IODP Expedition 375: Hikurangi Subduction Margin

Week 5 Report (1–7 April 2018)

Operations

This week we finished the observatory installation at Site U1518 and started coring operations at Site U1520.

Hole U1518H

The week started with the installation of the CORK-II stage of the observatory. The 412 m long CORK-II casing string consisted of 342 m of 4½ inch drill pipe, two swellable-packer joints, one quadrant-seal joint, drill collars, and a bull nose. The CORK-II wellhead was attached to the running tool at 0245 h on 1 April, and the entire assembly was lowered inside the ACORK 10¾ inch casing until the CORK-II wellhead was ~17 m above the ACORK wellhead.

At 1230 h on 1 April, we assembled the 407 m long instrument string, consisting of ~365 m of Spectra rope carrying 30 miniature temperature loggers, the ~22 m long osmosampler package, weak links, sinker bars, and the top plug. The top plug was connected to the logging wireline and the instrument string was lowered slowly to the seafloor and then inside the CORK-II 4½ inch casing until the flow meter landed in the CORK-II seat at 323 m below seafloor (at 2105 h), followed soon after by the top plug latching inside the CORK-II wellhead. Next, the instrument string was released by activating the Electrical Release System (ERS) mechanism, the CORK-II landed inside the ACORK wellhead, and it was released from the running tool at 0020 h on 2 April, completing the observatory installation. The subsea camera and drill string were recovered, the beacon was retrieved, and we departed for Site U1520 at 0815 h.

Hole U1520C

Following an ~10 h deviation to the Gisborne Pilot Station for a personnel transfer, we proceeded to Site U1520, arriving at the coordinates of Hole U1520C at 1848 h on 2 April. We assembled a rotary core barrel (RCB) coring assembly and reentered Hole U1520C at 0525 h on 3 April. The next several hours were spent cleaning cuttings out of the inside of the 642 m deep casing that had been installed the previous week. RCB coring started at 1200 h on 3 April and continued until the end of the week. Cores U1520C-2R to 43R penetrated from 646.0 to 1044.5 m and recovered 234.15 m (59%). At midnight on 7 April, we were cutting Core 44R, the last core at this hole intended to penetrate a seismic reflection at ~1050 m.

Science Results

Science activities during the week included processing and measurements of Site U1520 core sections and shipboard samples, and collecting personal samples for postcruise research.

Lithostratigraphy

We observed two primary types of lithologies in Hole U1520C. Cores U1520C-2R to 4R are composed of greenish gray, slightly to moderately bioturbated, calcareous mudstone and marl indurated by a strong diagenetic overprint. Scattered interbeds include gray to dark gray volcaniclastic siltstone and tuff. Cores 5R to 9R are similar in composition, but with a better preservation of nannofossils. Cores 10R to 22R contain moderately bioturbated, variegated calcareous mudstone and marl with lower levels of diagenetic replacement. Colors vary in response to different admixtures of clay minerals and calcareous nannofossils. Distinctive deposits of a matrix-supported conglomerate display flow banding and colorful mixtures of clasts that include altered basalt, calcareous mudstone, marl, and chalk.

We observe a fundamental lithofacies shift in Core U1520C-23R, where a sharp depositional contact separates marl from pale olive green to light brown volcaniclastic coarse sandstone. Larger clasts in the polymodal grain-size distribution are angular to subrounded, poorly sorted, and range in size up to granules and pebbles. The dominant clast compositions include altered basalt and undifferentiated volcaniclasts. Intervals of matrix-supported grain fabric are most common. In some intervals, the primary grain fabric is clast supported, and interstitial space is filled by a pervasive calcite cement. The cemented zones show less chemical alteration. The finer matrix is poorly sorted and composed of clay minerals, basaltic volcaniclasts, altered glass shards, palagonite, and carbonate. The volcaniclastic lithofacies extends without interruption to Core 34R, where another interval of variegated marl occurs, before resuming in Cores 35R to 41R.

Biostratigraphy

Preliminary biostratigraphic results suggest that Hole U1520C recovered an early Late Miocene to Late Cretaceous sedimentary sequence. We subdivide the cored sequence into six sedimentary packages punctuated by hiatuses: Cores 2R–8R are early Late Miocene, Core 9R is Middle Miocene, Cores 10R–11R are Early Miocene, Cores 12R–14R are Late Oligocene, Sections 15R-7 through 23R-4 are Early to Middle Eocene with possible Late Paleocene reworking, and Sections 34R-2 through 34R-CC are Late Cretaceous.

Paleomagnetism

Our investigations focused on establishing a magnetostratigraphy based on magnetic inclination data obtained from Hole U1520C. Archive-half core sections were subjected to alternating field (AF) demagnetization up to a peak field of 30 mT. Additional AF and thermal demagnetization

experiments were conducted on discrete samples, which confirm the section results. We were able to identify 14 magnetic polarity intervals between 650 and 800 mbsf but have not assigned specific chrons to these. Between 800 and 850 mbsf all samples are affected by significant magnetic overprints, probably caused by minerals that have magnetic coercivities <20 mT. The volcaniclastic sediments recovered below 850 mbsf carry an exclusively normal polarity direction that is likely not primary. We infer that the volcaniclastic sediments were remagnetized in a normal polarity field following their emplacement in the Late Cretaceous.

Structural Geology

Calcareous mudstones and marls in the upper part of Hole U1520C typically exhibit gentle to horizontal bedding dips, except where disrupted within abundant soft-sediment debris deposits. Intervals of high-angle normal faults occur with generally downdip striations (for example, at 660–675 and 690–706 mbsf). Scattered subvertical fractures, both filled and open, are dispersed between 795 and 850 mbsf, but open fractures may have been enhanced by drilling disturbance. Several distinctive zones of more pervasive deformation are seen in the marly clays (for example, at ~720 and 765 mbsf). These intervals contain closely spaced planar to wavy dissolution seams, sometimes occurring in intersecting sets, and are probably related to compaction. Below 850 mbsf, lithified volcaniclastic deposits contain rare open fractures and quartz or calcite veins with variable orientations, increasing in abundance and thickness with depth. Broad zones of disseminated pore-filling calcite cement occur throughout the volcaniclastic section.

Geochemistry

We processed 35 whole-round (WR) samples in the Geochemistry Laboratory. In the pelagic sediment section of Hole U1520C, core sections were cut, capped, and taped on the catwalk, then immediately scanned on the Whole-Round Multisensor Logger (WRMSL). WR selection for pore water geochemistry was based on the gamma ray attenuation (GRA) density log in real time. In contrast, WR samples from the volcaniclastic section deeper in the hole were chosen and cut directly on the catwalk. Despite the high densities and cemented nature of the cored material, pore water was recovered in all units. Salinity, alkalinity, and chloride concentrations were determined in near-real time, and the remaining pore water was preserved for additional shipboard and shore-based geochemical analyses. Salinity values range from 34 to 37 PSU. Chloride concentrations decrease from 566 to 530 mM in the pelagic sediments, and are variable between 528 and 567 mM in the volcaniclastic section. Alkalinity was measured on select samples based on the volume of pore water recovered. Alkalinity values range between 0.4 and 0.7 mM in the pelagic sediments, and between 1.69 and 2.43 mM in the volcaniclastic sediments.

Physical Properties and Downhole Measurements

Porosity values in Hole U1520C decrease systematically with depth from 45% at 646 mbsf to 34% at 664 mbsf, followed by an increase to 48% at 690 mbsf. Between 690 and 750 mbsf,

porosity values are nearly constant with an average value of 30%. *P*-wave velocity values increase with depth from 2000 m/s at 646 mbsf to ~2400 m/s at 690 mbsf, and stay constant to 845 mbsf. Thermal conductivity values increase gradually from 1.2 W/(m·K) at 464 mbsf to 1.7 W/(m·K) at 700 mbsf, and stay constant to 840 mbsf.

Core-Log-Seismic Integration

We undertook a preliminary analysis of various logging-while-drilling (LWD) physical properties collected at Site U1520 during Expedition 372 to help characterize the site geology. We also made comparisons of velocity data from a preliminary full waveform inversion with other available prestack depth migrated seismic data. A synthetic seismic trace was generated using LWD logging data for the upper 750 mbsf of Hole U1520C. Logging data and seismic sections with depth estimates were provided to enable tracking of coring progress in the context of seismic reflections and to assist with operational decisions. Preliminary interpretations of seismic reflection stratigraphy were made in the deeper part of Hole U1520C.

Observatory

The observatory installation at Site U1518 was completed with the deployment of the CORK-II and instrument string. Observatory scientists met with IODP JRSO engineers and the Siem Offshore tool pusher prior to the deployment of the instrument string to finalize details, and they assisted during the deployment on the rig floor. Once the observatory was deployed, we started working on the Site U1518 report.

Education and Outreach

Live Broadcasts

This week we conducted four live broadcasts with schools and universities in Australia, New Zealand, and the United States. These reached 190 people, from elementary school to university students.

Social Media

We posted photos and videos (see below) on Facebook (https://www.facebook.com/joidesresolution), Twitter (https://twitter.com/TheJR), and Instagram (http://instagram.com/joides_resolution). Facebook had 8,223 followers, Twitter had 3,987 followers, and Instagram had 1,073 followers. We also promoted the "Ask-Me-Anything" Reddit session scheduled for 8 April.

Videos

Videos on the Site U1518 observatory pressure umbilical, on the CORK wellhead and valves, and on dolphins were posted on YouTube, Facebook, and in the observatory blogs listed below. We also started working on an animation of the observatory installation and other laboratory activities.

Blogs

We continued our series on the Site U1518 Observatory in the "Ship's log" on on http://joidesresolution.org.

Technical Support and HSE Activities

The following technical support activities took place during Week 5.

Laboratory Activities

- We processed cores from Hole U1520C including taking all samples with rock saws.
- Technical staff cross-trained on the Natural Gamma Radiation Logger (NGRL) and Spinner Magnetometer and reviewed the IODP Depth Scales with the Expedition Project Manager.
- We conducted coordination and troubleshooting between ship and shore Chemistry Technicians on methods to improve problematic results on the Natural Gas Analyzer (NGA).
- We reviewed the ship and shore websites' laboratory layout pages and links to user guides. Work will continue next week and updates will be submitted to the webmaster.

Application Support Activities

- We continued work on the Cahn Balance program.
- We made minor configuration and display adjustments to the *P*-wave velocity application.

IT Support Activities

- We dealt with daily loss of satellite connection caused by equinox solar interference.
- We conducted miscellaneous maintenance.

HSE Activities

- The IODP technical staff Marine Emergency Training Squad (METS) participated in a simulated fire drill.

- We held the weekly fire and boat drill as scheduled.
- We tested safety showers and eye wash stations.
- We inspected the chemical spill kits and related supplies.