

IODP Expedition 393: South Atlantic Transect 2

Week 5 Report (3–9 July 2022)

In Week 5 of International Ocean Discovery Program (IODP) Expedition 393, South Atlantic Transect 2, we completed operations at Site U1558, reaching the target of ~200 m of basement coring, and moved to Site U1583 (proposed Site SATL-33B), the middle site of the transect located on 31 Ma crust, where we cored sediment down to the basement contact at Holes U1583C and U1583E. Holes U1583A, U1583B, and U1583D each consisted of single missed mudline cores. This week we encountered some challenges. While pulling the bit out of Hole U1558D, the reentry cone and casing were pulled out the seafloor by the bottom-hole assembly (BHA), ending operations in that hole. In Hole U1583E, the advanced piston corer (APC) barrel became stuck inside the BHA and took 1.5 days to recover.

On 6 July 2022, the scientists and representatives of the ship's crew held a ceremony on the bow to honor the life of IODP scientist Dick Kroon, 1957–2022.

Operations

Hole U1558D

When the week began we had been coring Hole U1558D for five days, and had reached a depth of 326.6 meters below seafloor (mbsf). Cores U1558D-31R to 39R penetrated from 326.6 to 370.2 mbsf and recovered 18.9 m (43%), reaching 203.4 m into basement to meet our 200 m basement target depth for this site. At 0330 h on 4 July we set back the top drive and pulled the bit up to 126.3 mbsf, observing 20,000 lb drag. At 0445 h we deployed the subsea camera to observe the bit release and guide reentry, in preparation for downhole logging. We pulled the bit out of the hole to 4317 m below sea level (mbsl), 17 m above seafloor. However, at 0615 h the drill pipe was observed by the subsea camera to be still inside the reentry cone, with the cone much higher up than it should be. The extra weight on the drill string confirmed that the cone and casing had been pulled out of the hole by the BHA. From 0730 to 0830 h we attempted unsuccessfully to free the casing by pushing into the seafloor. We raised the camera back up to the ship, and from 1030 to 1100 h we attempted to free the drill string from the casing by rotation. A weight decrease of 30,000 lb was observed on the hook load indicator. The subsea camera was deployed again and at 1345 h we observed that the cone had fallen away and that some of the BHA drill collars appeared to be bent, but the casing hanger and casing crossover were still attached. The decision was made to retrieve the drill string and deal with any casing at the surface. When the drill string reached surface, however, the casing hanger and casing were no longer attached. The bit cleared the rotary table at 0215 h on 5 July. We disassembled the BHA, examined it for damage, and set aside the bottom three drill collars, one of which was slightly bent. We then secured the rig floor for transit and raised the thrusters, ending operations at Hole U1558D and Site U1558.

Transit

At 0530 h on 5 July we started the 227 nmi transit to Site U1583 (proposed Site SATL-33B) and arrived at 0300 h on 6 July. The transit took 21.5 h at an average speed of 10.6 kt.

Site U1583 (SATL-33B)

The ship switched to dynamic positioning (DP) mode at 0315 h, beginning operations at Hole U1583A. On site, we noted a 41 m discrepancy between the precision depth recorder (PDR) 12 kHz depth estimate of 4234 mbsl and the prospectus seafloor depth estimate of 4193 mbsl. Ship heave was 3–4 m. The APC/extended core barrel (XCB) BHA was made up and lowered down to 4229 mbsl, 5 m above the PDR estimated depth.

Holes U1583A and U1583B

At 1545 h we started Hole U1583A. Core U1583A-1H recovered 9.14 m and the mudline depth could not be determined. At 1715 h we started Hole U1583B with the drill bit 5 m shallower; Core U1583B-1H recovered 9.38 m and the mudline depth again could not be determined.

Hole U1583C

We moved 10 m to the north, pulled the bit up 10 m shallower to 4214 mbsl, and at 1845 h we started Hole U1583C and recovered a mudline at 4214.6 mbsl. Coring continued with the full-length APC system with the Icefield orientation tool run on each core. Temperature measurements were taken on Cores U1583C-4H, 7H, and 10H. Core U1583C-12H hit hard rock when it was fired, based on some damage to the cutting edge of the APC shoe. This was confirmed when the bit encountered hard formation 2 m below the top of the Core 12H at 104.5 mbsf. This depth was ~33 m shallower than expected from the site survey seismic interpretation of basement depth at ~138 mbsf. The XCB coring system was then deployed for Core U1583C-13X, which penetrated 3 m to 107.5 mbsf and recovered 1.9 m of basaltic rock. The bit was then pulled out of the hole, clearing the seafloor at 1540 h on 7 July, and ending Hole U1583C. Cores U1583C-1H to 13X penetrated from 0 to 107.5 mbsf and recovered 110.2 m (102%).

Hole U1583D

We started Hole U1583D 50 m to the south of Hole U1583C and 20 m to the south of the preexpedition site coordinates, which will be the location for hard rock coring in Hole U1583F. Core U1583D-1H recovered 10.04 m and the mudline depth could not be determined. Coring was terminated and Hole U1583D ended at 1730 h on 7 July.

Hole U1583E

We raised the bit by 5 m and at 1835 h we started Hole U1583E in the same location. Core U1583E-1H recovered a mudline at 4210.1 mbsl. While retrieving Core U1583E-2H, the core

winch weight indicator showed that the core barrel had become detached from the core winch line. An overshot was made up using a core catcher and a rotary core barrel (RCB) core barrel. The barrel was lowered and the APC core barrel was retrieved. Coring continued to Core U1583E-12H to a depth of 105.2 mbsf. All were full length APC cores with the Icefield orientation tool run all but two (Cores U1583E-3H and 4H). Temperature measurements were taken on Cores U1583E-3H and 8H.

After cutting Core U1583E-12H, the APC core barrel could not be pulled back into the BHA. From 1230 to 1545 h on 8 July we tried to free the barrel by pumping and washing over it, but it would not move. We decided to deploy the Kinley wireline cutter and crimper tool to cut the winch core line just above the APC corer. The Kinley cutter was deployed at 1610 h and the hammer/actuator was deployed at 1640 h. However, based on the core winch line tension, the Kinley cutter had stopped before reaching the bottom of the drill string and cut part way down. Approximately 1560 m of core winch line was pulled up to the ship and we then started to raise pipe. The drill pipe was pulled out of the hole to a depth of 2562 m below rig floor (mbrf) when the severing tool was found in stand number 83. A second Kinley cutter was deployed in an effort to sever the remaining core winch line from the sinker bar assembly. This was unsuccessful and the rig crew continued to pull the drill string out of the hole, cutting and removing the remaining core winch line at each stand. The second severing tool was found at the top of stand 55. The rig crew continued to pull the drill string to surface, cutting and removing the core winch line as before. By midnight on Saturday 9 July, the bit had reached 425.5 mbrf. Cores U1583E-1H to 12H penetrated from 0 to 105.2 m and recovered 105.2 m (100%).

Science Results

During Week 5, the science party processed and described basalt in Cores U1558D-31R to 39R and Core U1583C-13X and sediment cores from Holes U1583A–U1583E.

Petrology

The macroscopic description and Deutsche Montan Technologie (DMT) scanning of cores from Hole U1558D were completed. The description of thin sections continues. Cores U1558D-23R to 39R (287.8–370.2 mbsf) form a single unit (Unit 5) with 5 subunits. Unit 5 consists of a sequence of pillow, sheet, and a massive flow of sparsely to moderately plagioclase-olivine-phyric basalt with distinctive bimodal plagioclase shapes. Unit 5B shows variolitic textures. Unit 5D contains continuous recovery of a single massive flow that is at least 2.95 m thick and the center of this flow shows the coarsest groundmass grain size of Hole U1558D.

The hydrothermal alteration in Hole U1558D is dominated by the abundance of alteration halos that develop from chilled margins and flank hydrothermal veins. Strong orange colored halos appear in Core U1558D-15R at 244.1 mbsf and are present until the base of the hole and are generally associated with pillow margins extending >50 mm into the pillow interior. In Unit 5, a

further alteration type appears that is recognized by a mixed gray-brown appearance and is generally (but not exclusively) associated with the variolitic texture. A total of 2964 veins have been individually logged in Hole U1558D and contain calcium carbonate, clays, Fe-oxyhydroxides, zeolites, and some sediment infill.

Lithostratigraphy

The sedimentology group described lithology, ichnology, mineralogy, and core disturbance of all sediment cores from Site U1583 based on visual core description, smear slide analysis, X-ray diffraction (XRD) analysis, and carbonate content. Core U1583C-1H is mainly nannofossil ooze with clay, Core 2H contains a 6 m thick interval of pelagic clay, and Cores U1583C-3H to 12H are mainly nannofossil ooze with clay. Hole U1583E contains the same sequence and lithology as Hole U1583C.

Geochemistry

Analytical work on Site U1559 samples was finalized with the completion of inductively coupled plasma-atomic emission spectroscopy (ICP-AES) analyses of Hole U1559D whole rock samples. Sediments from Holes U1558D, U1558E, and U1558F were analyzed for carbonate, inorganic carbon, and organic carbon contents, completing work on the sedimentary cores of Site U1558. Interstitial water (IW) and Rhizon water samples from Hole U1583C were collected and aliquoted, and analyses for these have begun, with ion chromatographic measurements underway, ICP-AES water measurements completed, and spectrophotometric measurements (on Cary and third-party Tecan instruments) finalized for phosphate and ammonia (both below instrument detection limits, as was the case at Hole U1558F). Hole U1583C sediment samples were powdered for XRD analyses and weighed in preparation for coulometry, total carbon, and nitrogen measurements.

A subset of the hard rock samples from Hole U1558D were powdered, ignited, and measured for loss on ignition (LOI), and portable X-ray fluorescence spectrometer (pXRF) measurements were made on the powders from Cores U1558D-2R to 29R. The Hole U1558D basalts are largely consistent in terms of their immobile element composition, with TiO_2 contents between 0.8 and 1.1 wt% down to Core 23R, where they increase to >1.3 wt%. K_2O and Rb enrichments are larger compared to Site U1559, but on average are lower than seen at Sites U1556 or U1557. Unusual clay(?) -rich domains in the intercalated Hole U1558D sediments can have >4.0 wt% K_2O .

Comparative examination of the results for interstitial waters from Holes U1558D and U1583C sheds light on what has been a longstanding Geochemistry Laboratory question regarding agreement problems between ion chromatographic and ICP-AES results for the alkali metals. In short, there are ICP-specific issues with measuring Na and K at high concentration in waters, so the ion chromatographic data are the results that should be reported. Full details on this issue will be incorporated into the Geochemistry Methods chapter.

Microbiology

The microbiology team collected approximately one sample per 10 m advance of basement in Hole U1558D and sediment in Hole U1583C 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. The PFMD supply began to run short so we did not run this tracer in Hole U1583C, instead saving the remaining PFMD for the hard rock hole at Site U1583. Oxygen measurements were made on Cores U1583C-1H to 12H using a third-party oxygen probe instrument at approximately six measurements per core.

Micropaleontology

The micropaleontology team focused on nannofossil and foraminifera biostratigraphy for Hole U1583C. Cores U1583C-1H to 3H contain a condensed Pliocene and Miocene sequence, likely with one or more hiatuses. Cores U1583C-4H to 12H contain Oligocene sediment aged 23–30 Ma. The age of the lowermost sample, 30.1 Ma, is close to the expected basement age for this site of 30.6 Ma.

Paleomagnetism

This week, the paleomagnetism team continued magnetic measurements on discrete samples of basement cores of Hole U1558D, on archive half cores and discrete samples from Hole U1583C, and on archive halves from Hole U1583E. Core 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 24 sediment cubes were collected and measured from Hole U1583C cores, which is 2 samples per core, along with 21 additional basement samples from Hole U1558D. Thermal demagnetization was done on a total of 9 of the collected basement cubes. Basalts from Hole U1558D reveal mostly clear characteristic remanent magnetization (ChRM) despite being heavily altered in multiple sections. The ChRM within the cores mainly displays negative inclinations, which indicates normal polarity. The majority of basaltic cubes from Hole U1558D have high median destructive fields (MDF). Data from sediment cores is still being analysed, but it contains a series of clear reversals in the Oligocene sequence which show promise for magnetostratigraphy.

Physical Properties and Stratigraphic Correlation

The Physical Properties specialists continued processing basement core material from Hole U1558D as well as sediments from Holes U1583A to U1583E. This included running all whole-

round sections through the Special Task Multisensor Logger (STMSL) for stratigraphic correlation, the Natural Gamma Radiation Logger (NGRL), Whole-Round Multisensor Logger (WRMSL), and X-ray track, as well as running discrete measurements of compressional velocity and compressional and shear strength on sediment section halves from Hole U1583C. The last cylindrical hard rock core pieces from Hole U1558D were imaged using the DMT core scanner. Thermal conductivity was measured on 86 core pieces or section halves that captured the representative lithologies from the holes. Moisture and density (MAD) and *P*-wave velocity measurements were performed on 36 discrete cubes along with 24 samples from different sedimentary lithological units. Bulk density increased from 1.65 g/cm³ at the top of Hole U1583C to 1.85 g/cm³ near the bottom of the hole, as a result of increasing compaction. The pelagic clay interval in Core U1583C-2H has a lower density of ~1.55 g/cm³ and is also characterized by relatively high NGR levels of ~35 counts/s compared to background levels in nannofossil ooze around ~5 counts/s. Five formation temperature measurements were made with the advanced piston corer temperature (APCT-3) tool at Site U1583, three in Hole U1583C and two in Hole U1583E, indicating a temperature gradient of 25°C/km. Stratigraphic correlation between physical property records in Holes U1583C and U1583E yield a splice record, but several stratigraphic gaps remain.

Education and Outreach

This week the Onboard Outreach Officer made 25 new posts (crossposted on each of the social media sites), ran six ship-to-shore video tours, followed up with programs to confirm interest for ship-to-shore broadcasts, and wrote a post for the JR Expedition Log. Video footage made for the expedition video series is being assembled by the Onshore Outreach Officer.

- [Twitter](#) has an average of 94 engagements (minimum is 12 and maximum is 387) per post, and an engagement rate of 2.4%, with 33 additional followers.
- [Facebook](#) posts reached 7,890 people, with 250 page views and 4 new followers.
- [Instagram](#) posts reached 2,741 accounts, engaged 384 accounts, and has 12 new followers, 7 unfollows.
- We gave six ship-to-shore video tours to a total of ~80 people, including to a group of students at Science Camps of America in Hawaii, the largest of which was to the St. Paul's Steam Competition in São Paulo, Brazil (~150 people).
- The [JOIDES Resolution website](#) has three new blog posts, including "Did you say fusion beans?" about ICP-AES elemental analyses.

Technical Support and HSE Activities

Technical staff supported the science laboratories at Sites U1558 and U1583.

Laboratory Activities:

- Organized for World Courier sample shipments.
- Resolved DESClogik problems with exporting or copy/pasting data by uninstalling and relaunching the program, or through removing and reloading the macroscopic template.
- Repaired the ribbon cable in the TK04 thermal conductivity unit which had caused inconsistent communications.
- Core photos taken in Splitting Room were processed.
- Took sixty close-up core images.
- The Icefield magnetic orientation tool was downhole for almost 57 h for Core U1583E-12H because of the stuck core barrel. It recorded data the entire time and batteries remained above 1.6 V.
- An offset was detected in the Section Half Multisensor Logger (SHMSL) color reflectance data, which was resolved by replacing the shutter box. Close review of the measurements will be performed after the change.
- Used the TruPoint300 to verify the draft of the ship and continued to work on GPS tide measurement to understand the datum relationship for potential application to the new IRIS rig instrumentation system.
- Replaced all rock saw blades, except for the parallel saw.

IT Support Activities

- Risk Assessment remediation tasks continue for yearly IT security assessment of the ship's information resources.
- We started prepping for removal of Adobe CS6, Acrobat X/XI Pro, and Acrobat Reader X/XI from all shipboard computers, to remediate the risks posed by the unsupported Adobe products.
- The shipboard 2013 mailboxes have all been migrated over to the newer 2019 Exchange servers.

Health, Safety, and Environment Activities:

- Conducted showers and eye wash safety checks.