IODP Expedition 376: Brothers Arc Flux

Week 2 Report (13–19 May 2018)

The second week of the International Ocean Discovery Program (IODP) Brothers Arc Flux Expedition (376) consisted of (a) installation of a reentry funnel and 10¾ inch casing to 94 m in Hole U1527B, (b) setting up the same reentry funnel and 10¾ inch casing string in Hole U1527C upon their inadvertent return to the vessel from Hole U1527B, and (c) rotary core barrel (RCB) coring from 99.9 m to a final total depth of 238.0 m in Hole U1527C. All times in this report are in ship local time (UTC + 12 h).

Operations

This week began while we were continuing casing operations in Hole U1527B, consisting of (1) assembling a mud motor, underreamer, and 9⅞ inch tri-cone bit; (2) connecting the hydraulic release tool (HRT) to the 10¾ inch casing assembly; and (3) attaching the reentry funnel and hard rock landing frame to the casing. At 1000 h on 13 May, we started lowering the entire 94 m long casing string and drilling assembly to the seafloor. We deployed the subsea camera system at 1530 h to observe the reentry system while drilling in the casing, and we began drilling it into the seafloor at 1715 h. At 2400 h on 13 May, the end of the casing had reached 34.3 m. On 14 May, we continued to drill in casing from 34.3 to 102.1 m, and we had to work several tight spots from 82 to 102 m. At 0030 h on 15 May, the pilot bit reached the final planned depth of 105.5 m, completing drilling in the 10¾ inch casing in Hole U1527B. We activated the HRT to detach the drilling assembly from the casing at 0114 h and began recovering the drill string and the subsea camera system. When we attempted to pull the HRT through the moonpool at 1010 h on 15 May, we observed that the reentry system was still attached to the drill string. We landed and dismantled the reentry system in the moonpool, and we were able to free the drilling assembly underreamer arms from the casing, which had hung up on the underreamer arms. When the drilling assembly was pulled up to the rig floor at 1530 h, we discovered that the pilot drilling bit was missing and the bit sub was also damaged. Upon examination of the damaged components, we determined that the bit most likely failed at 92 m and that its remains or material that broke off the bit sub came into contact with the underreamer arms and damaged them slightly while drilling continued to the final casing depth. This caused the underreamer arms to stick in the open position, which is how the reentry system managed to come back to the surface. After laying out the damaged equipment, we started to recondition the drilling assembly and reentry system for installation in Hole U1527C, 20 m south of Hole U1527B. The casing stinger assembly was shortened by ~5 m and the underreamer was exchanged.

On 16 May, we continued the reconditioning of the drilling assembly and reentry system and started lowering it to the seafloor at 0615 h. We picked up the 94 m long casing string and

reassembled the reentry funnel in the moonpool, welding the funnel and hard rock landing frame to the 10¾ inch casing. We deployed the subsea camera system at 0945 h to observe the reentry system while drilling in the casing. We picked up the top drive and started drilling Hole U1527C at 1130 h on 16 May. Drilling continued throughout the rest of the day and was completed at 0045 h on 17 May when the pilot bit had reached 99.9 m. Immediately after this was concluded, we deployed the go-devil to activate the HRT, which freed the casing at 0056 h. We then started pulling the drill string out of the hole, reaching the seafloor at 0315 h. We set back the top drive, retrieved the subsea camera system, and the bit returned to the rig floor at 1150 h on 17 May. After taking apart the drilling assembly, we flushed the mud motor and underreamer with fresh water. At 1300 h, we started making up the RCB bottom-hole assembly using a new RCB bit and lowered it to the seafloor. We deployed the subsea camera system and reentered Hole U1527C at 2014 h on 17 May. We picked up the top drive, dropped a core barrel, and recovered the subsea camera system. At midnight, the bit had reached the base of the casing and we began RCB coring from 99.9 m.

On 18 May, Cores U1527C-2R to 15R penetrated from 99.9 to 214.0 m. The first nine of these cores partially took only 10 min to cut and had no to extremely poor recovery (0 to 0.54 m), retrieving pebbles of unconsolidated volcanic deposits. While cutting Core 11R, we encountered a substantial formation change at ~187 m and core recovery increased to 29%. The time to cut Core 11R increased to 70 min. To enhance the core recovery even more, we decided to cut half-length cores (4.8 m), and recovery for the remainder of cores recovered on 18 May improved to 72%. We circulated 410 barrels of mud sweeps for hole cleaning at various depths. The change in formation was reflected in the lithology, intersecting a consolidated volcaniclastic breccia. On 19 May, Cores U1527C-16R to 20R penetrated the same formation from 214.0 to 238.0 m and recovered 8.5 m (35%). We pumped mud sweeps for hole cleaning at various depths. After cutting Core 20R at 0700 h, we observed a tight hole and had to work it from 234 to 125 m with high drill string torque and poor hole conditions, leading to stuck pipe at 125 m (30 m below the end of the casing string). We pumped mud sweeps at 234, 145, and 130 m. At 2045 h on 19 May, we offset the vessel ~75 m to access a drill pipe connection at the rig floor to retrieve Core 20R and to release the bit in an attempt to free the drill string. We offset the vessel to the original position at 2230 h and continued to work the stuck drill string from 125 to 116 m with high torque.

Science Results

Scientists spent the first half of the week continuing to acquire, analyze, and write up Hole U1527A data, as well as preparing the corresponding presentations and reports. Later in the week, they described and analyzed the cores recovered from Hole U1527C. Scientists also attended talks on the alteration mineralogy of magmatic-hydrothermal systems studied at the surface of Brothers volcano and selenium-tellurium mineralization in magmatic-hydrothermal

system studied in the volcanic-hosted massive sulfide deposits of the Troodos ophiolite complex (Cyprus).

Core Description

The igneous petrologists and volcanologists continued to develop microscopic and macroscopic descriptors for the DESClogik program. We submitted and revised a draft of our Methods section and wrote up the results for Hole U1527A. The portable X-ray fluorescence (pXRF) spectrometer was calibrated and multiple standard reference materials were analyzed to determine the accuracy and precision. X-ray analysis of powdered samples confirmed a dacitic composition for all samples recovered from Hole U1527A. Two thin sections from Hole U1527A were described: both represent slightly altered, moderately vesicular plagioclase-clinopyroxene phyric dacite. Thin sections revealed glomerocrysts with aggregates of euhedral-subhedral plagioclase, clinopyroxene, and minor Fe-Ti oxide. In Hole U1527C, Core 1R through 10R revealed lithologies similar to Hole U1527A, comprising an unconsolidated volcaniclastic deposit, even though any attempt for a correlation between the holes is compromised by the very low recovery. From Core 11R downwards, recovery increased significantly and the lithology changed from a slightly altered plagioclase-clinopyroxene phyric dacite lava with moderate to high vesicularity to a moderately to strongly altered, generally non-vesicular, matrix-supported, polymict lapilli-tuff to tuff breccia, containing at least three different types of lapilli- to block/bomb-sized volcanic clasts (altered plagioclase phyric dacite, altered medium-grained clasts, fresh fine-grained clasts). Work is in progress to further characterize the cores recovered in Hole U1527C (down to Core 20R), using macroscopic, microscopic, and pXRF techniques.

The alteration petrologists and mineralogists continued to refine and formalize their workflow and descriptive terminology, based on the core recovered during the past week. Importantly, criteria agreed upon for definition of "Degree of Alteration" continued to evolve, and will likely do so as more core is examined and the range of alteration styles within Brothers volcano becomes clearer. For Site U1527, two highly contrasting styles of alteration have been intercepted. Relatively fresh dark gray dacite in both Hole U1527A (Cores 1R to 15R) and Hole U1527C (Cores 2R to 10R) contained only minor zeolite coatings of vesicles and Fe-oxyhydroxide. In contrast, strongly pervasively altered breccia of yellowish brown to greenish blue color characterizes the high recovery sections lower in Hole U1527C (Cores 11R to 20R). In these highly altered intervals, almost all of the primary igneous minerals have been replaced by secondary alteration minerals such as chlorite, sericite, clay, silica, magnetite, and trace disseminated pyrite. Chlorite alteration appears to be pervasive throughout these intervals. Breccia clasts show a range of degree of alteration, from rare fresh clasts, to abundant completely altered clasts. Yellow-brown sericite(?) alteration occurs as repeating meter-scale intervals with sharp contacts that appears to overprint earlier chloritic alteration. The alteration mineralogy will be confirmed and updated with results from XRD analysis and thin section observations.

Paleomagnetism

The initial part of Week 2 was spent processing six discrete dacite samples from Hole U1527A. Three samples were treated for AF demagnetization and the remaining three were treated for thermal demagnetization. After removal of a soft drilling overprint, the samples coherently showed an inclination of the primary component of the magnetization which is aligned with the inclination of the geomagnetic field at the latitude of Brothers volcano, suggesting the Hole U1527A lavas formed during the current normal polarity chron. After these demagnetization experiments, the samples were also subjected to isothermal remanence magnetization experiments. We also worked on the Methods section and finalizing the Hole U1527A report. Finally, the first eight archive half sections from Hole U1527C were measured, using the superconducting cryogenic rock magnetometer and the data analyzed to optimize working half discrete sampling.

Geochemistry

During Week 2, the geochemistry team analyzed rock samples from Hole U1527A against certified calibration standards for inorganic carbon content via coulometry, for total carbon, total nitrogen, and total sulfur via elemental analyzer, and for major, minor, and trace elements via inductively coupled plasmas–atomic emission spectroscopy (ICP-AES). Instrument blanks and detection limits were defined for each method, and optimal wavelengths for ICP-AES were identified. Data processing is ongoing. Initial ICP-AES bulk rock results corroborated the dacitic composition of Hole U1527A lavas. Calibration and blank tests were also performed on the gas chromatography thermal conductivity detector (GC-TCD) in preparation for molecular hydrogen determination on borehole fluid samples. The geochemistry Methods section was updated to reflect new information derived from the analysis of calibration standards. Headspace gas measurements for methane and hydrogen were performed on rock samples from Hole U1527C. In anticipation of reactive, low pH conditions within the borehole environment, Kuster Flow-Through Sampler (FTS) contamination tests were performed by cleaning the fluid sampler with acetone and deionized water, reassembling into the deployment configuration, and filling with (1) fresh deionized water and (2) unfiltered drilling seawater. After 12 h at 20°C, reacted waters were expelled through the valve assembly. Pre- and post-test waters will be processed alongside samples following analytical methods for borehole fluid geochemistry. The Kuster FTS was then cleaned and outfitted with high-temperature resistant Kalrez o-rings to prepare it for downhole sampling.

Petrophysics

The petrophysics group submitted the Methods sections for Physical Properties and Downhole Measurements and write-ups on the fluid inclusion technique and experiments specifically designed for this expedition. The Kuster FTS was assembled to make it available for fluid contamination tests carried out by the geochemistry team. In collaboration with the geochemists,

Kuster FTS sampling protocols have been established. Also, experiments for measuring downhole temperatures continued. The use of borehole temperature monitoring strips that began last week was abandoned in the housing tool at the core barrel head due to doubtful temperature measurements. Instead, they have been successfully tested in the Sediment Temperature Tool (SET) for >55°C. In addition, specifically designed thermometers made of glass capillary tubes were proven to withstand subsea pressures during a run with the subsea camera system and will be used to supplement and complement other thermometric methods. For trapping borehole fluids, the technical staff designed and constructed a perforated brass holder for gold foil-wrapped fractured crystals that were provided by downhole logging scientists and put into two recesses on the sides of the coring bit used in Hole U1527C. Unfortunately, this bit had to be left in the hole and was not retrieved. This experiment will be continued at Site U1528.

Physical properties measurements were completed for cores from Hole U1527A. Variation in *P*-wave velocity with lava porosity were found to be consistent with previously published data from andesitic lavas in New Zealand. Physical properties measurements have begun on cores from Hole U1527C, including successful measurement of thermal conductivity, which is comparable to similar lithologies in other magmatic-hydrothermal settings. A new workflow is being trialed to rapidly obtain *P*-wave velocities of principal lithologies soon after cores arrive on deck. The aim is that these data can then be used to refine existing seismic interpretations of expected depths of drilling targets, while drilling is still in progress.

Microbiology

The microbiologists set up the sampling, procedures, and GC for analysis of volatile components and tracer contamination experiments. We also finalized our Methods section. We obtained microbiology samples derived from the hard rocks recovered from >150 m in Hole U1527C. We performed initial perfluoromethyl decaline (PFMD) tracer contamination tests and started measurements for volatiles such as H_2, CO, CH_4, and H_2S. We are processing our data and we have begun shipboard prokaryote incubation experiments.

Education and Outreach

The Education and Outreach (E&O) team successfully conducted several live events with museums, exhibitions, and schools in New Zealand and the United States. Highlights included live interactive events with (1) the Museum of New Zealand Te Papa Tongarewa that focused on the technical capabilities and facilities of the *JOIDES Resolution* (JR) and introducing IODP in general (74 attendees in Wellington) and (2) the IODP exhibition "In Search of Earth's Secrets." The E&O team began working on a 360° JR tour project, developed thin section resources for schools, worked on classroom activities addressing the biodiversity of hydrothermal vents and convection of hydrothermal plumes, and started an acrylic painting project that utilizes the ship's wobbling as the artist. Preparations are ongoing to conduct a tour in Māori for a Māori school.

One scientist was assisted in an outreach event to her university. Two other scientists from Japan and China, respectively, were set up for blog posting. Four blogs were posted on http://joidesresolution.org. Overall, there have been 18 social media posts this week on Facebook (https://www.facebook.com/joidesresolution), Twitter (https://twitter.com/TheJR), and Instagram (http://instagram.com/joides_resolution). Facebook had a weekly reach of ~13,000 users; the most popular posts were the reentry cone splash (4,600 reached) and "core on deck" video (3,800 reached). On Twitter, 13 tweets garnered 67,300 impressions, 2,114 profile visits, 86 mentions, and 46 new followers. Instagram registered 150 views for three posts. One YouTube video on the casing operations in Hole U1527B was uploaded (168 views to date).

Technical Support and HSE Activities

During this week, the IODP JRSO technical staff continued supporting the science operations at Site U1527.

Laboratory Activities

- Underway Geophysics Laboratory:
  - Work continues to reorganize the laboratory to create more storage space for items transferring from the Upper Tween storage.
- Fantail:
  - Work on the port level wind system refurbishment:
    - System was fully dismantled and individual parts serviced;
    - Siem Offshore mechanic made the necessary alterations to the new cable sheave;
    - The new sheave, bushings, and acme screw drive nut were reassembled;
    - The level wind was fully installed and tested;
    - Additional work is still needed on the chain tensioner.
- Water Column Temperature:
  - We are routinely using the advanced piston corer temperature tool (APCT-3) to measure the water temperatures profile.
  - Staff have been running laboratory tests to determine the response time of the tool to water temperature changes.
  - A CTD package selected by technical staff has been recommended to management that can provide real time data via the telemetry pod.
- Physical Properties:
  - Velocity application upgraded to support velocity anisotropy measurements on whole-round pieces.
  - Testing continues on a new program algorithm for the *P*-wave measurement that does not use a threshold detection procedure and accurately picks the first arrival.

- Other support activity:
    - Technical staff fabricated a crystal holder that attaches to the outside of the bit body. This has been designed to house shocked quartz crystals so that they are exposed to the formation fluids as part of a geochemical downhole study.
    - A pivoting support was fabricated for the Kuster FTS to allow the gas phase to be separated from the fluid phase during the sample extraction.

IT Support Activities

- Upgraded Extreme Networks EMC software to version 8.1.2. Improvements include updated NAC agents and web management capability.
- Implemented the new build server on the JR (removed old server Pinatubo from service) and upgraded another server to Windows Server 2016.

Application Support Activities

- Updated velocity application to support whole-round measurements on the caliper.
- Updated LORE report addenda to show (sample/test/result) comments for *P*-wave velocity (PWC), PWC discrete, and X-ray diffraction (XRD) report.
- LIVE 4 distributed.
- LabVIEW 2017 updates. Spare imager (SHILb) updated. KappaBridge instrument host updated, including rebuild of AMSSpin.
- BuildJR now on Windows 2016; old server Pinatubo retired.

HSE Activities

- Technical staff completed the weekly check of safety showers and eyewash stations.
- Held the weekly fire and boat drill as scheduled.