IODP Expedition 390: South Atlantic Transect 1

Week 5 Report (8–14 May 2022)

The fifth week of International Ocean Discovery Program (IODP) Expedition 390, South Atlantic Transect 1, involved sediment coring with the advanced piston corer/extended core barrel (APC/XCB) system at Site U1556 in Holes U1556C, U1556D, and U1556E, as well as beginning our operations at Site U1557. The week ended with operations suspended and a period of waiting on weather due to high heave conditions. All times in this report are ship local time (UTC + 2 h).

Operations

Coring in Hole U1556C continued during Week 5 of the expedition, with Cores U1556C-2H through 32X. APC cores (Cores 1H through 16H) were collected using nonmagnetic core barrels and oriented for paleomagnetic research using the Icefield MI-5 magnetic orientation tools. Advanced piston corer temperature (APCT-3) tool temperature measurements were made on Cores 4H, 7H, 10H, and 13H. Cores 12H through 15H were partial strokes but had full or nearly full recoveries. Cores 13H through 16H required overpull forces of 10,000–20,000 lb; we switched to XCB coring following Core 16H. Core 30X penetrated to 276.3 meters below seafloor (mbsf) and recovered basalt fragments in the core catcher. Two additional 2 m advances were made to capture the sediment/basement interface (Cores 31X and 32X) using the XCB system with the polycrystalline diamond compact (PDC) cutting shoe. The PDC cutting shoe was demonstrated during Expedition 390C to provide high-recovery cores across the sediment/basement interface. Overall, Cores 1H through 30X penetrated to 276.3 mbsf and recovered 281.74 m of sediment (102%). Cores 31X and 32X advanced another 4 m to 280.3 mbsf, recovering 2.07 m (52%). Core 32X had 77% recovery.

After Core U1556C-32X, we pulled out of the hole to the seafloor, officially ending Hole U1556C at 1920 h on 10 May 2022. The vessel was moved 20 m south and the bit was spaced out to 5015.0 meters below rig floor (mbrf) in preparation for Hole U1556D. The objective of this hole was to recore the top 40–50 m of sediment, as cores from Hole U1556C were severely disturbed across this interval, and we hoped to improve the quality of microbiological and chemical sampling. The hole was spudded at 2120 h on 10 May and returned a core barrel with 9.5 m of sediment and no definitive mudline. The decision was made to terminate the hole. The vessel moved another 20 m south and Hole U1556E was spudded at 2300 h from a shot depth of 5010.0 mbrf. Core U1556E-1H recovered 5.12 m of sediment, establishing water depth as 5003.1 meters below sea level (mbsl). Coring in Hole U1556E continued through Core 5H, achieving a depth of 43.1 mbsf and recovering 43.33 m (100.5%). Cores from Hole U1556E were not oriented and no temperature measurements were made.

The bit cleared the seafloor following completion of Hole U1556E at 0610 h on 11 May. We began tripping the drill pipe toward the surface, while moving the vessel in dynamic positioning mode to Site U1557 at a speed of 0.5 kt. We arrived on site at 1436 h, with the APC/XCB bit reaching the rig floor at 1530 h, marking the end of Hole U1556E. The bottom-hole assembly for rotary core barrel (RCB) coring in Hole U1557D, including a new C-4 bit with a mechanical bit release, was made up and installed. Site U1557 was visited during preliminary Expeditions 390C and 395E, where Expedition 390C cored the sediment section in Hole U1557A via APC/XCB and installed a reentry system with casing extending to 60.0 mbsf. Expedition 395E extended the casing in Hole U1557D to 571.6 mbsf with a total hole depth of 575.6 mbsf.

Pipe was tripped toward the seafloor, stopping twice to fill the drill pipe with water. At 0415 h on 12 May, the subsea camera system was deployed through the moonpool to guide reentry into Hole U1557D. The Conductivity-Temperature-Depth sensor was attached to the subsea camera frame. We located and reentered Hole U1557D at 0653 h, recovered the subsea camera system, and began tripping pipe in the casing to the hole bottom. Core U1557D-2R, the first recovered core in this hole following the two drilled intervals, arrived on deck at 1925 h. Coring continued smoothly through Core 8R; Core 9R had advanced only 1 m when it was recovered due to poor weather and drilling conditions. We then pulled out of the hole, with the bit reaching the seafloor at 0930 h on 14 May, and tripped pipe to a depth 3327 mbrf, where we positioned ourselves to wait for weather conditions to improve. Overall, Cores U1557D-2R through 9R advanced 61.5 m to a depth of 637.1 mbsf and collected 36.81 m of material (60%). Core 3R had 88% recovery.

Science Results

Week 5 of the expedition began with coring sediment to basement in Hole U1556D, the second APC/XCB sediment hole cored at Site U1556. The first, Hole U1556A, was cored during Expedition 390C. Material from Hole U1556A was curated, analyzed on whole-round and section half tracks, and samples were taken for interstitial water (IW) chemistry. During Expedition 390, we accomplished much more thorough analysis, including stratigraphic correlation, collection of discrete samples for physical properties, paleomagnetism, X-ray diffraction (XRD), and analysis of microfossils for age model refinement. Microbiological samples were collected as whole rounds on the catwalk and processed. IW was sampled both by squeezing of whole rounds and by using Rhizon samples. Dissolved oxygen was measured in whole-round cores prior to splitting. Cores from Site U1561, visited during Expedition 395E, were also described, although no discrete samples were taken as only the archive halves are available shipboard. Finally, we began initial description and analysis of RCB cores from Hole U1557D.

Site U1556

Cores from Holes U1556C, U1556D, and U1556E were curated, described, and sampled. Hole U1556C was drilled to the sediment/basement interface. Coring of Holes U1556D and U1556E

was motivated by severe disturbance of the uppermost cores in Hole U1556C, which represents an important chemical and microbiological transition zone. As such, we wanted an additional copy of the first five cores.

Sedimentology

Cores from Holes U1556C, U1556D, and U1556E were described both macroscopically and microscopically (smear slides) during Week 5. Discrete XRD samples provided additional mineralogical context. These cores contain alternating intervals of silty clay and pinkish-white or gray calcareous nannofossil ooze, which lithifies to chalk downhole. There are rare intervals that are more enriched in foraminifera. Clay color transitions from brown to reddish-brown downhole. Bioturbation, where it occurs, is sparse to moderate and consists primarily of trails, tracks, and burrows. An organic-rich diatom ooze is present in Cores U1556C-1H and U1556D-1H. XRD data reveal intervals where calcite and siliciclastic fluctuations appear antiphase, reflecting changes in the lysocline, as well as intervals where the compositional variations of silty clays may reflect changes in terrigenous input. Improved recovery in Hole U1556C relative to Hole U1556A should result in a more complete sampling of the Eocene/Oligocene boundary.

Petrology

Cores U1556C-30X through 32X contain the sediment/basement interface. Recovered material consists of sedimentary breccia with sparsely to moderately olivine phyric basalt, as well as glass clasts. The matrix is calcareous sediments with clay.

Micropaleontology

Approximately 90 samples (including core catcher samples and additional discrete samples from carbonate-rich intervals of the working halves) were examined for biostratigraphy at Hole U1556C. Site U1556 ranges in age from recent to middle Paleocene. Much like Site U1557, preservation and abundance vary by lithofacies, and sometimes prevent the precise dating of the sediments. The Miocene/Pliocene boundary occurs somewhere around Core U1556C-7H, the Oligocene/Miocene boundary occurs in Core 17X, and the Eocene/Oligocene boundary occurs in Cores 23X–25X. There is significant reworking spanning Cores 26X–30X, with middle Paleocene taxa co-occurring with middle/lower Eocene taxa. In general, it seems that Cores 26X–29X are middle Eocene in age (to roughly planktic foraminifer Zone E5, or ~50 Ma). An ~10 My hiatus occurs somewhere in Cores 29X–30X, spanning the Paleocene/Eocene transition. The base of Core 30X is middle Paleocene in age, equivalent to that observed in Holes U1556A and U1557B.

Paleomagnetism

Sediment sections from Holes U1556C, U1556D, and U1556E were measured on the superconducting rock magnetometer. To expedite core flow, inline alternating field (AF) demagnetization was applied at fields of only 5 and 20 mT after measurement of the natural remanent magnetization. All three holes displayed clear polarity reversals, which can be tied to

Hole U1556A for magnetostratigraphic correlation. Furthermore, Hole U1556C recovered material from depth intervals that were not recovered at Hole U1556A, including around the base of the sediment package, which will allow better constraint of the basal age. Additionally, we collected ~2 discrete sediment cubes per core from Hole U1556C, for a total of 59 sediment samples and one basement sample from the sediment/basement interface. Anisotropy of magnetic susceptibility and bulk magnetic susceptibility (MS) were measured on all discrete cubes. Likewise, all cubes were AF demagnetized, sometimes up to 190 mT, for rock magnetic analysis and to aid in the magnetostratigraphic interpretation. Several of the discrete sediment samples displayed noisy orthogonal vector plots (OVPs). Of the 59 sediment samples, 49 had OVPs "clean" enough to contribute to defining the characteristic remanent magnetization. Only 28 of these samples gave maximum angular deviation angles <15°. A subset of the 59 sediment cubes was used in isothermal remanent magnetization (IRM) acquisition experiments to better understand the mineralogy of the sediments. Both the AF demagnetization and IRM experiments suggest the presence of titanomagnetites/titanomaghemites of various oxidation states and/or grain sizes. The basement samples display more well-behaved OVPs, trending cleanly to the origin, although only one appears to represent Chron C26r, the expected chron at the sediment/basement interface. The other two suggest the dominance of an overprint, either due to drilling or the alteration process.

Physical Properties and Downhole Measurements

During Week 5, 219 whole-round sections and core catchers from Hole U1556C, seven whole-round sections and core catchers from Hole U1556D, and 33 of the 38 whole-round sections and core catchers from Hole U1556E were run through the track systems for natural gamma radiation (NGR), gamma ray attenuation (GRA) bulk density, MS, and *P*-wave velocity data. Split core measurements were made on 235 sections from Hole U1556C, seven sections from Hole U1556D, and 36 sections from Hole U1556E, including color reflectance and point magnetic susceptibility, and 2-D images were generated with the Section Half Imaging Logger. Distinct changes in NGR, GRA density, and MS correlate well with lithologic changes, particularly in the intervals characterized by alternating clay-dominated and carbonate-dominated layers. *P*-wave velocity (*x*–*y* direction) was measured on 28 sediment sections, and triaxial velocity was measured on two additional discrete samples from the hard rock interval at the base of Hole U1556C (Cores 30X–32X). In sedimentary sections, *P*-wave velocities from discrete sampling are consistent with *P*-wave velocity track data, and trends co-vary with density. Moisture and density data from 63 discrete samples show generally good agreement with GRA density track data, and show the variability in density and porosity across the varying lithologies. Thermal conductivity measurements were made on 32 representative sections of Hole U1556C cores, with values ranging from 0.8 to 1.5 W/(m·K).

During coring of Hole U1556C, "live" stratigraphic correlation of MS and GRA bulk density data obtained from the Special Task Multisensor Logger to Hole U1556A was conducted. This correlation allowed us to track the position of coring gaps in Hole U1556C relative to Hole U1556A and prevent them from aligning. To achieve this, we twice modified the shot depth of

the APC system to maximize recovery across core breaks within Hole U1556A. After coring, we refined our downhole correlation using NGR, GRA bulk density, MS, and color reflectance data. We started assembling a splice for Site U1556.

Geochemistry

IW was extracted by squeezing and Rhizon samplers for Hole U1556C (Cores 1H–30X) and U1556E (Cores 1H–5H). IW splits were preserved for postexpedition research and shipboard analyses on alkalinity, pH, salinity, nutrients (e.g., phosphate), sulfide, dissolved organic carbon, and major/minor elemental concentrations. The IW profiles from Hole U1556C are similar to those from Hole U1556A, cored during the Expedition 390C. The squeeze cake after IW extraction was then used for total carbon (TC) measurements on the carbon-hydrogen-nitrogen-sulfur analyzer and for carbonate analyses on the coulometer. Additional samples (one per core) were also selected from the working half of the sediment cores for TC and carbonate analyses. For Hole U1557D, rock samples were chosen for loss on ignition and inductively coupled plasma–atomic emission spectroscopy analyses from Cores 2R to 4R. At least one representative sample was selected for each basalt type to obtain bulk major and minor elemental compositions.

Microbiology

The microbiology team collected sediment samples at Hole U1556C (Cores U1556C-2H through 31X) and Hole U1556E (Cores U1556E-1H through 5H). The team processed all samples destined for physiology experiments in the anaerobic chamber in the walk-in cold room, while samples destined for postexpedition cell counts and nucleic acid analysis were conducted at room temperature between two KOACH air-filtering units to mitigate contamination. This dual setup allowed faster sample processing. In addition, the dissolved oxygen concentrations of sediment cores were measured in both Holes U1556C and U1556E. To test for potential contamination, drilling fluid was collected during coring of Hole U1556C on 9 May and Hole U1556E on 10 May. During postexpedition research, DNA will be extracted from these samples to create a database of potential contaminants for comparison with cored samples.

Site U1561

Sedimentology

Cores U1561A-1H through 9X, U1561B-1H, and U1561C-1H were described both macroscopically and microscopically (smear slides) during Week 5. The cores contain brown silty clay with zeolites transitioning to a light yellowish-brown calcareous nannofossil ooze downhole.

Petrology

Cores U1561A-8X and 9X contain the sediment/basement interface at Site U1561. Recovered material consists of aphyric basalt emplaced as a pillow lava flow.

Site U1557

During Week 5, we began RCB coring of Hole U1557D, where a reentry system and casing was installed during Expeditions 390C and 395E. During Expedition 390C, basement depth was recorded at 564.0 mbsf in Hole U1557B. At Hole U1557D, casing was installed into the basement with the cored interval beginning at 575.6 mbsf.

Petrology

Cores U1557D-2R through 7R have been described for igneous and alteration petrology. They consist of clast-supported sedimentary breccia and contain highly or completely altered basalt clasts with cryptocrystalline groundmass.

Physical Properties and Downhole Measurements

At Site U1557, 33 whole-round sections from Hole U1557D were run through the track systems for NGR and MS. Other analyses are ongoing.

Microbiology

The microbiology team collected basement samples at Hole U1557D (Cores U1557D-2R, and 4R–8R). Samples were processed for preservation for shore-based analysis and incubation experiments. Subsamples from the microbiology whole rounds from these cores were preserved for cell counts and analysis of community DNA, RNA, and lipids during postexpedition research.

Education and Outreach

The following outreach activities took place during Week 5.

- Posted four new "Expedition Log" (blog) posts, two video and two text. All blog posts contain an audio reading of each post's text to increase accessibility. Blog posts are available on the *JOIDES Resolution* expedition website.
- Facebook: Reached 7,080 people and added 19 new followers.
- Twitter: 20 new tweets posted, 1,589 engagements, and 66 new followers. One Outreach Officer did a "takeover" of the @IAmSciComm Twitter account, posting 62 tweets reaching their 32.7k followers.
- Instagram: 12 new posts, including three videos, reached 1,404 accounts; gained seven new followers.
- Completed nine ship-to-shore broadcasts, reaching an audience of ~480 people in two countries (USA and Japan).

Technical Support and HSE Activities

The following technical support activities took place during Week 5.

Laboratory Activities

- Supported processing and sampling of sediment cores from Hole U1556C, including shipboard discrete samples for standard analyses, squeezing of IW samples, and collection of microbiological samples.
- Began planning for the end-of-expedition return shipment.
- Began coordinating COVID testing requirements for all departing staff and scientists.
- Site fix data on IRIS was found to be incorrect; we are using the JRDataServer information until the issue can be resolved.
- Cleaned, greased, and exercised the magnetometer winch on the fantail.
- Core Laboratory
    - Icefield Tool #2007 stopped recording twice, and then restarted during two separate deployments. When it restarted a second time, we observed a sudden change in the magnetic dip. The tool will not be used again until the issue is resolved.
    - The gantry bayonet settings were found to be incorrect, resulting in the bayonets giving the same value for all measurements. Default settings were modified and system is functioning.
- Chemistry and microbiology
    - An upright incubator was set up for additional refrigerated sample storage.
    - Phosphate analyses were conducted on both the Cary UV-Vis and the third-party Tecan plate reader instrument for comparison. Results were comparable, although the Cary UV-Vis was found to have a higher background, which may be attributable to growth inside the Cary autocuvette. The cuvette was replaced and the instrument background dropped closer to zero. A new protocol for rinsing the system with ethyl alcohol after each expedition is recommended.

Application Support Activities

- Added a refresh button to the Image Grabber software.
- Work was conducted on the Sample and Data Request Management (SDRM) and Auther projects.
- Worked on the LDAQ M-DRIVE module for future use.
- Changed settings for Expedition 395E and 390C legacy data so that samples can be modified as needed.
- Addressed a repeated LIMS service outage caused by browsing QAQC samples via the SampleMaster sample entry screen “Edit” tab.

IT Support Activities

- TAMU email service patching was completed.
- Video Display Units (VDUs) are ready to be updated to mac OS Monterey 12.3.1.
- Tested Office 2019 package releases.
- Engaged in troubleshooting site fix data from IRIS by studying IRIS, RigWatch, and Navpac data feeds and sources.
- Enabled TeamViewer on the Aeris XRD computer to allow vendor support.

HSE Activities

- Emergency shower and eye wash stations were tested.
- Conducted a wipe test in the Radiation Van.
- Staff and scientists participated in a fire and lifeboat drill.