High-Frequency Multi-Channel Seismic Investigations of Active Processes at the Waitaki Canyon – Northern Otago Shelf

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Abstract

The Otago Canyon System is comprised of several submarine canyons and channels of varying sizes incised into the continental shelf off southeastern New Zealand (Fig. 1). The Waitaki Canyon is the largest and northernmost canyon in the Otago Canyon System, but the processes involved in the formation and evolution of this significant bathymetric feature have not yet been studied in great detail. Our ongoing research is focussed on the dynamic nature of canyon development, focusing on processes of sedimentary erosion, transport and deposition along the upper length of the canyon. The role that ocean currents, tides, sea-level fluctuations, and tectonic activity play in controlling these processes is also a topic of investigation.

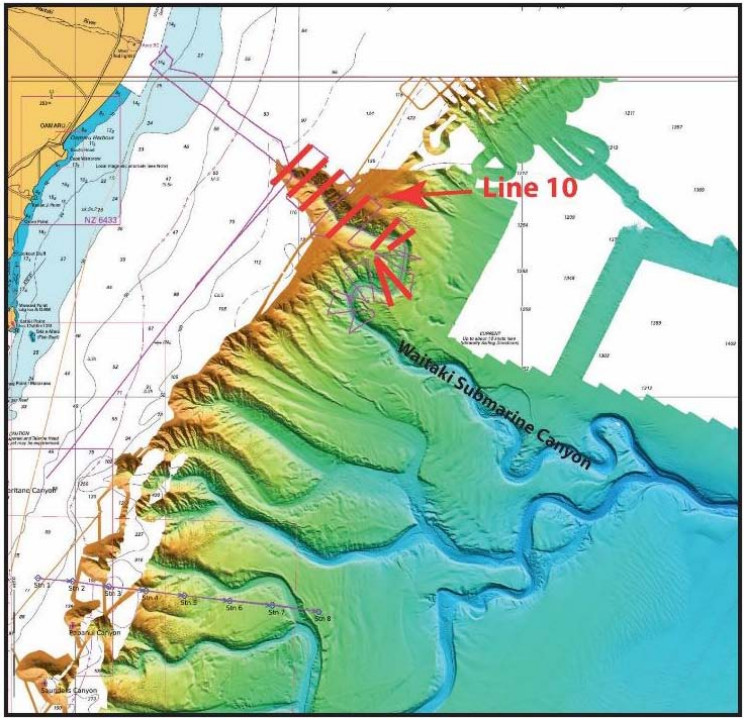

Figure 1. Bathymetric data from the vicinity of the Otago Canyons.

The proximity of the Otago Canyon System to the University of Otago's research facilities (including RV Polaris II) has enabled repeated high-resolution seismic investigations in the region that are not routinely available in the open ocean. There is an abundance of data now available in the region: pre-existing high-resolution bathymetric data, multi-channel boomer data, and 2- and 3-D marine seismic data from the petroleum industry, along with new multi-channel boomer and bathymetric data specifically collected for this project. These tools will enable us to develop a model of the evolution of the Waitaki Canyon, and that model can then be used in combination with sedimentological evidence to further our understanding of how mid-shelf canyon systems develop.

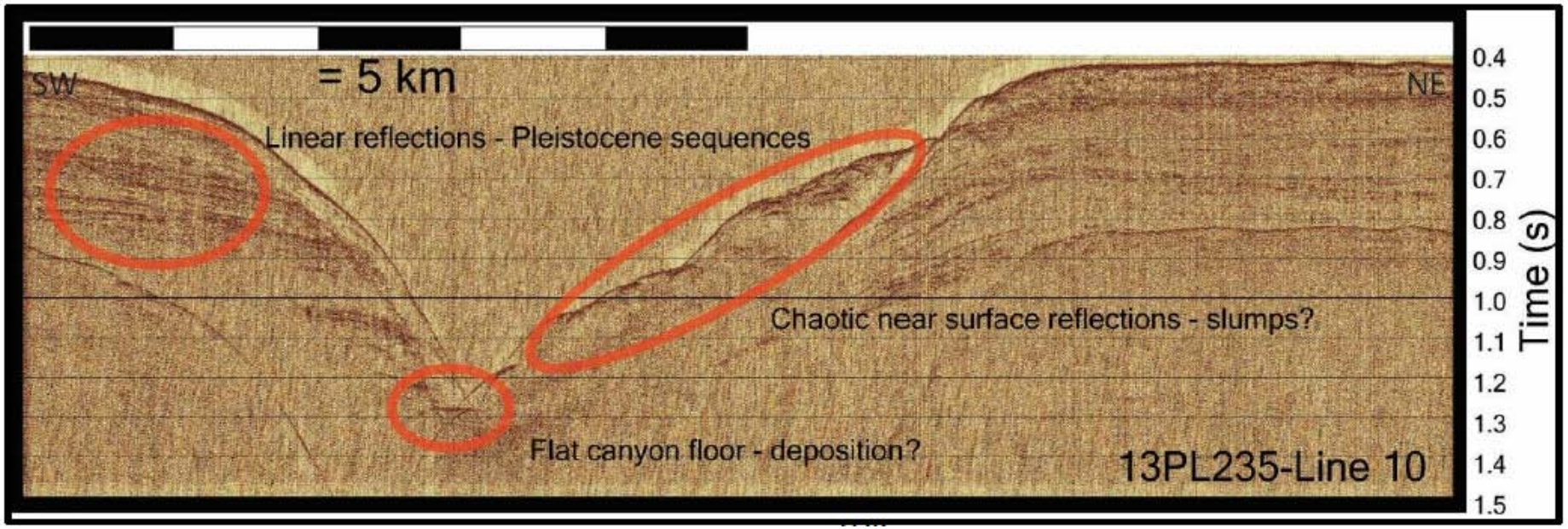

Figure 2. 13PL235 - line 10 showing Waitaki Canyon in cross section cutting through stacked Pleistocene sequences.

Several features can be identified and interpreted in preliminary rudimentary unmigrated sections (e.g., see Fig. 2):

- Slumping: Reflective bodies with little coherent internal structure are present in a number of the cross-channel sections that may be indicative of slump deposits formed from failure of canyon walls.
- Asymmetry in canyon walls: The asymmetric nature of the canyon walls is clearly observed in almost all sections. Similar asymmetric development of channels has been identified previously in the Bounty Channel, with causes including the south-to-north flowing Southland Current and the Coriolis deflection of density currents. It is plausible that similar processes could be in effect here.
- Narrow and sharp vs. broad and flat canyon floors: Some sections show a flat and wide canyon floor, which may be indicative of sediment deposition.

- Paleochannels: Some reflective patters in the seismic data (and also in the multibeam images of the present-day seafloor) appear to be infilled channels of previous canyon paths, indicating that lateral migration of the canyon system occurs through time.

These data provide an opportunity to investigate key sedimentary processes associated with the transport of sediment through a canyon system and its eventual accumulation downstream. The high frequencies present in the seismic data should enable interpretations of stratigraphic packages as thin as 1 m. Processes that will be targeted include storm-induced turbidity currents and slumping or mass failure of poorly consolidated sediment in canyon walls. Also, the relationship with oceanographic processes such as temperature/density driven currents will be examined. This region lies directly in the path of the north-flowing Southland Current, a manifestation of the boundary between subtropical and subantarctic water masses in the southern Pacific Ocean.

An additional dataset is to be collected in early 2015 to improve the resolution of cross-channel imaging and to tie the stratigraphy imaged in these sections to Pleistocene outcrops on land. Direct sampling of seafloor sediments and canyon wall outcrops will be attempted. Additional seismic processing is still required to improve the coherency of the sections and to migrate dipping structures and stratigraphy into a more optimal configuration. Nearby petroleum industry seismic and well datasets will also be integrated with these high-frequency boomer data – along with new high-resolution multibeam imagery currently being planned with colleagues at the University of Otago.

Acknowledgements

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