IODP Expedition 395E: Complete South Atlantic Transect Reentry Systems

Site U1561 Summary

Background and Objectives

International Ocean Discovery Program (IODP) Site U1561 (proposed Site SATL-55A) is located in the central South Atlantic Ocean at 30.4°S, ~1250 km west of the Mid-Atlantic Ridge on seismic line CREST05 at position CDP 16750. A reflector at ~6.56 s two-way traveltime (TWT) was interpreted as the top of basement at 126 m below seafloor (mbsf) (Coggon et al., 2020). This site is located 13 nmi north of Site U1556, and the basement at both sites is predicted to have formed at ~61.2 Ma at a half spreading rate of ~13.5 mm/y. Oceanic crust at these sites is the oldest that will be drilled during South Atlantic Transect Expeditions 390 and 393.

After completing reentry system installations in Holes U1560B, U1557D, and U1556B for the South Atlantic Transect, ~2.5 d of operations time remained on Expedition 395E before we had to depart for Reykjavík on 14 May. In consultation with the Expedition 390/393 Co-Chief Scientists, it was decided to use this time to core a single hole at nearby alternate Site SATL-55A, which became Site U1561. The sedimentary succession at Site U1561 was expected to be thinner than at nearby Sites U1556 and U1557 and would provide information on sediment accumulation patterns and pore water chemical profiles of this local area.

Operations

Hole U1561A

After completing the 13 nmi transit from Site U1556, we arrived at Site U1561 at 0324 h on 11 May 2021. We lowered the thrusters and entered dynamic-positioning (DP) mode at 0349 h. The advanced piston corer/extended core barrel (APC/XCB) bottom-hole assembly (BHA) was made up and was lowered to the seafloor. Based on the seafloor reflection in the seismic profile, the water depth at Site U1561 was expected to be 4857 m below sea level (mbsl) (Coggon et al., 2020). As we arrived on site, the precision depth recorder (PDR) 3.5 kHz signal malfunctioned and the depth reading had to be taken with the 12.5 kHz signal instead, which gave an apparent water depth of 4963 mbsl (106 m deeper than the depth in the *Scientific Prospectus* [Coggon et al., 2020]). Because of this discrepancy, below 4857 mbsl we slowed the descent of the drill bit and monitored the weight of the drill string. The drill string took noticeable weight at 4927 mbsl, indicating that the BHA was partly supported by the formation. We raised the drill bit to 4917 mbsl to attempt a mudline core, which returned full, showing that the seafloor was shallower than 4917 mbsl. We raised the drill bit by a further 5 m to 4912 mbsl for a second attempt, but this core was also full and did not recover a mudline. These two cores were later designated to be Cores U1561B-1H and U1561C-1H, respectively. The drill bit was raised to 4907 mbsl for a third attempt.

Hole U1561A (30°43.2902′S, 26°41.7162′W) was spudded at 2335 h on 11 May and Core U1561A-1H recovered 6.7 m, establishing a seafloor depth of 4909.5 mbsl. On 12 May, Cores 2H to 6H advanced from 6.7 to 46.2 mbsf. Core 6H struck hard rock, which bent the APC cutting shoe. We switched to the XCB and Cores 7X to 9X advanced from 46.2 to 48.9 mbsf (Core 7X was empty). Core 9X took 2 h to advance 1.2 m, recovering 1.18 m of basalt. The slow rate of penetration was partly caused by the BHA being mostly above the seafloor, limiting the weight that could be applied safely. Cores 1H to 9X recovered 45.4 m (93%). At 2245 h we stopped coring to prepare for the transit to Reykjavík. We raised the drill bit, clearing the seafloor at 2355 h, and reaching the rig floor at 1150 h on 13 May, ending operations at Hole U1561A.

From 1230 to 1730 h we deployed the subsea camera to 4881 mbsl, without the drill pipe, to detorque the camera's umbilical cable. This was done because the cable had wrapped around the drill pipe up to eight times during a deployment at Site U1556, and any residual twisting could damage the cable. While the camera was being lowered and raised back, the ship was secured for transit. We raised the thrusters, and at 1806 h we began the sea passage to Reykjavík, Iceland. The transit took 22.6 d at an average speed of 10.6 kt.

Principal Results

The sediment/basalt contact at Hole U1561A is at 46.2 mbsf, and is a sharp transition. We did not expect to reach basalt at 46.2 mbsf because the main basement seismic reflector is at ~126 mbsf at this site location, as estimated from seismic data. We do not yet know the reason for this discrepancy, nor for the differing estimates of seafloor depth between the seabed seismic reflection (4857 mbsl), the 12.5 kHz PDR reflection (4974.4 mbsl), and the mudline depth (4920.8 mbsl).

Cores U1561A-1H to 9X were measured on the whole-round (WR) and split-core track systems. Sections from Cores 8X and 9X, containing basalt, were measured on the WR tracks but were not split, and were instead preserved in nitrogen gas-flushed bags for description and analysis during Expeditions 390 and 393. Core catcher samples from Cores 1H to 6H were collected for postexpedition biostratigraphic dating. We collected one sample per core for headspace gas analysis as well as 1–2 WR samples per core for chemical analysis of interstitial water (IW). The squeezed sediments from the IW samples were measured on the carbonate coulometer and X-ray diffraction instruments. No systematic core description took place during Expedition 395E.

The sediment is red-brown clay from the seafloor to 22.5 mbsf (<1% calcium carbonate), and carbonate ooze from 22.5 to 46.2 mbsf (81 to 90 wt% calcium carbonate). This change in lithology is reflected in the magnetic susceptibility and natural gamma radiation data, which shift from relatively high values above 22.5 mbsf to lower values below, as a result of the higher contents of terrigenous sediment in the red-brown clay. Some paleomagnetic reversals are evident in the superconducting rock magnetometer (SRM) data, but not as many as would be expected if sediment had been continuously deposited at this site since the crust formed

~61.2 Ma, indicating that there are discontinuities or intervals of condensed sedimentation in the succession.

Preliminary analysis of the IW chemistry data shows that sulfate decreases slightly from 29.6 mM in the top core sample to ~26.5 mM for the samples below ~20 mbsf. Ammonium has more variability, ranging from 12 μM in the top to 62 μM deeper in the hole. Most dissolved element profiles have some downhole structure, but over narrow concentration ranges; for example, magnesium varies between 52.7 mM in the shallowest sample to 48.5 mM in the deepest sample. These results suggest that there is low diagenetic or microbiological activity at Site U1561, consistent with this site's open ocean location quite far from sources of abundant organic matter.

Reference

Coggon, R.M., Christeson, G.L., Sylvan, J.B., Teagle, D.A.H., Estes, E., Williams, T., and Alvarez Zarikian, C.A., 2020. *Expedition 390/393 Scientific Prospectus: The South Atlantic Transect*. International Ocean Discovery Program. https://doi.org/10.14379/iodp.sp.390393.2020