IODP Expedition 372: Creeping Gas Hydrate Slides and Hikurangi LWD

Week 4 Report (18–24 December 2017)

Operations

The week began with the start of coring at Hole U1517B (proposed Site TLC-04B) at 0130 h on 18 December. Since a good mudline core was desired and Core U1517B-1H was recovered full, Hole U1517B was abandoned at 0200 h. The vessel stayed in position, raised the bit by 4 m, and coring in Hole U1517C started at 0210 h on 18 December. The water depth was determined to be 720.9 m.

Cores U1517C-1H and 2H penetrated to 15.2 m before switching to the half-length advanced piston corer (HLAPC) to recover a silt-rich interval. Cores U1517C-3F to 14F (15.2–71.6 m) were taken before switching back to the full-length APC for Cores U1517C-15H to 18H (71.6–108.3 m), all of which had partial strokes. The HLAPC was redeployed for Cores U1517C-19F to 36F (108.3–188.5 m). Of these, Cores U1517C-19F, 20F, 22F, 23F, 25F to 28F, and 30F to 36F all recorded partial strokes. All full-length APC cores were oriented and seven formation temperature measurements were made (Cores 15H, 17H, 20F, 23F, 26F, 29F, and 34F). A total of 177.8 m of core was recovered from the 188.5 m interval (94%).

After completing operations at Site U1517 at 1310 h on 19 December and a short 20 nmi transit, the ship arrived at Site U1518 (proposed Site HSM-15A) at 1635 h. The logging-while-drilling (LWD) bottom-hole assembly (BHA) and drill pipe was run to 300 mbsl and the LWD tools were tested. After the test, assembly of the drill string continued. The LWD tool string contained the geoVISION, SonicScope, NeoScope, TeleScope, proVISION, and StethoScope tools.

The LWD tools and drill string were run to 2460 mbsl and the subsea camera was deployed to determine the depth of the seafloor. While the camera descended, 115 ft of drill line was cut off. The seafloor was tagged at 2636.4 mbsl. The camera was brought to the surface and the top drive installed. Hole U1518A began at 0855 h on 20 December. Weather conditions and sea state deteriorated over the next few hours and the logging tools were pulled out of the hole at 1605 h, ending Hole U1518A. LWD data was collected from 0 to 117 m. The ship began waiting on weather and was offset 20 m to the southeast of Hole U1518A. At 1310 h on 21 December, an attempt was made to begin Hole U1518B; however, the sea conditions were still too rough and prevented the start of the hole. After an additional 3 h of waiting on weather, Hole U1518B successfully began at 1600 h and LWD operations continued to 372.7 m. After logging a portion of the thrust fault zone, the tools were pulled up to 334.7 m. Three pore pressure measurements were attempted using the StethoScope tool, all with poor results. The tools were then pulled up to 234.0 m to try three additional StethoScope measurements; these were unsuccessful as well. The tools were lowered back to the bottom of the hole, a mud sweep was used to clean the hole, and the tools advanced to 372.7 m. LWD continued to a total depth of 600 m. After finishing the

hole, we circulated a mud sweep to clean out the hole, and pulled out of the hole. The bit cleared the seafloor at 1825 h on 23 December.

The bit arrived back on the rig floor at Hole U1518B at 0100 h on 24 December. The ship was secured for transit at 0257 h and arrived at Site U1519 (proposed Site HSM-01A) at 0530 h after a 15.4 nmi transit. The LWD BHA was assembled and contained the geoVISION, SonicScope, NeoScope, TeleScope, proVISION, and StethoScope tools. The LWD tools and drill string were deployed to 952 mbsl and the tools were tested before starting the hole. Hole U1519A began at 1200 h and by midnight the bit had advanced to 221.1 m. Real time LWD data include the ultrasonic caliper, resistivity, gamma ray, porosity, annular pressure, nuclear magnetic resonance, and resistivity images. The annular pressure is being closely monitored for safety.

Science Results

The Core Description team scanned and described all cores from Hole U1517C. The cores are dominated by repeated greenish-gray, graded beds characterized by fine sand to clayey silt. Deformation features are distributed through the uppermost ~60 m of the core. Volcanic tephra occur throughout but are particularly prevalent towards the lower part of the hole (180–187 m). Five units were defined based on the lithological characteristics and core physical properties. These units correlate well with identified seismic facies of the Tuaheni landslide and the underlying sedimentary sequence.

Physical properties measurements for Hole U1517C included the whole-round track systems, thermal conductivity, moisture and density, and strength and velocity measurements. Core samples have low porosities (~44%) starting a few meters below the seafloor. A porosity shift occurs at ~66 m, with values increasing to 48% below this depth. *P*-wave velocity and strength measurements on cores were compromised or prevented by gas disturbance below 20 m. Thermal conductivity measurements yield values averaging 1.2 W/(m·K) in the cored section. Magnetic susceptibility and natural gamma ray measurements are being integrated with the core descriptions and the Hole U1517A LWD results.

The Downhole Measurements team provided an initial analysis from Hole U1517A for lithology and hydrate interpretation for the subsequent coring of Hole U1517C. The group received the initial files downloaded from the LWD tools and the processed data from the SonicScope and proVISION tools. Each Downhole Measurements subgroup worked on figures and the initial interpretation for the Site U1517 report. Basic resistivity image processing, selection of dip and fracture orientations, identification of logging units, and basic descriptions are ongoing. Six main logging units are identified based on resistivity, velocity, and neutron porosity. Indications for gas hydrate were found from 106–150 m in thin intervals that ranged from ~30 cm to below the resolution of the resistivity logging measurements (~5 cm). Hydrate saturation was calculated

and saturations in some layers reached 60%. In addition, the Downhole Measurements scientists were responsible for safety monitoring during drilling.

The Log-Seismic Integration subgroup extracted seismic wavelets from the seafloor near Site U1517 as the basis for producing synthetic seismograms. The velocity and density logs were edited prior to combining them to make reflectivity series in depth. The extracted wavelet was convolved with the series to produce synthetic seismograms that were then used to correlate features on the seismic line to log-produced features from the synthetic seismograms.

The advanced piston corer temperature tool (APCT-3) was deployed seven times in Hole U1517C. Four successful deployments between 81 and 132 m define a linear temperature-depth profile with a gradient of 39.8°C/km. This gradient combined with the average thermal conductivity measured on cores yields an estimate of vertical conductive heat flow of 49 mW/m^2.

The Geochemistry Laboratory processed 74 interstitial water (IW) whole rounds and completed analyses of alkalinity and major anions. Pore water alkalinity has two maxima at ~17 and 70 m, with values of 19 mM and 37 mM respectively. The sulfate–methane transition zone is observed at 15 m, consistent with the observed increase in methane at this depth. Chlorinity was measured by titration and by ion chromatography (IC) with good agreement between the data sets. IW samples in the zones of expected gas hydrate presence were selected guided by infrared camera scans; the Cl data in these samples indicate the presence of discrete gas hydrates occurrences between ~135 to 165 m. Preliminary analyses yield gas hydrate saturation values (S_h) from 5% to 9% in five of the gas hydrate bearing samples, 10%–18% in two samples, and >50% saturation in three samples. A single maximum of ~60% of the pore space occurred in a thin (5 mm) coarse dark layer in Section U1517C-25F-1 at 136 m. A total of 62 headspace samples were taken from cores of Hole U1517C to measure the composition of hydrocarbons for safety measurements. Within these samples methane concentrations significantly increased to concentrations of 1% starting at depths below 16 m. Very low concentrations of ethane might be present at around 160 m; however, concentrations are at the detection limit. Sample analysis for total organic carbon and inorganic carbon is underway.

Education and Outreach

Ten live video broadcasts were completed this week with elementary, junior high, and high schools in the United States and with the Georgia Sea Turtle Center. The broadcasts included ship tours, explanations of expedition science, information about ocean careers, and Q&A sessions with scientists and technical staff. Two members of the science party had an interview with the podcast show "Futureproof."

Seven original posts were made to Twitter (https://twitter.com/TheJR), five posts to Instagram (http://instagram.com/joides_resolution), and 11 posts to Facebook (https://www.facebook.com/

joidesresolution). Eight blog posts were made and posted to the http://joidesresolution.org web page. Topics included interviews with individuals on the ship and topics related to activities at sea.

Technical Support and HSE Activities

IODP JRSO technical staff engaged in various maintenance projects, laboratory technical cross-training, as well as preparing for coring operations.

Laboratory Activities

- Bathymetric data was collected during the transit from Site U1517 to Site U1518.
- H_2S sensors were calibrated.
- The sample grabber in the XRD was not picking up samples and is starting to fail.
- A service call has been scheduled to repair the liquid nitrogen generator.
- Preparing shipping papers for refrigerated and frozen shipments.

Application Support and I.T. Activities

- LIME 4.4 was released to fix the display image editor.
- Working to plot new DESClogik columns in LIVE.
- Work has started on updating the IMS application on the superconducting rock magnetometer (SRM).
- CorelDraw was installed on PCs.
- The Sharp copier is broken and a service call is being scheduled.

HSE Activities

- The technical staff completed the weekly check of the safety showers and eyewash stations.
- The weekly fire and boat drill was held on 24 December.