IODP Expedition 393: South Atlantic Transect 2

Week 6 Report (10–16 July 2022)

In Week 6 of International Ocean Discovery Program (IODP) Expedition 393, South Atlantic Transect 2, we cored basement rocks in Hole U1583F at the middle site of the transect on 30 Ma crust (proposed site SATL-33B), and we prepared for downhole logging operations in that hole.

Operations

Hole U1583E

As the week began we were raising the bit to the ship after completing sediment coring in Hole U1583E, with the advanced piston corer (APC) barrel stuck in the base of the bottom-hole assembly (BHA). We continued to raise the pipe from 414 meters below sea level (mbsl) and the bit reached the rig floor at 0435 h on 10 July 2022, ending Hole U1583E. The rig floor team then disassembled the lower part of the BHA and found that the APC core barrel assembly had stuck in the landing saver sub because a shear pin had become wedged between the landing seat and the core barrel. The APC cutting shoe was undamaged. Core U1583E-12H penetrated from 99.0 to 105.2 meters below seafloor (mbsf) and recovered 6.13 m (99%).

Hole U1583F

At 1000 h on 10 July we began assembling the rotary core barrel (RCB) BHA and then lowered it down to 4174 mbsl, where we paused to slip and cut the drill line and pick up the top drive. At 0030 h on 11 July we started RCB Hole U1583F and washed down through most of the sediment column to 101 mbsf (Drilled Interval U1583F-1-1). Core U1583F-2R penetrated from 101.0 to 109.5 mbsf and recovered 6.4 m (76%) of clayey nannofossil ooze. At the start of drilling Core U1583F-3R the basement was contacted at 109.7 mbsf. Coring continued to Core U1583F-8R at a depth of 142.9 mbsf. With a hole in basement established, a free fall funnel was deployed at 1450 h on 12 July to aid in reentry if needed to deepen the hole or to log. Coring continued with a typical half-core advance of 4.8 m. From Core U1583F-12R there was up to 3 m of backfill in the hole after each core, and the drill string experienced high torque at times. We ran a 30-60-barrel mud sweep after every core to flush out the cuttings. The last five cores averaged only 7% recovery and the bit had been run for ~73 h of drilling time, so coring was terminated at 1230 h on 16 July after recovering Core U1583F-29R. Hole U1583F reached 129.8 m into basement, and Cores U1583F-3R to 29R penetrated from 109.5 to 239.5 mbsf and recovered 39.4 m (30%).

To prepare for wireline logging in Hole U1583F we ran a 75-barrel mud sweep, released the RCB bit at the bottom of the hole, and set the end of the pipe at 102.8 mbsf. At 1730 h we began to rig up the triple combo logging tool string, consisting of natural gamma radiation, neutron porosity, density, and electrical resistivity tools. The radioactive source was left out of the

density tool. The tool string was lowered down the pipe, but at 540 mbsl it developed an electrical fault and had to be raised back to the ship. By midnight on 16 July the fault had been found in the electrical resistivity tool so we replaced it with the backup resistivity tool.

Science Results

During Week 6, the science party processed and described basement rocks in Cores U1583F-3R to 29R and sediments in Cores U1583E-12H and U1583F-2R.

Petrology

Macroscopic description of Hole U1583F, core surface portable X-ray fluoresence spectrometer (pXRF) measurements, and Deutsche Montan Technologie (DMT) image scanning were completed. Production and description of thin sections continues. Three eruptive sequences comprising seven units and 11 subunits were differentiated in Hole U1583F, with the sequences split by sedimentary breccias, which were remarkably well recovered. Volcanic rocks consist mostly of aphyric to moderately plagioclase-olivine-(augite) phyric pillow lavas, with lesser sheet flow units and one 10–15 m thick massive flow at the top of the hole (Unit 1). pXRF was used to analyze cut core surfaces at approximately 0.5 m spacing, and this workflow is now sufficiently streamlined that downhole data was available during core description, with steps in Cr concentrations corroborating the petrologically defined unit boundaries (e.g., between Units 4 and 5). The basalts in Hole U1583F are somewhat less altered than in the transect holes drilled in older crust, with relict fresh olivine and glass present through much of the upper sequence, but overall alteration intensity increases downhole. A complex series of green-gray-brown alteration haloes are present in the upper sequence, and gray-brown alteration halos dominate in the lower two sequences. Oxidation and alteration is also present in the breccias, and veins were logged in detail throughout the hole.

Lithostratigraphy

Two sediment cores were described this week, both from immediately above the sediment/basement contact. Cores U1583E-12H and U1583F-2R are nannofossil ooze with clay. The sedimentology team focused on writing up the descriptions from Holes U1583A–U1583E.

Geochemistry

Sediment and water (interstitial water [IW] and Rhizon) samples from Hole U1583C were analyzed this week. Sediments have, on average, ~80 wt% $CaCO_3$, and most units and subunits are close to the hole average apart from the clay-rich Unit II which has much lower values of calcium carbonate, with some samples reaching near zero wt% carbonate. Total organic carbon (TOC) measurements average ~0.15% wt% TOC and show a gradual decrease with depth in the sediments, with a relatively large peak of ~0.4 wt% TOC at ~83 mbsf (Unit IVB; interbeds of calcareous ooze, nannofossil ooze, and clayey nannofossil ooze).

Ion chromatography (IC) measurements (Ca, Mg, K, SO_4, Na, Cl, Br) of IW and Rhizon water samples from Hole U1583C yield significant trends downhole. With the exception of Mg, most elements (Ca, K, SO_4, Na, Cl, Br) show an increase in concentrations from 0 to ~20 mbsf (clayey nannofossil ooze in Unit II and clay with clayey nannofossil ooze in Unit III). Unit IVA (~18–82 mbsf; nannofossil ooze with clay and foraminifera interbedded with clayey nannofossil ooze) is mostly uniform with depth in Mg, K, Na, Br, and a gradual decrease from higher concentrations (from the bottom of Unit III) to uniform concentrations is seen in the first ~10 m of Unit IVA in Ca, SO_4, Br, Cl, and Na. Concentrations of Ca, K, and SO_4 increase slightly towards the bottom of the hole (Subunits IVB and IVC). Mg is uniform downhole in Unit II (0 to ~11 mbsf), decreases sharply with depth in Unit III (~11–18 mbsf), and then gradually decreases from Subunit IVA to IVC (nannofossil ooze with clay, foraminifera, and calcareous ooze). B, Li, and Si (measured by ICP) show similar profiles to that of K, with a more dramatic increase in Si concentrations observed within Subunit IVC. pH (7.5 to 7.9) and alkalinity (2.0 to 2.6 mM) show opposing trends throughout the hole, and a positive correlation ($R^2 = 0.37$) is observed between Ca concentrations and alkalinity.

Data collection from Hole U1558F basement samples started with the completion of powder pXRF measurements and the first inductively coupled plasma–atomic emission spectroscopy (ICP-AES) runs; data are currently being processed. Samples from Expedition 390 Sites U1556 and U1557 are being rerun on the ICP-AES and the dataset was shared with our Expedition 390 colleagues.

Microbiology

The microbiology team collected approximately one basement sample per 10 m advance in basement in Hole U1583F, where recovery was sufficient, 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. Sample handling was conducted using an ethanol-washed steel rock box and chisels. 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. To test the contamination of drilling fluid, we collected the inner and outer rock chips containing perfluorocarbon tracer (PFT) (perfluoromethyldecalin [PFMD]) from each whole-round, until we exhausted the supply of tracer during Core U1583F-12R (as anticipated).

Micropaleontology

This week the team worked on the biostratigraphy of Site U1583 and constructed an age-depth model in conjunction with the paleomagnetists. In preparation for the next site, Site U1560, shore-based scientists were conducting micropaleontological analyses of the core catcher samples from Hole U1560A, which was drilled during IODP Expedition 395E. Shipboard and shore-based team members also prepared their Site U1583 chapter sections.

Paleomagnetism

The paleomagnetism team conducted continuous and discrete measurements on basement cores and samples from Hole U1583F. Continuous measurements were performed using the superconducting rock magnetometer (SRM) to monitor remanence magnetization before and after 3 different alternating field (AF) demagnetization steps (5, 10, and 20 mT). A total of 16 basalt cubes were collected and measured from Hole U1583F cores. The samples were mostly from less altered gray background basalt with a few more altered samples containing brown or orange halos. They reveal mostly clear characteristic remanent magnetization (ChRM) as expected from fresh igneous rocks. ChRM components mainly display positive inclination, which indicates reversed polarity. It is notable that there is a high variation in median destructive field (MDF) between basaltic cubes from Hole U1583F.

Physical Properties and Stratigraphic Correlation

The physical properties specialists continued processing basement core material from Hole U1583F. 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, and thermal conductivity, at a resolution of least one per core when the material recovered allowed for it. All whole-round track measurements were completed for Hole U1558F and they show two intervals with noticeably elevated magnetic susceptibility (MS). The highest magnetic susceptibility occurs between ~112–119 mbsf, in the massive lava flow making up Lithologic Unit 1, and a smaller peak occurs between ~158–162 mbsf, in the basaltic sheet flows of Lithologic Subunit 3B. Twenty-seven discrete measurements of thermal conductivity were made on hard rock core pieces covering a range of lithologies and alteration intensities, with a mean thermal conductivity of 1.62 ± 0.18 W/m·K (±1 standard deviation) for the hole. Discrete sample measurements are ongoing. To date, 13 samples have been processed from Hole U1583F and they show an average bulk density of ~1.8 g/cm^3 in the lowermost sediment and ~2.8 g/cm^3 in the basement. In addition to these petrophysical measurements, all relatively cylindrical core pieces were scanned using the DMT core scanner prior to being split, and all sediment archive half sections from Holes U1583C and U1583E were run through the X-ray image scanner.

Education and Outreach

This week the Onboard Outreach officer made 27 new posts (crossposted on each of the social media sites), ran seven ship-to-shore video tours, and wrote a post for the JR Expedition Log.

Social Media

- Twitter has an average of 57 engagements (minimum is 11 and maximum is 372) per post, and an engagement rate of 2.77%, with 60 additional followers.

- Facebook posts reached 6,848 people, with 221 page views and 8 new followers.
- Instagram posts reached ~1,700 accounts, engaged 286 accounts, and has 15 new followers, 8 unfollows.
- We gave six ship-to-shore video tours to a total of ~125 people, including to the Two Oceans Aquarium in Cape Town.
- The *JOIDES Resolution* website has two new blog posts, including "Thank you to the Siem crew (the best problem solvers)"

Technical Support and HSE Activities

Technical staff supported core processing and science laboratories at Site U1583.

Laboratory Activities

- Finished last bottle of PFMD microbiological contamination tracer, as anticipated.
- The source rock analyzer (SRA) is fully functional again.
- Section Half Imaging Logger (SHIL) images were checked for quality control.
- All of the breccia basement cores were fully documented with close-up images.
- Icefield magnetic orientation tool (MOT) 2052 was tested after ~57 h deployment on Core U1583-12R and is fully functional even after extreme accelerations while trying to retrieve the stuck core barrel.
- The cover of the Section Half Multisensor Logger (SHMSL) light source's RS-232 connector was replaced after the previous one was discovered to be loose, causing loss of communication during measurement.
- It was observed that SHMSL sensors occasionally drag hard rock pieces during measurement because the instrument moves on the X-axis before the Y-axis has completed its movement up. We are troubleshooting this problem, but in the meantime the safety clearances were increased and the speed and accelerations of the X- and Y-axis were reduced. It is recommended not to lift the hard rock pieces above the core liner plane when preparing the section for scanning.
- Troubleshooting and testing the X-ray imager to investigate source ramping issues.
- Set up a "dark" area in the Microscopy Laboratory for UV scanning of sections and smear slides to look for any sedimentary organic matter.
- Worked with the sedimentologists to improve the level of detail in the visual core description (VCD) lithology column.

IT Support Activities

- Updated Adobe products on the PCs.
- Helped the Imaging Specialist upload CloseUp images and discussed ways of improving the workflow.

Health, Safety, and Environment Activities

- Conducted showers and eye wash safety checks.