

IODP Expedition 376: Brothers Arc Flux

Week 8 Report (24–30 June 2018)

Week 8 of the International Ocean Discovery Program (IODP) Brothers Arc Flux Expedition (376) consisted of (a) rotary core barrel (RCB) coring in Hole U1531C, (b) installing casing in Holes U1531D and U1531E, (c) turbine-driven coring system (TDCS) and RCB coring in Hole U1531E. All times in this report are in ship local time (UTC + 12 h).

Operations

This week began while we were RCB coring in Hole U1531C. Cores U1531C-2R to 3R penetrated from 15 to 28.4 m. Cores U1531C-1R to 3R overall recovered 2.25 m (8%). We pumped mud sweeps at 23, 25, and 28.4 m. We experienced tight hole conditions throughout coring, facing high torque and frequent overpull, so Hole U1531C was abandoned at 28.4 m. At 0815 h on 24 June, we started pulling the drill string out of the hole, and it cleared the seafloor at 0845 h. We set back the top drive, continued raising the drill string, and the bit arrived at the rig floor at 1340 h, ending Hole U1531C. Inspection of the bottom-hole assembly (BHA) revealed massive wear on the outside diameter of the bottom three drill collars and the mechanical bit release. We then decided to install a reentry system with short casing string to establish a stable hole for reaching deeper coring and logging objectives at Site U1531. We made up a BHA with a 12¼ inch tri-cone bit, an 11¾ inch underreamer (set to 16½ inch), and a mud motor. At 2200 h on 24 June, we assembled a reentry system with 16 m of 13⅜ inch casing, a reentry funnel, and a hard rock landing frame. After the drilling BHA was lowered through and attached to the reentry system, at 0500 h on 25 June, we started lowering the entire reentry system to the seafloor. At 0800 h, we deployed the subsea camera and sonar system, continued lowering the drill-in casing assemblage, and picked up the top drive. We started drilling the casing into the seafloor in Hole U1531D at 1030 h. It reached a total depth of 19 m at 1445 h. We then deployed the go-devil to activate the hydraulic release tool (HRT). It released the reentry system, but we were unable to pull the drilling assembly clear of the casing string, as the underreamer arms did not retract completely. We attempted to free the reentry system for 3.5 h unsuccessfully, so we decided to pull the drill string and attached reentry system out of the hole and back to the vessel. After the bit cleared the seafloor at 1835 h, we offset the vessel 400 m to the east. We set back the top drive, retrieved the subsea camera and sonar system, and continued raising the drill string. While we were retrieving the casing and drilling assembly to the surface, the reentry system and casing unfortunately dropped off the drilling assembly at 2310 h, in sight of the moonpool with doors open, while picking up the last drill collar. We began taking apart the drilling BHA, and the bit arrived back at the rig floor at 0045 h on 26 June. We then started making up a new drilling BHA with a 12¼ inch tri-cone bit, an 11¾ inch underreamer (set to

16½ inch), and a mud motor to drill 16 m of 13¾ inch casing into Hole U1531E. This hole is located on the saddle between the Upper and Lower Cone of Brothers volcano. We tested the mud motor and underreamer at 0530 h and continued assembling the BHA, but then had to stop operations for 7 h due to inclement weather. At 1545 h on 26 June, we began assembling the casing string, but had to stop operations again at 1900 h as the weather deteriorated. The next 24.25 h were spent waiting on weather to improve enough to resume operations. At 1915 h on 27 June, we continued connecting the drilling BHA (mud motor, underreamer, and drill bit) to the casing string. After welding the casing system, we attached the reentry funnel and hard rock landing skirt. We opened the moonpool doors and started lowering the casing and reentry system to the seafloor at 2350 h. After deployment of the subsea camera and sonar system at 0230 h on 28 June, we continued lowering the casing assembly, picked up the top drive, and positioned the vessel to start drilling. We started Hole U1531E at 0705 h, and by 1545 h we had drilled down to 17.9 m, working through tight spots. We then deployed the go-devil to activate the HRT to release the drilling assembly from the casing. We were initially not able to retrieve the drilling assembly from the casing string and had to work the drilling assembly to get the underreamer arms to close. After it released from the casing at 1605 h, we raised the drill string above the top of the reentry funnel and observed that the casing had been lifted 4.2 m while we were trying to release. This left the base of the casing shoe at 10.7 m below the seafloor. We then recovered the subsea camera, set back the top drive by 1730 h, and recovered the drill string to the rig floor. We flushed the mud motor and underreamer with fresh water and disassembled the HRT components and the BHA. At 0030 h on 29 June, we began making up the CDEX turbine-driven coring system (TDCS) for running a second test on this expedition. We assembled the TDCS core barrels and BHA, including a 9⅞ inch polycrystalline diamond compact (PDC) bit. We started lowering the TDCS BHA to the seafloor at 0530 h, deployed the subsea camera and sonar system at 0845 h, and picked up the top drive. We then reconfigured the TDCS core barrels and conducted a “drop test” deployment, i.e., dropped the core barrel and retrieved it prior to reentry. We reentered Hole U1531E at 1347 h on 29 June, lowered the drill string to ~8 m below seafloor, and flushed the interior of the casing. While recovering the subsea camera, we checked for fill below the end of the casing at 10.7 m. At 1430 h, we deployed a TDCS core barrel, washed down to the bottom of the hole at 17.9 m, flushed it with two back-to-back high-viscosity mud sweeps, and retrieved the TDCS core barrel (ghost core U1531E-2G; 0.5 m of fresh dacite pebbles). The next TDCS barrel got stuck in the BHA and could not be recovered after three attempts. We then terminated the TDCS test and started pulling the drill string out of the hole. It cleared the seafloor at 2045 h. We set back the top drive and recovered the drill string, and the bit arrived back on the rig floor at 0110 h on 30 June. We then made up a RCB BHA and started lowering it down to the seafloor. We deployed the subsea camera and sonar system at 0915 h. We then continued lowering the drill string, picked up the top drive, and maneuvered the vessel for reentry. At 1133 h on 30 June, we reentered Hole U1531E. After recovering the subsea camera, we reassembled the rig floor, pumped a 40-barrel high-viscosity mud sweep to clean the hole, and lowered the bit until it encountered hard fill at 9 m below seafloor (inside the casing).

At 1245 h, we dropped a RCB core barrel and washed back to bottom of the hole at 17.9 m (Core U1531E-4G; containing dacitic lapilli). We then cut half-length Cores U1531E-5R to 7R from 17.9 to 30.5 m and recovered 0.6 m (5%). We had to pump multiple high-viscosity mud sweeps to keep the bottom of the hole clean to be able to keep coring.

Science Results

This week, scientists continued to describe and process cores from Site U1531 as well as work on collecting, analyzing, and writing up results from Sites U1530 and U1531. Scientists held a Site U1530 science summary meeting for the laboratory groups to present their results and submitted their Site U1530 reports. We also held two sampling parties for postcruise research.

Core Description

The Igneous Petrology/Volcanology team continued logging cores from the Lower Cone Site U1531 (Cores 376-U1531C-1R to 3R, U1531E-2G to 4G and 5R) as they were recovered, and selected samples for shipboard analyses together with other laboratory specialty groups. Cores U1531C-1R to 3R (0–23.75 m), U1531E-2G to 4G (no depth advance), and U1531C-5R to 9R (17.90–34.95 m) recovered unaltered fragments of moderately vesicular, plagioclase-pyroxene phyric dacite lava. Portable X-ray fluorescence spectrometer (pXRF) analyses indicated a very similar chemical composition to the unaltered Brothers dacites recovered from Hole U1527A and Site U1529. Microscopic analyses revealed slight mineralogical differences relative to the previous sites, most notably by the presence of orthopyroxene.

The Alteration group continued to describe and document alteration mineralogy and textures of material recovered from Site U1531 based on macroscopic and microscopic observations of four thin sections (Holes U1531A–U1531E). Cores from Site U1531 are classified as unaltered to slightly altered with smectite as the major alteration mineral. Rarely, vesicles are lined with iron-oxyhydroxides intergrown with zeolite minerals and subordinate native sulfur and document their slightly altered nature. The rock material lacks any perlitic texture.

The main structures at Site U1531 include volcanic fabrics and fractures. Volcanic fabrics are well developed in fragments of dacitic lava, ranging from weak to strong. Fabrics are defined by elongated vesicles, plagioclase microlites, and to a lesser extent plagioclase phenocrysts and glomerocrysts. Fabric dip ranges from moderate to steep. A few pieces have lineations defined by vesicles; all plunges are subparallel to the dip. Several core pieces from all holes of Site U1531 have microfractures delineated by the growth of halite in thin delicate desiccation cracks under the laboratory atmosphere after pieces are cut and dried. Discrete fractures are best preserved in Hole U1531C. Fractures range from shallow to steep and are typically marked by a secondary mineral such as native sulfur or iron-oxyhydroxide.

Geochemistry

Geochemical analysis of five samples from Holes U1531A–H1531C and duplicate samples from Hole U1530A was performed via inductively coupled plasma–atomic emission spectroscopy (ICP-AES) and elemental analysis. Unaltered lavas from Hole U1531 are typical dacites, with SiO_2 ranging from 62.3 to 64.5 wt% and $\text{Na}_2\text{O} + \text{K}_2\text{O}$ ranging from 6.3–6.5 wt%. The similarity of major elements in fresh dacites from Sites U1527, U1529, and U1531 confirms the low compositional range previously observed in dacites at Brothers volcano. Water-soluble sulfate extraction experiments were finalized for Site U1528 by quantitatively extracting anhydrite by shaking rock powders with deionized water for 12 h, followed by analysis via ion chromatography and ICP-AES. Additional tests were also performed to evaluate the effect of shipboard rock powder preparation methods (e.g., water cleaning of core wedge) on dissolution of anhydrite and other water-soluble minerals. Using a relatively anhydrite-rich sample from Hole U1530A (tuffaceous mudstone of Igneous Unit 2), it was found that the amount of dissolved Ca and S released in water rinses only accounted for ~3% of the total anhydrite present in the rock.

Paleomagnetism

During this week, we completed the last measurements of the magnetic properties of discrete samples from Hole U1530A, which confirmed a general direction consistent with the geomagnetic field at the location of Brothers volcano, with slightly shallower inclination ($\sim -50^\circ$) relative to the inclination directions from samples at Sites U1527 and U1528. We also measured five archive-half sections and five discrete samples from the first cores recovered from Site U1531. These fresh dacite rocks are characterized by large natural remanent magnetization (NRM) intensities, and a stable primary magnetization component with an inclination very close to the geomagnetic field inclination at the location of Brothers volcano.

Petrophysics

Physical properties data were obtained for cores from Holes U1531A, U1531B, and U1531C. Density, porosity, P -wave velocity, magnetic susceptibility, and natural gamma ray measurements made on limited, fragmented core recovered from these holes are consistent with fresh dacitic lavas and tephras, and are similar to values determined for Igneous Unit 1 at Sites U1527, U1528, and U1529.

Downhole Formation MicroScanner resistivity images suggest the presence of numerous fractures and veins along the logged interval from Hole U1530A. Further onshore analysis will continue on the downhole measurements performed in Hole U1530A. We also prepared the Elevated Temperature Borehole Sensor (ETBS) tool and the Kuster Flow-Through Sampler (KFTS) tool for the final temperature logging and fluid sampling runs, respectively, which are planned in Hole U1528D.

Two sets of experimental crystals were recovered from the RCB coring bit in Hole U1531C and from the TDCS PDC bit in Hole U1531E. The bronze holder from Hole U1531C showed a green patina and some CuSO_4 precipitates, and the calcite crystals exhibit dissolution. These findings indicate presence of corrosive fluids in Hole U1531C.

Microbiology

During Week 8, the Microbiology team processed one fresh volcanic rock sample from Hole U1531C (Core 1R-2, 44–51 cm) for postcruise onshore investigation. A total of eight drilling fluid and perfluoromethyl decaline (PFMD) contamination test samples from Holes U1531A–U1531D were collected to analyze the concentration of tracers, following our increasing the rate of PFMD tracer injected during coring at Site U1531.

Education and Outreach

Week 8 saw the number of live events continue to taper off with the conclusion of the USA school year. In total, we conducted five events to a total audience of 363 people in various countries around the world including the USA, New Zealand, and Mexico. We successfully presented our final event in a four-part series to the Museum of New Zealand Te Papa Tongarewa with an emphasis on the trials, tribulations, and triumphs of Expedition 376. We conducted a videoconference meeting for Women in Geothermal Energy (WING). This live event hosted nine different connections simultaneously, initiated by shipboard scientists who are members of WING, with a varying audience size at each place joining the call. The participants received an introduction to Brothers volcano and a ship tour.

On 29 June, the *JOIDES Resolution* passed her fortieth anniversary of launch as *Sedco/BP 471* in 1978. We conducted a Facebook Live Stream event on this day which included a *JOIDES Resolution* trivia quiz and a “pin the reentry cone” on Brothers volcano game with scientists and staff in the stream. This event had 248 viewers.

With less streams to prepare and conduct, additional time was spent on producing outreach content and the development of ongoing projects for postcruise activities. We made three posts on the *JOIDES Resolution* blog (<http://joidesresolution.org>), including an information graphic of an extremophile microbe named after a microbiologist sailing with us, a post about the moonpool, and a gallery of images taken from thin sections from Brothers volcano. Development of curriculum material continued as well.

Five “Scientist Spotlight” videos were produced covering Microbiology, Alteration Mineralogy, Physical Properties, Igneous Petrology, and Paleomagnetism.

It was a very successful week for our social media. On Facebook (<https://www.facebook.com/joidesresolution>), our posts reached 15,428 people and engaged 4,634. The most popular post

was a Scientist Spotlight video with a focus on alteration mineralogy (5,300 reached, 997 engagements). Our videos on Facebook accrued a total of 7,457 views. Twitter (<https://twitter.com/TheJR>) saw four posts during this week, with 121 total engagements and 5,183 impressions. Instagram (http://instagram.com/joides_resolution) had four posts, with a total of 282 likes; the most popular post was a video of thin sections rotating, comparing fresh minerals to altered minerals—this video had 333 views.

Technical Support and HSE Activities

During this week, IODP JRSO technical staff continued to support science operations at Site U1531 and preparations for a return to Site U1528 to perform additional borehole fluid sampling and temperature measurements. Sampling of recovered material from Sites U1530 and U1531 was conducted. Also, staff started end-of-expedition cleanup and began preparing the offgoing shipments.

Laboratory Activities

- No issues to report.

Application Support Activities

- JR6A Spinner Magnetometer: We reuploaded treatment series that were recoded, e.g., from Alternating Field to Isothermal Remanent Magnetization measurements. We implemented a cleanup for duplicated data from the reupload cycle.
- Whole-round line scanner (WRLSC): We uploaded the remaining surface composite images. We repaired the (Expanded WRLSC) report used for quality assurance inspection of the individual surface image scan components.
- DescLogik Core Description Software: We chased the root cause for a DescLogik upload failure, but we can't repeat the failure. We conducted debugging of DescLogik data retrieval anomaly, caused by recovery of multiple ghost cores in a row with differences in depths.
- Data Publishing Web Service Project: We continued addition, debugging, and testing of new services for static page generation and modification.
- Natural Gamma Ray: We carried out LabVIEW 2017 distribution on the instrument HP Z240 that will become the new instrument host during the upcoming dry dock period.

IT Support Activities

- We assisted with troubleshooting a central processing unit (CPU) utilization issue with the Subsea Digital Video Recorder (DVR) computer. When the DVR software is running, CPU utilization ramps up to 100%. We have found that this issue seems to be related to a

specific serial interface for telemetry data. We will troubleshoot further when the subsea camera system is back on board.

- An Acronis Backup and Data Protection Software issue preventing backups from running has been corrected and instrument host backups are completing normally. The issue was related to an outdated configuration file pointing to the old software location on the storage server.

HSE Activities

- Technical staff completed the weekly check of safety showers and eyewash stations.
- We held the weekly fire and boat drill on 26 June as scheduled.