IODP Expedition 372: Creeping Gas Hydrate Slides and Hikurangi LWD

Site U1519 Summary

Background and Objectives

Site U1519 (proposed Site HSM-01A) is located on the upper continental slope ~35 km from shore. The site is located on regional seismic profile 05CM-04 at the landward edge of a 12 km wide midslope sedimentary basin at 1000 m water depth. The basin is officially unnamed, but referred to here as the North Tuaheni Basin. The slope west of the basin rises to the edge of the continental shelf and hosts the North Tuaheni Landslide. This and other landslides have delivered late Quaternary mass transport deposits directly into the basin.

Active thrust faults of the upper plate reach the seafloor on the shelf west of Site U1519 and on the mid-lower slope to the southeast. No active thrust faults are recognized directly beneath the North Tuaheni Basin; however, an apparently inactive northwest-dipping thrust lies 1.1 km below Site U1519. This fault is associated with an eroded hanging wall sequence. The plate interface thrust, characterized by slow slip earthquake events (SSEs), lies about 5 km below the basin floor.

The primary objective at Site U1519 was to acquire logging-while-drilling (LWD) data down to 650 m to help characterize the nature of the sedimentary sequences in which a borehole observatory is planned to be installed on Expedition 375. Coring operations at Site U1519 are also planned for that expedition. The objective of the borehole observatory is to record measurements of pressure and temperature over multiple SSE cycles on the inner margin approximately above the loci of large SSE displacements modelled from geodetic data. In addition to informing planning of the observatory targets, LWD logs and core from Site U1519 will provide constraints on the evolution of the upper slope and basin environment, as well as the timing of apparent thrust cessation across this section of the inner continental slope.

Site-specific objectives include the following:

- Characterize the lithological composition and geophysical properties of the basin above the SSE source region to inform selection of the stratigraphic targets for the borehole observatory installation. This includes formation density, resistivity, porosity, natural gamma radiation, sonic velocities, consolidation state, and gas hydrate content.
- Identify the distribution and density of fractures visible in borehole images to evaluate deformation of the basin at a subseismic scale.
- Identify the present maximum and minimum stress orientations from borehole breakouts, and compare these with data from the other sites to evaluate regional variations in contemporary stress across the margin.

- When core is collected from Site U1519 during Expedition 375, the cores will provide additional information on meso- and microscale structure, lithology, porosity, permeability, density, shear strength, age, thermal conductivity, natural gamma radiation, sonic velocities, and geochemical compositions of present and past pore fluid. Pore fluid analysis of samples will help to evaluate the source of fluids above the region of SSEs, while geotechnical measurements undertaken on core samples will provide information on fault and host formation permeability, consolidation state, frictional properties, and strength.

Operations

The vessel arrived at Site U1519 (38°43.6372′S, 178°36.8537′E; water depth 1000.7 mbsl) at 0530 h (UTC + 13 h) on 24 December after a 15.4 nmi transit from Site U1518. The LWD bottom-hole assembly (BHA) was assembled and contained the geoVISION, NeoScope, StethoScope, TeleScope, SonicScope, and proVISION tools. Hole U1519A began at 1200 h on 24 December and continued to 26 December. After logging to 650 mbsf, mud was circulated to clean the hole, and the LWD tools and drill string were pulled out of the hole. The bit cleared the seafloor at 0425 h and the rig floor at 0855 h. The vessel began the transit to Site U1520 at 0910 h on 26 December.

Principal Results

Logging While Drilling

Six LWD tools were deployed on the BHA while drilling Hole U1519A, providing both real-time and recorded mode data to investigate slow slip at the Hikurangi subduction zones. LWD data in Hole U1519A was collected to 650 m. Based on the LWD measurements, three main logging units and ten subunits were identified. Several significant features were interpreted from the logs. From 140 to 220 m there are low values of gamma ray, resistivity, and velocity due to borehole washouts. Below 550 m, resistive layers are identified in the imaged interval. These intervals are characterized by the spikes of high resistivity and velocity. Borehole breakouts are identified in the intervals from 597 to 650 m, oriented along a northeast–southwest strike. Bedding features show various directions and angles throughout the borehole. Fractures occur sparsely throughout the borehole, but a fracture cluster is located just below the sandy interval (~230 m).

Log-Seismic Integration

LWD logs were correlated to a depth converted version of seismic line 05CM-04 and high resolution seismic line TAN1404-P3106. The quality of the LWD data was sufficient for correlation, except for some gaps in compressional velocity and missing density at the top of the site. We were able to tie the main lithological units from the LWD data to seismic reflection units in the sequences that fill the North Tuaheni Basin and the transition to the underlying slope sequences. In particular, the image data match very well with the amplitudes and structures of

the reflections in the high resolution seismic data. The mismatches in depth between the seismic and log data will allow us to refine the velocity profile at the drill site in order to better convert the depth section.