FS Sonne

Cruise SO310 (S-555)

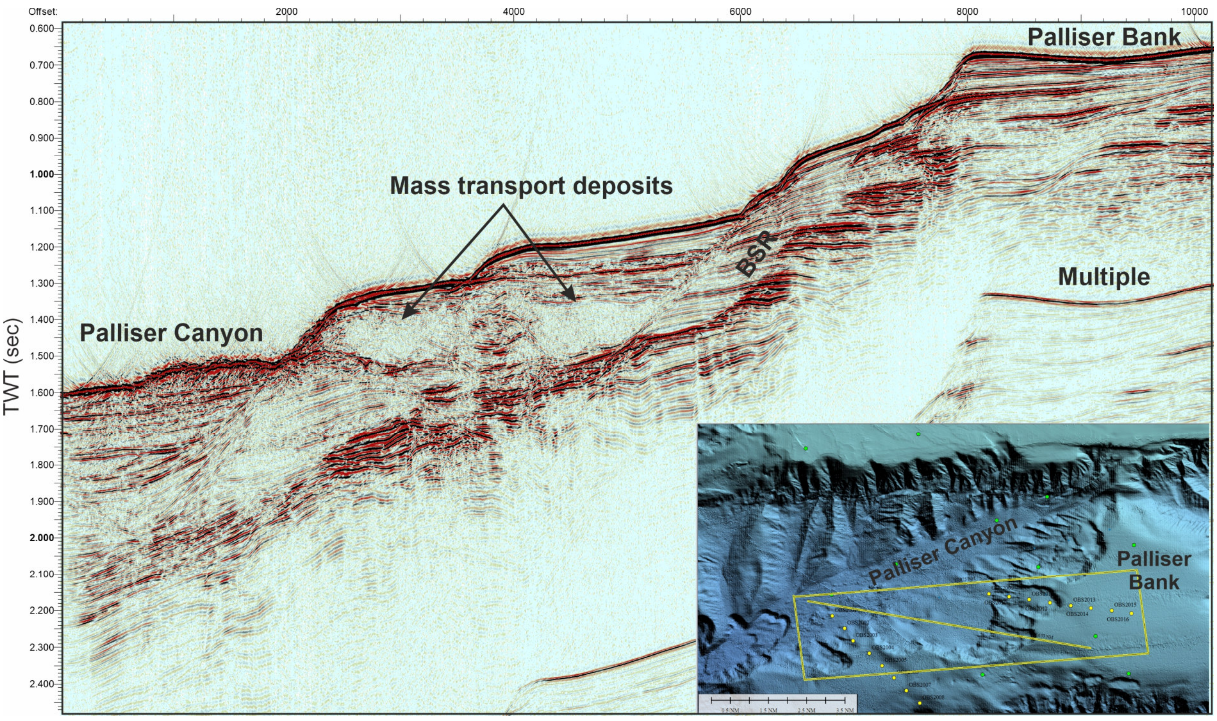
20.02.25 – 22.03.25, Wellington – Wellington

Weekly Report No. 2, 24.02. – 02.03.2025

Quantifying the role of mass wasting in submarine canyons on active and passive margins (MAWACAAP)

2. Weekly Report

We have had a busy and very successful week. The acquisition of detailed 2D seismic data over the northern flank of Palliser Bank continued into the evening of 23 February. The data shows many features of great significance to our objectives. The seismic profile shown below extends from the Palliser Bank, across a prominent landslide scarp at the edge of Palliser Bank, to the thalweg of the Palliser Canyon. The Palliser Bank itself shows well-stratified sediments. Parallel profiles show near-surface gas accumulations and diapir-like features in places. Thick landslide bodies are found on the slope towards Palliser Canyon. A clear BSR (Bottom Simulating Reflector) is also imaged, which appears to pinch out on the seafloor at a landslide scarp. Stratified sediments are imaged beneath the thalweg of the Palliser Canyon. A dense network of such profiles was used to select the final location of the 3D cube.

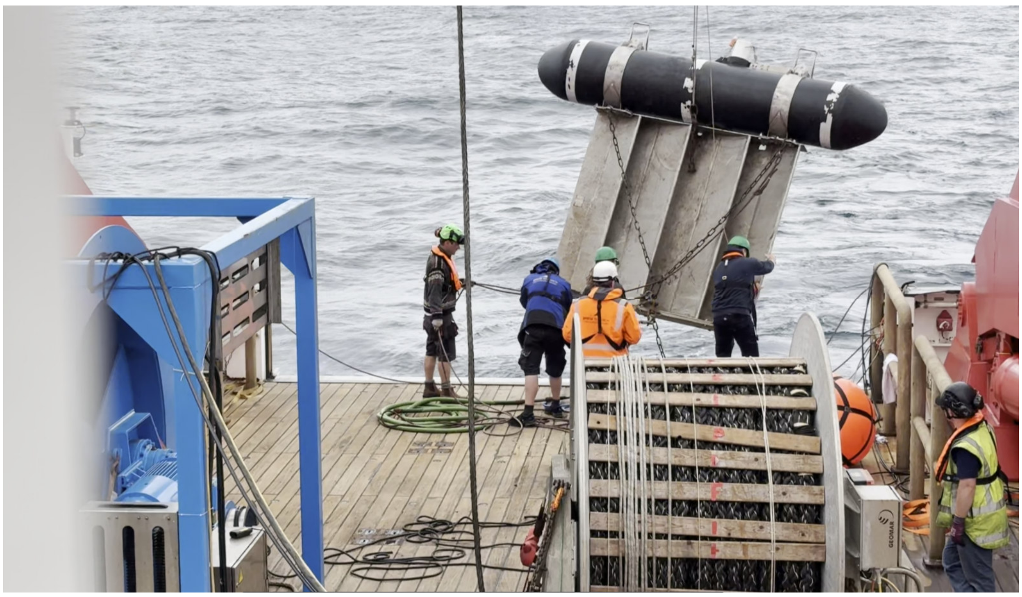


Example of a 2D seismic profile from the Palliser Bank to the thalweg of the Palliser Canyon. The yellow line in the inset map shows the location of the profile. The yellow box marks the location of the 3D seismic cube. Yellow dots show the locations of the OBS for the full waveform experiment. Green dots show the location of the OBS for seismological studies.

After retrieval of the seismic gear, the following night was used to recover 4 OBS and deploy 16 OBS for a Full Waveform Inversion (FWI) experiment. 8 OBS each were deployed along two lines crossing landslide scarps of different morphology. The aim of this experiment is to characterize potential glide planes using seismic data by deriving high resolution seismic wave velocity and density models. The approach is making use of the full seismic waveform instead of using only traveltimes. The inclusion of the complete recorded wavefield in a seismic full waveform inversion not only allows to resolve small(sub-wavelength)-scale structural information, but also provides the distribution of elastic parameters in the subsurface. This approach is already used in the industry but usually on larger scales and for reflection data. If we succeed in determining the elastic parameters on a small scale, this would be a way of using seismic data to determine critical parameters for modelling slope stability, especially at depths that could otherwise only be reached by drilling. Prior to the start of the FWI experiment, gravity cores were taken at 3 stations along a profile crossing a prominent landslide scarp on the northern flank of the Palliser Bank. The first core targeted undisturbed sediments on the Palliser Bank and recovered 540 cm of background sediments. We used a 5 m core barrel for the flank core, which over penetrated on the first attempt. The second attempt with a 10m core barrel yielded 572 cm of mixed sediments. The thalweg core was very short and contained redeposited material such as a piece of coral and shell fragments.

Data acquisition for the FWI experiment began in the afternoon of 24 February. First, we collected two lines across the OBS with the seismic source and the streamer. The lines were reshot with the seismic source only to reduce the shot spacing on the OBS records. We then collected a perpendicular line and a circle around the OBS for accurate positioning of the OBS, which is critical to the accuracy of the FWI. We stopped seismic operations in the early hours of 25 February. Activities on 25 February were limited due to high winds (gusts of up to 10 Bft), but we were still able to use the time to re-image parts of the Palliser Bank with the multibeam systems of RV Sonne. Our survey was briefly interrupted on the morning of 26 February to collect some spare parts in Palliser Bay with the kind assistance of NIWA.

Back in the work area, we deployed the P-Cable for the 3D seismic survey. The P-Cable is a high-resolution 3D seismic system that can be deployed on conventional research vessels. It consists of 16 short streamers towed parallel to each other. The selected cube to be covered by the P-Cable is 10x4 km wide. We collect one line every 60 m, making a total of 69 lines. We acquired data with the P-Cable until the morning of 28 February, when we had to stop the survey due to increasing winds. So far, we have collected 31 lines, about 45% of the cube, and hope to complete the cube during the next window of calm weather. However, with the weather forecast predicting windy conditions in Cook Strait over the next few days, we decided to move to our second working area, Pegasus Canyon, some 80 nm to the south. Before starting the short transit, we collected three additional cores in the thalweg of Palliser Canyon. All cores are short (only up to 74 cm), but they clearly show redeposited material, suggesting that active sediment transport is taking place in the canyon. We also recovered three OBS that are outside the P-Cable cube.



Deployment of P-Cable. Photo: Christof Müller.

We arrived at the Pegasus Canyon work area early this morning (02 March). Pegasus Canyon is a 95 km long submarine canyon that begins on the continental shelf off the east coast of the South Island in approximately 100 m of water. The canyon has formed within an undeformed Plio-Pleistocene sedimentary sequence dominated by off-shelf progradation. It shows numerous landslide scarps of different size and morphology on its flanks. Following the deployment of three OBS, we have begun to acquire a network of 2D seismic profiles traversing Pegasus Canyon at various locations. We plan to continue acquiring seismic data over the next two days.

Everyone on board continues to be well. With best wishes on behalf of all participants

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On transit to Pegasus Canyon. Photo: S. Krastel