

IODP Expedition 398: Hellenic Arc Volcanic Field

Week 6 Report (15–21 January 2023)

During the sixth week of the International Ocean Discovery Program (IODP) Expedition 398, we drilled Site U1592 (Holes U1592A and U1592B) in the Anafi basin and Site U1593 (Holes U1593A, U1593B, and U1593C) off the Kolumbo submarine volcano.

Operations

Week 6 of the expedition began with half-length advanced piston coring (HLAPC) from Core U1592A-26F at 179.8 meters below sea floor (mbsf). HLAPC continued to Core 45F to 273.8 mbsf, where the barrel became stuck. Overpull up to 50,000 lb was ineffective. In attempting to drill over the barrel, the drill pipe became stuck, with indications the hole was filling in. The drill pipe was worked free and eventually the barrel was freed with 120,000 lb overpull. Once free, the HLAPC barrel and sinker bars were pulled. A single drill pipe joint was pulled so the hole could be reconditioned. The driller pumped mud sweeps while working the drill string. At 1330 h on 15 January 2023, an extended core barrel (XCB) was dropped and coring resumed with Core 46X from 273.8 mbsf. Coring continued into 16 January to Core 55X at 339.2 mbsf, the final depth for Hole U1592A. The rate of penetration (ROP) for the XCB was slowing to ~4 m/h, so the decision was made to switch to the rotary core barrel (RCB).

At 0730 h on 16 January, XCB coring was terminated. The drill string was tripped out of the hole and the bit cleared the seafloor at 0915 h. The bit cleared the rotary table at 1120 h, ending Hole U1592A. The crew began assembling the RCB bottom-hole assembly (BHA) with bit. Meanwhile, the vessel was offset 50 m southeast of Hole U1592A.

Hole U1592B was spudded at 1600 h. The seafloor depth was 693.1 meters below sea level (mbsl). The hole was drilled without recovery to 293.0 mbsf, with liberal mud sweeps to keep the hole clean. The drill down finished at 0100 h on 17 January at a depth of 293.0 mbsf. The driller started RCB coring with Core U1592B-2R from 293.0 mbsf on 17 January. Cores 8R through 13R had almost zero recovery and the sediment was assumed to be a pumice layer from the seismic profiles. Core 11R was a “punch” core, a 2 m advance with little to no rotation or pump, to try to recover some of the difficult pumice section. The recovery was still very poor, but measurable, as it recovered a handful of the ground pumice. Following Core 12R, the drill string became stuck, requiring several minutes, 100,000 lb overpull, and two mud sweeps to come free. Coring continued to 1545 h on 18 January with the recovery of Core 26R from 527.8 mbsf, the final depth for Hole U1592B. The bit cleared the rotary table at 2001 h and the rig crew secured the floor for transit. The thrusters were raised and the vessel was out of dynamic positioning (DP) control at 2052 h. All thrusters were up and secure and the sea passage started at 2100 h, ending Site U1592.

At 2306 h the vessel completed the 16.7 nmi passage to Site U1593 (proposed Site CSK-04C) in 2.3 h at an average speed of 7.3 kt. All thrusters were down and secure at 2318 h and the vessel was switched to DP control at 2324 h.

An advanced piston corer (APC)/XCB BHA with bit was assembled. On 19 January at 0245 h, Hole U1593A was spudded from 409.0 mbrf. Recovery for Core U1593A-1H was 4.7 m, giving a calculated seafloor of 402.5 mbsl. APC coring continued from Core 2H at 4.7 mbsf to Core 16H to 147.2 mbsf. Indications of impartial strokes on three consecutive cores, plus a high overpull on Core 16H, led to a switch to the HLAPC. HLAPC coring commenced with Core 17F and continued into 20 January, to Core 38F at a final depth of 250.6 mbsf. The bit cleared the seafloor at 0750 h, ending Hole U1593A.

The vessel was offset 50 m southeast of Hole U1593A. At 0940 h on 21 January, Hole U1593B was spudded from 412.0 mbrf. The recovery of 6.20 m in Core U1593B-1H gave a calculated seafloor of 415.3 mbrf (404.0 mbsl). APC coring continued from Core 2H to 11H, with the bit advanced to 101.2 mbsf. HLAPC coring began with Core 12F at 101.2 mbsf and continued into 21 January to Core 39F from 232.8 mbsf, the final depth for Hole U1593B. The bit cleared the rotary table at 1409 h, ending Hole U1593B. The vessel was offset 25 m north. At 1445 h, the crew started making up the RCB BHA with a bit and ran it to 402.7 mbrf.

Hole U1593C was spudded at 1752 h on 21 January and drilled ahead without recovery to 192.6 mbsf. Sweeps were pumped at 124 mbsf, 163 mbsf, and 192 mbsf. At the 192 mbsf mark, the drill pipe started experiencing increasing torque. The hole was worked, from 192 mbsf back to 173 mbsf, and another sweep was circulated. The week ended at midnight on 21 January with the bit at ~173 mbsf in Hole U1593C, with tight hole conditions.

Science Operations

All Expedition 398 laboratory groups completed their Site U1590 and U1591 reports and revised the Site U1592 reports.

Lithostratigraphy

The Sedimentology group described Cores U1592A-27F to 55X, U1592B-2R to 26R, U1593A-1H to 38F, and U1593B-1H to 39F.

Site U1592 was subdivided into five major lithofacies. Unit I (Cores U1592A-1H to 44F) consists of volcanoclastic and tuffaceous sediments, Unit II (Cores U1592A-45F to 55F and U1592B-2R to 14R) is dominated by nannofossil ooze with a low amount of volcanoclastics, Unit III (Cores U1592B-14R to 23R) consists of dominantly nonvolcanic dolomitic siliciclastic sediments, bioclastic limestones mark Unit IV (Cores U1592B-23 to 25R), and Unit V (Cores U1592B-25R to 26R) is marked by limestone basement.

Work on Site U1593 is still ongoing at the end of the week. Holes U1593A and U1593B predominantly consist of ash, lapilli, lapilli-ash, lithic crystal ash, calcareous mud, nannofossil ooze, tuffaceous ooze, and sand.

Average hole recovery was 71% in Hole U1592A, 50% in Hole U1592B, 60% in Hole U1593A, and 67% in Hole U1593B. Hole U1593C was drilled without recovery only.

Structural geology analyses at Site U1592 included description of cores retrieved from Holes U1592A and U1592B. A total of 323 structures were measured, and most of those measurements derived from relatively consolidated intervals. Observed and measured structures on cores are beddings, faults, deformation bands, and sediment veins. Analysis and description of structures from Site U1593 continues at the end of the week.

Biostratigraphy

The Biostratigraphy group analyzed 119 core catchers and multiple discrete (toothpick) samples from Sites U1592 and U1593 for planktic and benthic foraminifers, as well as calcareous nannofossils. Biostratigraphic markers identify crucial individual ages that enable a precise age-depth correlation throughout all holes. Several shells of benthic and planktic foraminifers were imaged with the shipboard scanning electron microscope (SEM). Biostratigraphic analyses could identify a hiatus or area of very low sedimentation rates in the lower part of Site U1592. Several thin section analyses revealed large benthic foraminifers (*Nummulites*) from Eocene beach rock fragments above the limestone basement in Hole U1592B. Most samples contain a significant amount of reworked nanno- and microfossils that probably originate on the surrounding islands.

Paleomagnetism

The Paleomagnetism group continued to measure natural remanent magnetization (NRM) on archive half core sections from Holes U1592A, U1592B, U1593A, and U1593B. The section measurements were accompanied by 80 discrete analyses and confirmed several Pliocene and Pleistocene magnetic reversals. At Site U1592, the group identified several paleomagnetic reversals that can be correlated to the Brunhes, Matuyama, and Jaramillo chrons and subchrons. However, due to the soupy ash intervals that suffered from significant reworking, drilling gaps, and greigite formation, this identification was only possible in correlation to biostratigraphic ages.

Geochemistry

This week the Geochemistry group conducted 23 inductively coupled plasma–atomic emission spectroscopy (ICP-AES) measurements on Sites U1592 and U1593. In the same way as reported last week, the ratios of different trace elements such as Ba/Rb vs. Ba/Zr, Ba/Y vs. Zr/Rb, but also SiO₂ vs. Na₂O + K₂O are used to link discrete volcanoclastic layers to eruptions and volcanic centers.

A total of 40 headspace gas samples from Hole U1592A were analyzed by gas chromatography (GC). Methane, ethane, and propane concentrations are below the detection limit throughout the hole. Headspace gas analyses were resumed on Hole U1592B when a depth was reached that was deeper than that of Hole U1592A, which occurred at 345.27 mbsf. Below this depth, headspace gas analyses were performed at a resolution of one sample per core or one sample every other core for half-length cores to the base of the hole. A total of 11 headspace gas samples were analyzed by GC for Hole U1592B. Methane, ethane, and propane concentrations are below the detection limit throughout Hole U1592B.

Physical Properties

Physical properties at Site U1592 are correlated with lithology and respective units. The topmost volcanoclastic Subunit Ia has low natural gamma radiation (NGR) counts and high magnetic susceptibility (MS) relative to other volcanoclastic units. Grain densities are as low as 1.9 g/cm³ in coarse, pumice-rich deposits. Volcanoclastic layers in Subunit Ic have lower MS and a factor of two higher NGR than Subunits Ia and Ib. Subunit Id exhibits large variations in MS and often has high MS compared to other sediments at this site. In Unit II, which is dominated by nanofossil-rich oozes, *P*-wave velocity increases with depth, NGR is low, and MS is low except where thin volcanoclastic layers have high MS. The dolomitic and siliciclastic layers of Unit III often display cyclic variations in NGR that are correlated with organic-rich layers. Limestones and marbles in Units IV and V have higher *P*-wave velocity, thermal conductivity, and bulk density, and lower NGR, than Units I–III.

Stratigraphic Correlation

Introduction of a CCSF-A depth scale and construction of a splice for Holes U1592A and U1592B was not necessary since both holes had only a short overlap between 293 mbsf and 339.2 mbsf. The Stratigraphic Correlators identified several correlations mainly based on the MS and NGR measurements derived with the Whole-Round Multisensor Logger (WRMSL) tool as well as on half core images. Correlations were identified between Cores U1592A-49X and U1592B-2R, U1592A-49X and U1592B-3R, U1592A-50X and U1592B-3R, U1592A-52X and U1592B-5R, U1592A-53X and U1592B-5R, and U1592A-53X and U1592B-6R, as well as between U1592A-55X and U1592B-6R. Those correlations were used to determine affine ties between both holes and to apply some minor shifts to the cores that did not exceed 6 m. All cores from Hole U1592A above 293 mbsf were not shifted, while all cores from Hole U1592B below 339.2 mbsf were shifted by a constant distance of 3.5 m to correlate Holes U1592A and U1592B above 339.2 m.

Education and Outreach

This week we had three media interviews and provided a written statement to a fourth outlet. We interviewed with: the Fairbanks Daily News-Miner (audience 7,562), KUAC Fairbanks (the local

NPR station, audience 36,000), and KPTH TV Crete. In addition, we provided a written statement to a freelance journalist writing for the Guardian.

We also had 11 live ship-to-shore tours this week, reaching approximately 629 students. Across all our social media platforms we had 13,968 impressions, and an average engagement rate of 7.04%.

Technical Support and HSE Activities

Laboratory Activities

- Staff processed cores and samples from Holes U1592A, U1592B, U1593A, and U1593B.
- Scanning electron microscope (SEM) training was held for staff.
- Pycnometer: Co-Chief Scientist requested moisture and density (MAD) data for large size pumice samples. Staff unsuccessfully tried to run it without the insert sleeve.
 - Recommendation to investigate possible code modification to accommodate large sample in the future.
- Began collecting information regarding scientists' requests of shipboard residue samples.
- Start preparing shipping documents.

IT Support Activities

- Completed Windows Updates.
- Replaced corrupted PC that would not apply updates.
- Updating Firefox with latest release on all systems.

Application Support Activities

- Penetrometer: Add clarifying notes to the laboratory manual regarding capture preferences and upload process.
- Thermal conductivity analyzer: Add clarifying notes to the laboratory manual regarding TeKa (vendor) vs. IODP ("TCON_CALC") computation of results.
- Barcode scanner reprogrammed for X-ray diffraction (XRD) to support data entry for samples derived from interstitial water (IW) squeeze cakes.

Health, Safety, and Environment

- Emergency shower and eye wash stations were tested.