

IODP Expedition 393: South Atlantic Transect 2

Week 8 Report (24–30 July 2022)

In Week 8 of International Ocean Discovery Program (IODP) Expedition 393, South Atlantic Transect 2, we continued coring volcanic rocks in Hole U1560B (proposed Site SATL-25A) with a second bit from 219.2 to 316.2 meters below seafloor (mbsf). After changing to an advanced piston corer/extended core barrel (APC/XCB) bottom-hole assembly (BHA), we reentered Hole U1560B and collected good downhole logs to the base of the hole with three downhole logging tool strings. Finally, Hole U1560C was cored to 129.3 mbsf and was the last hole of the expedition. The week ended with the vessel in transit to Cape Town, South Africa, at a speed of 10.5 kt.

Operations

Hole U1560B

As Week 8 started, the second bit of Hole U1560B was approaching the bottom of the hole and was ready to start coring. We found 1 m of soft fill and at 0030 h we restarted coring from 219.2 mbsf. Cores U1560B-22R to 41R penetrated from 219.2 to 316.2 mbsf and recovered 36.35 m (37%). There were no problems with torque and a 30–40 barrel mud sweep was run after every core to flush out any cuttings. At 2320 h on 26 July 2022, the decision was made to stop coring to leave time for downhole logging and a sediment hole at this site.

Basement coring at Hole U1560B had started at 124.0 mbsf, the depth of the existing hole, but the depth to the sediment/basement contact is not precisely known because the uppermost basement may have been partly drilled when drilling in casing during Expedition 395E in April 2021. True depth to the basement contact may be a little shallower, but not shallower than 122 mbsf, the depth of the casing shoe. Cores U1560B-2R to 41R penetrated from 124.0 to 316.2 mbsf (192.2 m of basement rocks), recovering 74.8 m (39%). Of the two C-7 rotary core barrel (RCB) bits deployed in Hole U1560B, bit number one drilled for 52.3 h over a 95.2 m interval with 38.44 m of recovery (40%), and bit two drilled for 42.5 h over a 97.0 m interval recovering 36.35 m of basalt (38%).

With ship heave increasing through the day to an extent where it would have not only posed problems for the downhole logging tools but also provide poor quality data, it was decided not to drop the RCB bit on the seafloor for logging. Instead, we decided to change to an APC/XCB bit and log through that, to give time for the heavy seas to subside, as forecasted. The RCB bit was raised to the ship, clearing the seafloor at 0225 h on 27 July and the rig floor at 0905 h. The bit, mechanical bit release, and RCB parts of the BHA were removed and replaced with an APC/XCB BHA. The RCB bit had been used for 42.5 drilling hours and had some wear to the inner teeth but was otherwise in good condition. We replaced it with a polycrystalline diamond

compact (PDC) bit for APC/XCB coring rather than the typical APC/XCB roller-cone bit, because the narrower diameter of the PDC bit ($9\frac{7}{8}$ inch compared to $11\frac{7}{16}$ inch) would allow it to reenter casing at Hole U1560B for downhole logging. The lockable float valve (LFV) was locked open to allow the logging tools to pass.

From 1115 h we lowered the bit to the seafloor and deployed the subsea camera to guide reentry. At 1755 h we reentered Hole U1560B and set the bit at 27.7 mbsf in the casing for downhole logging. From 2025 h we assembled the triple combo downhole logging tool string, consisting of magnetic susceptibility, electrical resistivity, density, neutron porosity, and natural gamma tools, and started lowering it down the pipe. It reached the base of the hole, 316 mbsf, and completed one pass in the open hole (122 to 316 mbsf) and a second pass from 316 mbsf through the open hole and casing to the seafloor. The triple combo was raised back to the ship and the Formation MicroScanner (FMS)-sonic tool string was assembled. At 0645 h on 28 July we started to lower it down the pipe. The bottom of the tool was kept 5 m off the bottom of the hole (311 mbsf) to prevent damage to the bottom part of the FMS tool. The tool made two passes in the open hole. After the second pass, one of the caliper arms would not fully close, remaining open by 0.2 inch and causing difficulty at first to bring the tool into the base of the BHA. However, we were able to bring the tool string to the surface without damage. We assembled the Ultrasonic Borehole Imager (UBI) tool string, and at 1545 h we lowered it down the pipe. This tool string also reached 311 mbsf and made two passes in the open hole, and was back on the rig floor at 2245 h. We rigged down the Schlumberger logging equipment and started pulling the bit out of Hole U1560B, clearing the seafloor at 2355 h. A total of 9.9 days (238.5 h) were spent on operations in Hole U1560B.

Hole U1560C

The ship was offset 10 m to the north in preparation for coring Hole U1560C. An XCB core barrel was deployed to close the LFV in the BHA, which had been set open for the previous day's downhole logging. The bit was set at 3721.7 m below sea level (mbsl) and at 0245 h on 29 July we started Hole U1560C. Core U1560C-1H recovered 6.5 m, placing the mudline depth at 3724.7 mbsl. To correct the stratigraphic overlap with cores from Hole U1560A, cored in April 2021 on Expedition 395E, we drilled ahead by 2.0 m at 15 mbsf (drilled Interval U1560C-3-1). Cores U1560C-1H to 15F penetrated from seafloor to 112.8 mbsf and recovered 111.9 m (101%). Advanced piston corer temperature (APCT-3) tool measurements were made on Cores U1560C-5H, 8H, and 11H. While taking the Core 11H APCT-3 measurement, the APC core barrel became stuck in the formation, and it required three drillover attempts and 160,000 lb overpull to free it. The APC piston rods had twisted during the process and as a result we switched over to half-length advanced piston corer (HLAPC) coring from Core U1560C-12F. The drill crew worked between cores to straighten the piston rods for the full-length tool.

After Core U1560C-16F reached 117.5 mbsf we switched to the XCB coring system in anticipation of reaching basement at approximately the depth it was found in Hole U1560A, 120.2 mbsf. Basement was found at 129.0 mbsf in Hole U1560C, 9.8 m deeper than in Hole U1560A. The two holes are only 10 m lateral distance apart, and the difference in basement depth reflects the rugged basement surface topography that is typical of slow/intermediate spreading rate ridges. Core U1560C-17X drilled a further 0.3 m into the basement and recovered two ~5 cm pieces of basalt. It was the last core of the expedition. Cores U1560C-1H to 17X cored from seafloor to 129.3 mbsf and recovered 122.75 m (96%). Nonmagnetic core barrels were used on all APC and HLAPC cores, and all full-length APC cores were oriented using the Icefield orientation tool.

From 0530 h on 29 July, the rig floor team coated the core line and then raised the bit to the ship, clearing the seafloor at 0900 h and the rig floor at 1655 h. The BHA was disassembled and stowed for transit and 115 ft of drill line was slipped and cut. We raised the thrusters and started the transit at 1930 h. The ship completed 48 nmi of the 1816 nmi voyage to Cape Town.

Science Results

During Week 8, the science party processed and described basement Cores U1560B-22R to 41R and sediment cores from Hole U1560C, and made an initial assessment of the downhole logging data from Hole U1560B.

Petrology

The petrologists made macroscopic descriptions, portable X-ray fluorescence spectrometer (pXRF) measurements, and took images of the core exterior with the Deutsche Montan Technologie (DMT) scanner of basement cores from Hole U1560B. The ~192 m of penetration in Hole U1560B completes the collection of basement cores to address the basement science objectives of the South Atlantic Transect. Microscopic description of Hole U1560B thin sections is ongoing. Volcanic basement recovered at Site U1560 was dominated by variably aphyric to moderately plagioclase-olivine phyric pillow basalts, with several significant units of 1–2 m sheet flows and an 11 m massive flow. The lavas have been split into six main stratigraphic units, with breccias recovered in the last core of the hole. Both relatively fresh and strongly altered basalts were recovered, with alteration being generally stronger in the lower half of the hole.

Lithostratigraphy

The sedimentology team described sediments from Hole U1560C. The succession at Hole U1560C consisted of 129.0 m of predominately nannofossil ooze with variable amounts of clay and foraminifers. Foraminifers were common in the upper 40 m and in the lower 20 m. Two

layers with slightly higher clay content were observed that could represent a shallowing of the carbonate compensation depth during these time intervals.

Geochemistry

This week the geochemistry team completed inductively coupled plasma–atomic emission spectroscopy (ICP-AES) hard rock runs 6, 7, and 8, which finalized ICP-AES analysis on Hole U1560B and all other Expedition 393 hard rock samples. pXRF analyses on these sample powders was also completed. We collected interstitial water (IW) samples from Hole U1560C for ion chromatography (IC), ammonium, and phosphate analyses, which are ongoing, and other analyses to be made in the last week of the expedition. Sediment samples have been freeze-dried, powdered, and are now being analyzed for total carbon, total nitrogen, and wt% carbonate content.

Igneous rocks from Sites U1583 and U1560 (on 30.6 and 15.2 Ma crust, respectively) are geochemically similar to each other. The rocks have variable TiO₂ contents, suggestive of varying degrees of magma chamber differentiation of the basaltic lavas before eruption. In terms of alteration, both sites show only moderate increases in K₂O, but they show distinctive patterns of MgO depletion, suggesting that seafloor weathering processes play a large role in their alteration history.

Microbiology

The microbiology team collected approximately one sample per 10 m advance of basement in Hole U1560B and sediment in Hole U1560C, for preservation for shore-based analysis. Before processing the basement whole rounds, they were imaged using the Foldio lightbox/turntable system. All sampling was done within the KOACH system, a portable air filtration unit that creates a particle-free area for low-contamination sampling. Subsamples from the microbiology whole rounds from these cores were preserved for cell counts and analysis of community DNA, RNA, and lipids for postexpedition research.

Micropaleontology

This week the team worked on the biostratigraphy of Site U1560 and constructed a robust age-depth model in conjunction with the paleomagnetic team. Shore-based scientists conducted micropaleontological analyses of core catcher samples from Hole U1560A. Sediments at Site U1560 are middle Miocene to Pleistocene in age, consistent with the expected age of the crust at this site, ~15.2 Ma. There appear to be no major hiatuses.

Paleomagnetism

The paleomagnetism team finished measurements on basement cores of Hole U1560B and sediment cores of Hole U1560C. Continuous measurements of remanent magnetization before and after three different alternating field (AF) demagnetization steps (5, 10, and 20 mT) were

made using the superconducting rock magnetometer (SRM) to provide a polarity stratigraphy for Hole U1560C and collaborate with the biostratigraphers on an age-depth model. A total of 15 additional basalt cubes were sampled and measured from Hole U1560B cores this week, making a total of 28 throughout the hole. The recovery rate of the basement cores was highly variant (0%–84%), and no samples were taken from some cores that had very low recovery. From Hole U1560C, a total of 26 cubes were taken and measured, which is about two per core. All of the samples were subjected to susceptibility measurements and AF demagnetization up to 190 mT step. For a subset of selected basalt samples, thermal demagnetization up to heating step of 580°C was applied. Isothermal remanent magnetization (IRM) measurements were applied to all of the basalt samples and 10 of the sediment samples.

Physical Properties and Stratigraphic Correlation

The physical properties specialists completed analyses on basement core and samples from Hole U1560B and processed all sediment core material from Hole U1560C. This included running all whole-round sections through the Natural Gamma Radiation Logger (NGRL) and Whole-Round Multisensor Logger (WRMSL), as well as making discrete measurements of moisture and density (MAD), *P*-wave velocity on both sediment and basement samples, and shear strength (automated vane shear [AVS]), compressional strength (penetrometer), and thermal conductivity on sediment working halves. In addition, all sediment archive halves were X-ray imaged.

Hole U1560C has ~5 m thick layers with elevated magnetic susceptibility and NGR values, the highest amplitude of them centered on 52, 59, and 90 mbsf, which mark layers richer in clay minerals. Hole U1560C sediments have a mean thermal conductivity of 1.24 ± 0.02 W/m·K ($\pm 1\sigma$), a mean bulk density of 1.70 ± 0.06 g/cm³, and mean porosity of $60.5\% \pm 4.3\%$.

Stratigraphic correlation between Hole U1560A (cored during Expedition 395E) and Hole U1560C was established while coring by means of density and magnetic susceptibility data acquired on the Special Task Multisensor Logger (STMSL).

Three wireline logging tool strings were run successfully in the basement section in Hole U1560B, reaching the bottom of the hole at every pass. In particular, two full passes each with the FMS-sonic (high resolution resistivity images of the borehole wall) and the UBI (360° acoustic images) will, after speed correction and other processing, provide a way to orient fractures and constrain the stratigraphy of intervals with incomplete recovery.

Education and Outreach

This week the Onboard Outreach Officer made 35 new posts (crossposted on each of the social media sites), ran ten ship-to-shore video tours, and wrote a post for the JR Expedition Log.

Social Media

- [Twitter](#) has an average of 44 engagements (minimum is 18 and maximum is 96) per post, and an engagement rate of 2.6%.
- [Facebook](#) posts reached 5,146 people, with 252 page views and 4 new followers.
- [Instagram](#) posts reached ~2,591 accounts, engaged 316 accounts, and has 6 new followers, 7 unfollows.
- We gave ten ship-to-shore video tours to a total of ~190 people, including to a group of ~60 students at the University of Ghana and to 11 students in the Earth History class at the University of Washington.
- [JOIDES Resolution website](#) has two new blog posts: “Sharing the knowledge and discussing representation,” and “Thank you to the Ship crew (from a scientist on board).”

Technical Support and HSE Activities

Technical staff supported core processing, science laboratories, and downhole logging at Site U1560. All cores have been split and final core processing and sample analysis is underway. Group photos were taken.

Laboratory Activities

- Conducted successful downhole logging of Hole U1560B with triple combo, FMS-sonic, and UBI tool strings.
- The seventh and last bottom water sample for this expedition was collected with the Niskin bottle on the vibration isolated television (VIT).
- Repaired a hard rock epoxy “gun.”
- Group photos were taken on the bow and were processed.
- The X-Ray source on the X-ray image logger was changed following user guide setup. Shielding was checked and lead sheeting metallic supports were installed where needed.
- The Section Half Multisensor Logger (SHMSL) bulb was changed on 28 July.
- Updated the confluence manual for ICP-AES sample preparation to specify that sediments, or samples high in carbonate, need to be weighed and ignited for loss on ignition (LOI) measurements in ceramic crucibles instead of quartz, as advised by science party geochemist. Sediments ruin the quartz crucibles.
- X-ray diffraction (XRD) petrology samples are complete and XRD sediment and carbonate samples are ongoing.

Health and Safety Activities

- Conducted showers and eye wash safety checks.
- Safety boat drill.