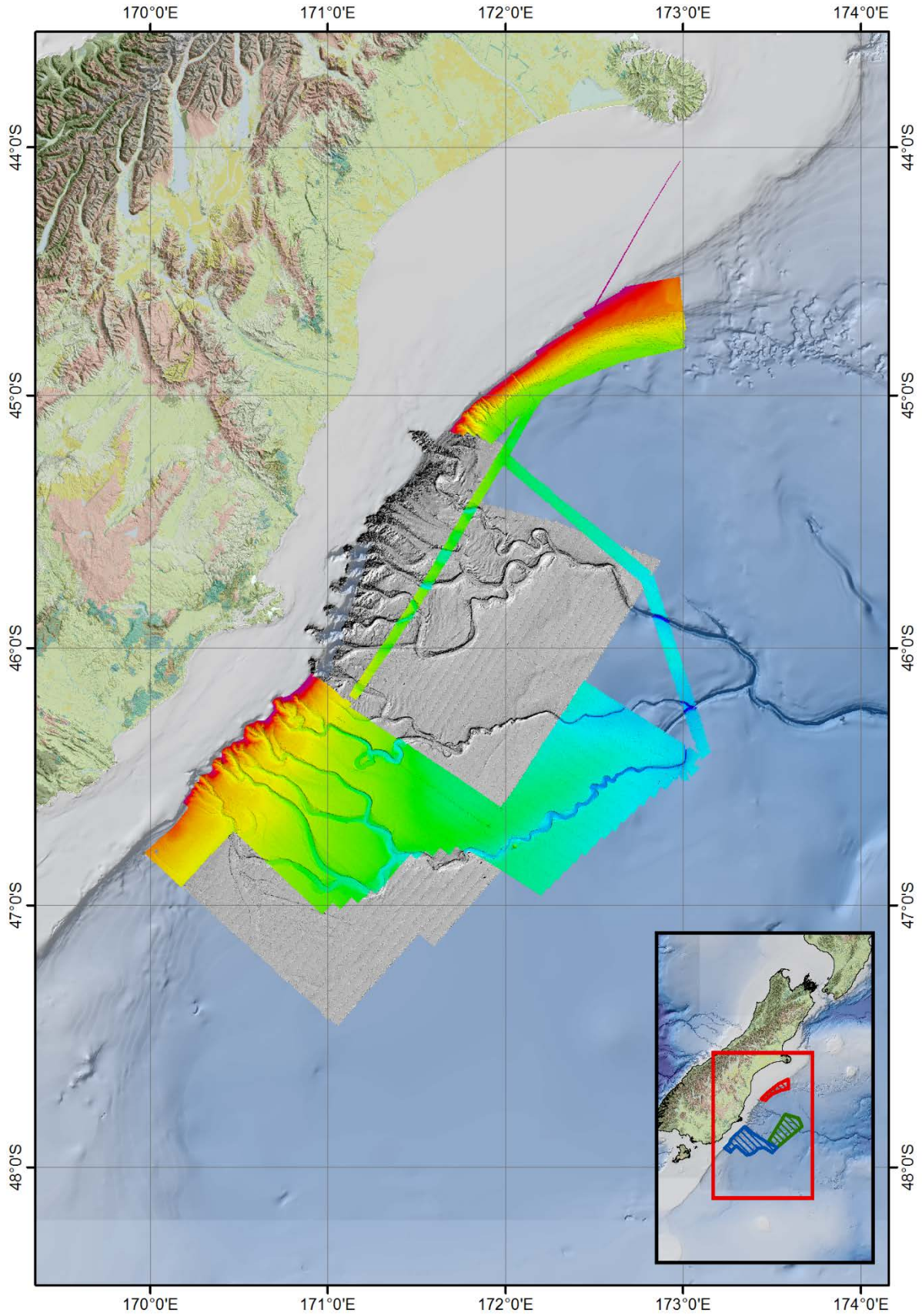


**Figure 4:** **TAN1608 MBES coverage (rainbow) and previous coverages (grey scale).**

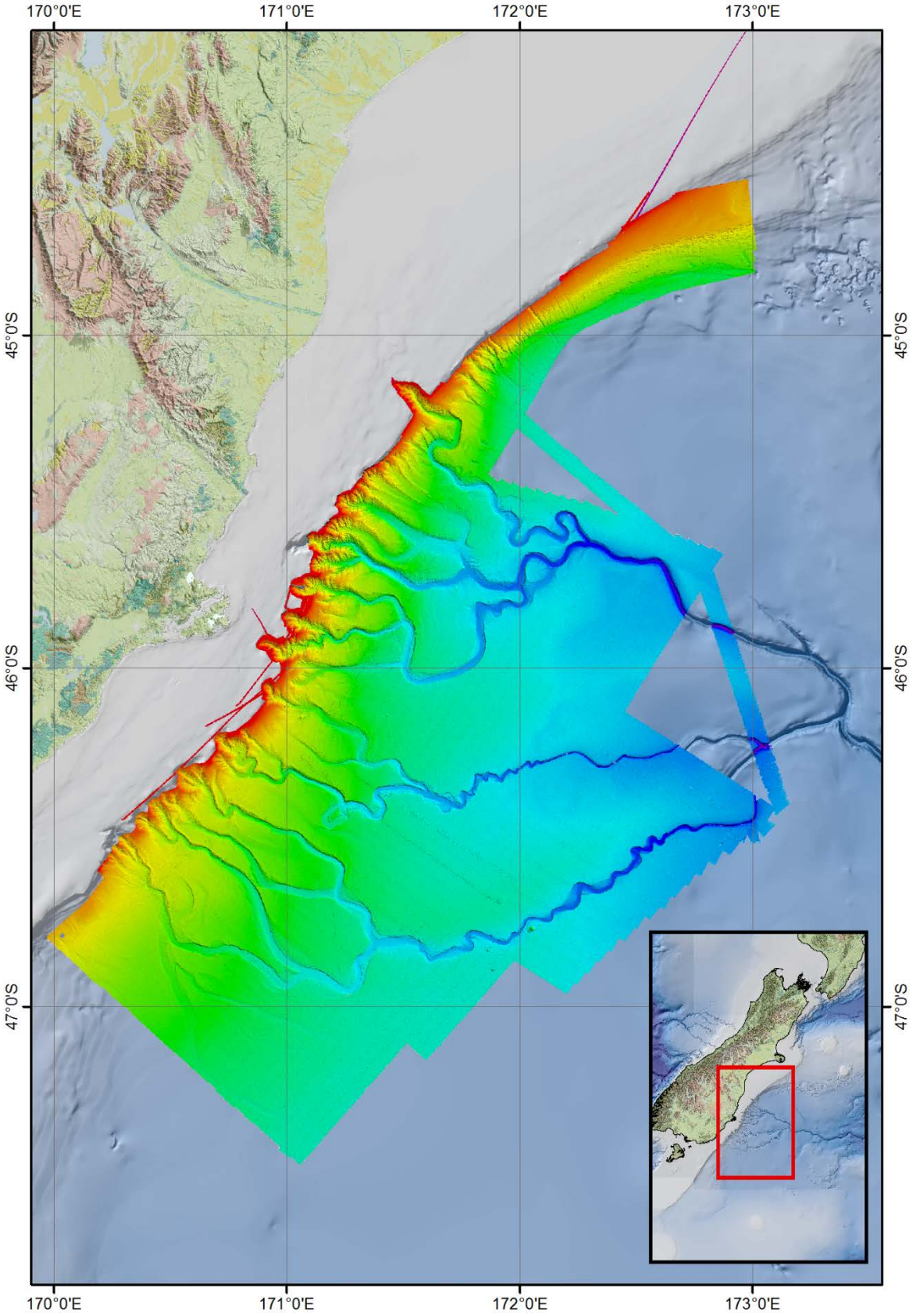


**Figure 5: Combined NIWA MBES coverage of the Otago Fan Complex and southern Canterbury upper slope.**

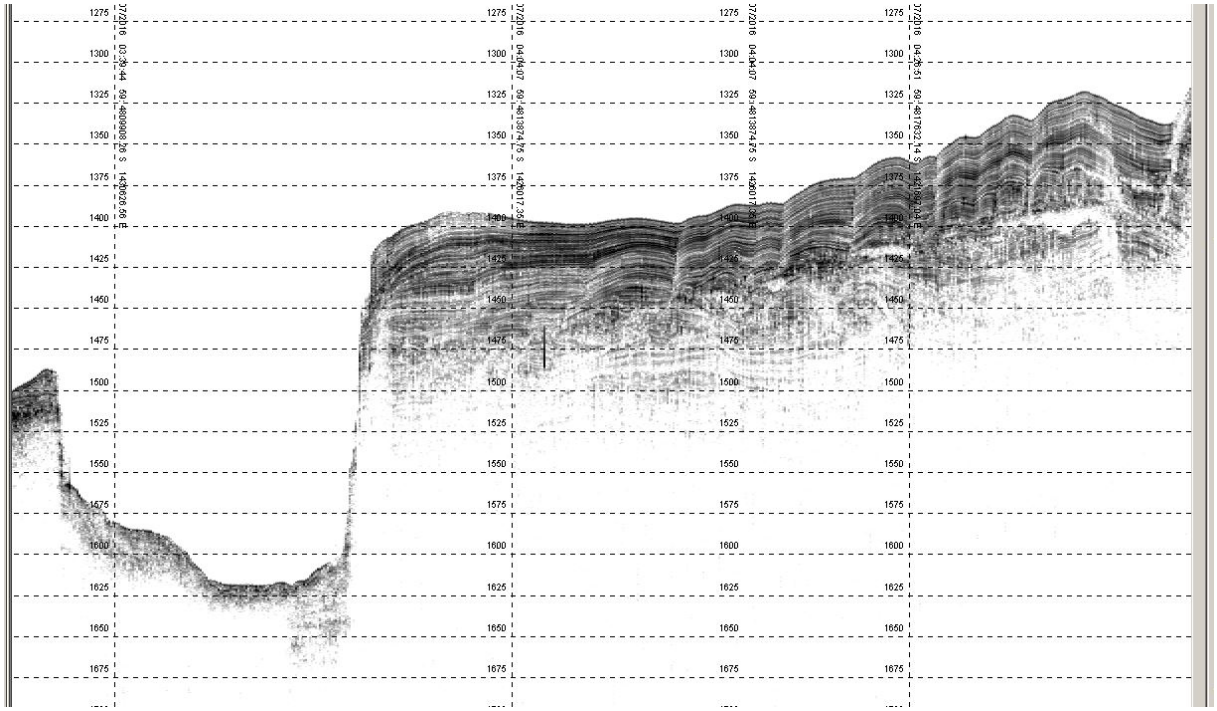

**Figure 6: Example TOPAS line crossing one of the canyons in the south of the area.**

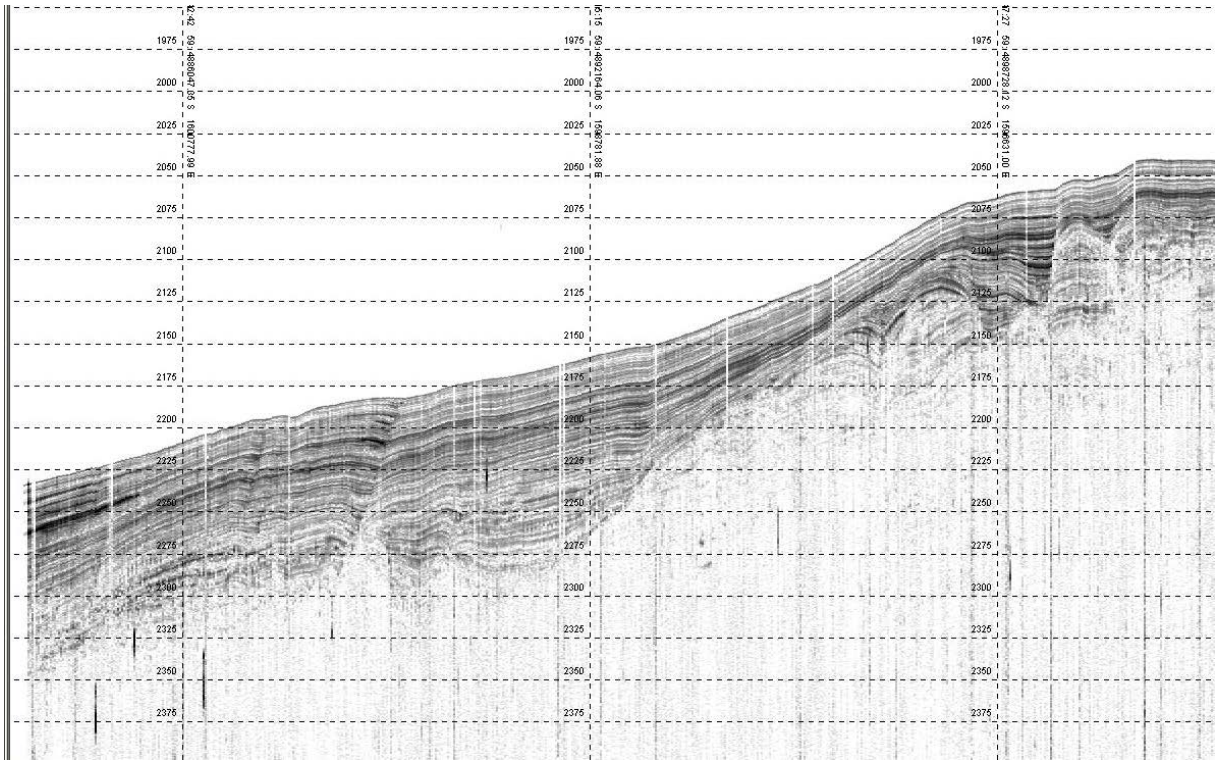

**Figure 7: Example TOPAS profile showing canyon overflow deposits in deep water from the southern arm of the canyon system.**

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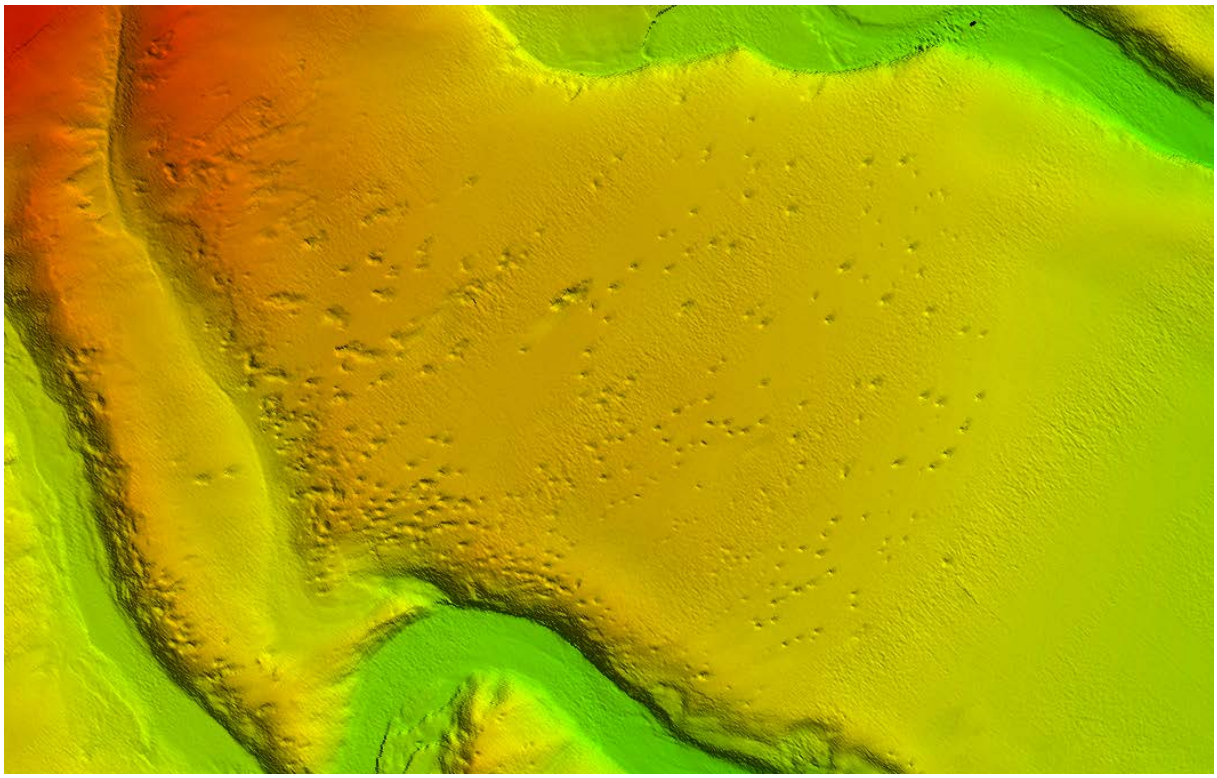

**Figure 8:** **Inter-channel pockmarks in ~600-700 m water depth off the Otago shelf.**

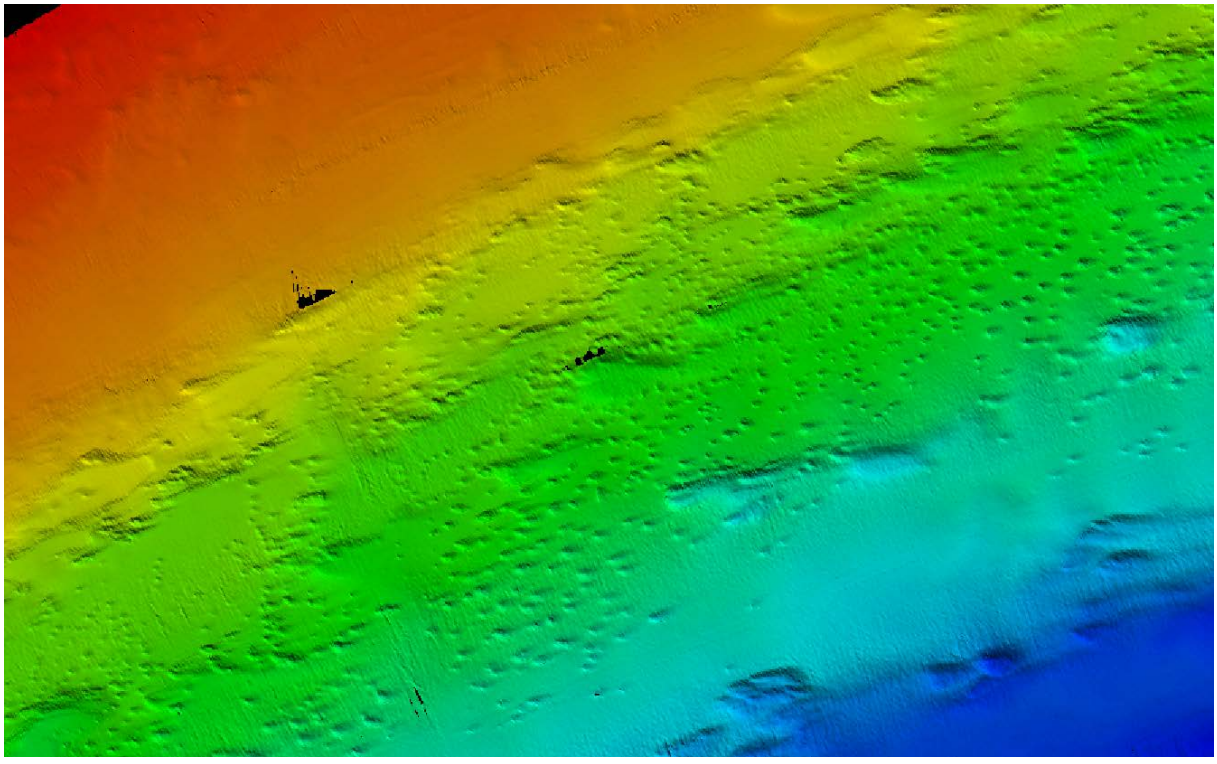

**Figure 9:** **Pockmark field on the Canterbury slope in ~600-900 m water depth.**

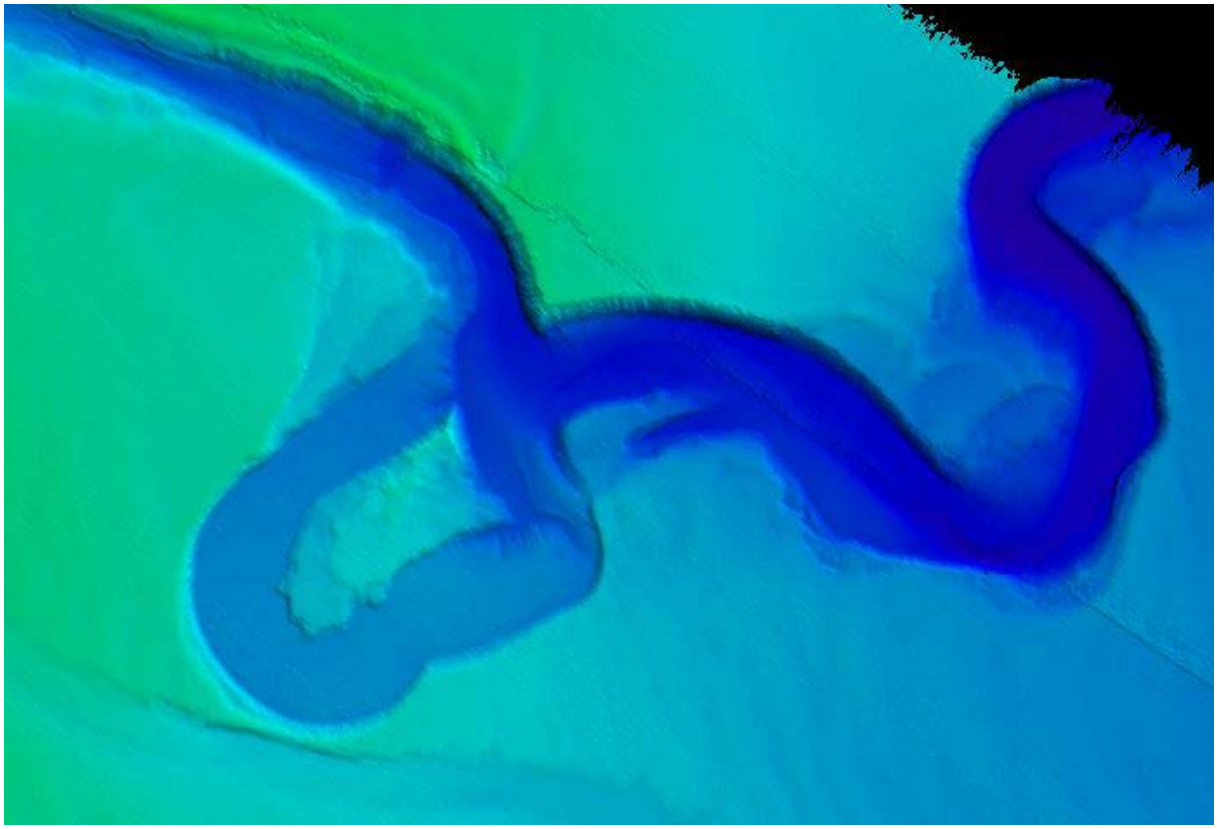

**Figure 10:** **Oxbow in the channel showing closure and cut-off by newer sediment transport route.**

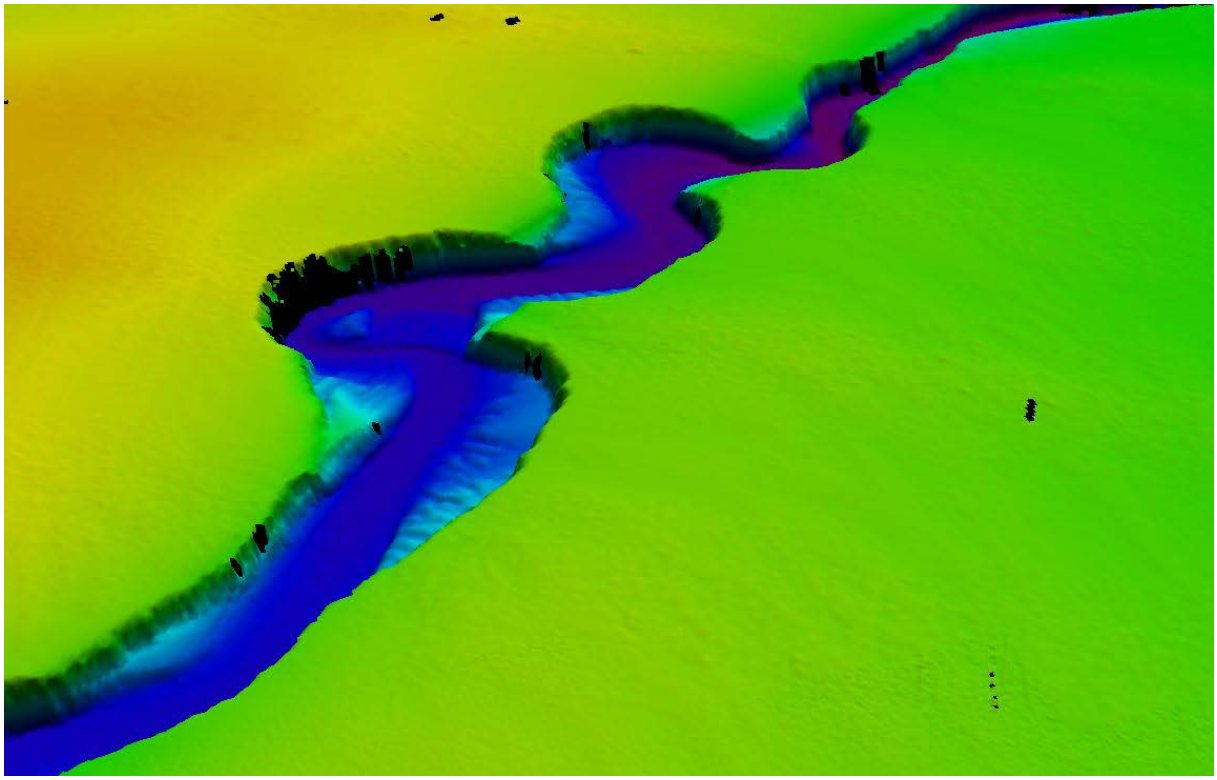

**Figure 11:** **Complex channel structure.**

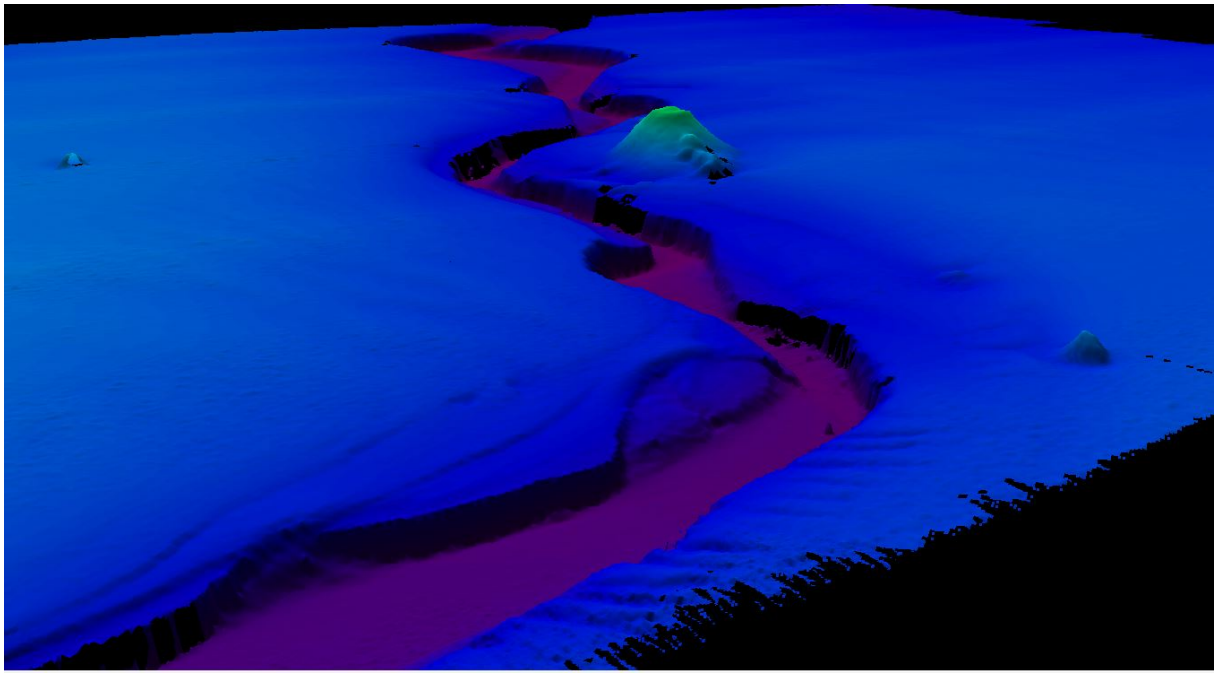

**Figure 12: Newly discovered mud volcano adjacent to the southern arm channel.**

# 7 Summary

This survey was undertaken with the intention of completing the data collection across the head of the Otago canyons and Fan Complex and Bounty Trough to act as a base survey for future voyages to determine the biodiversity of the area and to analyse the detailed geomorphic expression of tectonic and sedimentary processes.

The MBES data collected document the seafloor including southern portions of the Otago Fan Complex, and Centre and South Channels - tributaries associated with the Bounty Channel and Fan System, and associated levee and channel structures (Figure 4). This network of canyon-fed channels has been previously documented, but the detail afforded by MBES coverage was hitherto unknown

The survey documents:

- - the narrow v-shaped canyon heads of the Otago Fan complex progressing into broad U-shaped canyons,
- - the entrenched (250 m) 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 that when active the channel-levee system is evolving through time,
- - pockmarks predominately on the northern levees up to 200 m across and exhibiting up to 20 m relief.

Combining these data with those collected during previous voyages (especially TAN1209) has resulted in a dataset mapping the structure of the Otago Fan Complex, and North, Centre and South Channels which merge to form the Bounty Channel (Figure 5).

An additional dataset was collected across the southern Canterbury shelf to aid in the planning for an EU co-funded University of Malta/NIWA voyage in April 2017.

# 8 Acknowledgements

All aspects of the survey were successful thanks to the hard work of all involved.

The survey could not have been successfully completed without the professional efforts of all involved. We would like to acknowledge the efforts of the Master and crew of RV *Tangaroa* and NIWA Vessels Company. The crew of RV *Tangaroa* were, as always, helpful and professional and all work was carried out safely and efficiently. The small but dedicated survey party also performed up to high expectations as attested to by the quality of the data obtained.