IODP Expedition 398: Hellenic Arc Volcanic Field

Week 3 Report (25–31 December 2022)

During the third week of the International Ocean Discovery Program (IODP) Expedition 398, we completed Site U1598, our first site in the Anhydros Basin.

Happy New Year from everyone aboard Expedition 398.

Operations

Week 3 of the expedition began on 25 December 2022 in Hole U1589B with a switch to the half-length advanced piston corer (HLAPC) for Core U1589B-13F at 96.2 meters below seafloor (mbsf). All four runs of the advanced piston corer temperature (APCT-3) tool on this hole provided good data. Coring continued to Core 54F at 283.5 mbsf.

On 26 December, following Core U1589B-54F, the Sediment Temperature 2 (SET2) probe was deployed and inserted ~1 m into the formation at a depth of 288.2 mbsf. HLAPC continued until 1230 h to Core 70F and a final depth of 359.4 mbsf. The core barrel was retrieved and laid out. The SET2 probe was again deployed following Core 70F, this time at a depth of 359.4 mbsf, with successful results. However, the sediments had firmed up significantly and the tool did not get the full 1 m penetration. The drill string was pulled out of the hole with the bit clearing the seafloor at 1533 h.

A rotary core barrel (RCB) bottom-hole assembly (BHA) with a new bit was assembled. At 2030 h the BHA was completed, and the pipe trip began at 2100 h. After verifying the vessel position (20 m south of Hole U1589B) the center bit was dropped. Hole U1589C was spudded at 2304 h. The seafloor was confirmed by tagging it at 493.6 meters below rig floor (mbrf). The hole was drilled without recovery to 360.0 mbsf. The center bit was retrieved and replaced with an RCB barrel. RCB coring commenced from Core U1589C-2R at 360.0 mbsf. Coring continued through 29 December to the final Core 28R from a depth of 621.9 mbsf. The hole was then displaced with heavy (10.5 lb/gal) barite mud. The drill string was pulled out of the hole with the top drive to 544.8 mbsf. The top drive was racked back, the string tripped up to 50.4 mbsf, and the end of the drill string spaced out to 65.0 mbsf for logging.

Logging began at 1200 h on 29 December. The floor was rigged up for logging and the triple combo was assembled. The tool string was deployed at 1330 h. A downhole log was completed to 544.8 mbsf, where the tool encountered an obstruction. The tool logged uphole and was sent down again to 544.8 mbsf with its calipers closed. Following this, the primary uphole log pass was started. The triple combo became stuck with the top of the tool at ~227.7 mbsf. After trying multiple solutions, the tool remained stuck.

In working the pipe up and down, it was discovered the drill string was stuck. The hole was circulated with overpull applied to work it free. On 30 December, the drill string was unscrewed on the rig floor and a T-bar was installed on the logging line. The drill string was advanced downhole, washing down to just above the triple combo. The BHA washed over the logging tool for ~4 m, until 10,000 lb overpull was observed on the weight indicator. The logging tools came free. The drill string was pulled up to 115.5 mbsf when the BHA became stuck in the hole. After several attempts were made to free the BHA, the decision was made to sever the drill string. On 31 December at 0930 h the line was successfully severed. At 1800 h the rig floor was secured for transit and the thrusters were raised. The vessel was out of dynamic positioning (DP) mode and under bridge control at 1805 h. The sea passage to Site U1590 (proposed Site CSK-03A) started at 1818 h.

The vessel arrived on location and started lowering the thrusters at 1946 h. All thrusters were down and secured at 2012 h. The vessel was again switched to DP mode and on autocontrol at 2020 h, officially starting Site U1590. The transit to Site U1590 took only 1.9 h, covering 14.5 nmi at an average speed of 7.6 kt. The week ended at midnight on 31 December with the rig crew assembling the advanced piston corer/extended core barrel (APC/XCB) BHA in preparation to start Hole U1590A.

Science Operations

Expedition 398 scientists finalized all methods chapters and laboratory specific training during the transit period. Throughout the week, samples and data from Holes U1589A, U1589B, and U1589C were acquired and analyzed. A summary of this week's activities from each laboratory group follows.

Lithostratigraphy

The Sedimentology group described Cores U1589B-3H to 70F and U1589C-2R to 28R. The lithofacies encountered in Hole U1589B are the same as in Hole U1589A, though the recovery of ash and lapilli layers in the upper parts of the hole was better than in Hole U1589A. Unit I consists of volcaniclastic sediments, Unit II consists of calcareous oozes, and Unit III consists of shell-bearing siliciclastic sediments. Coring in Hole U1589C began at 360 mbsf, the depth of the base of Hole U1589B. Below this depth, two more distinct lithofacies were identified. Unit IV consists of altered siliciclastic sediments (breccia and conglomerates) and Unit V consists of limestone rocks. Units I and II were subdivided into further subunits.

The main structure observed in Holes U1589B and U1589C is bedding with a shallow angle that slightly increases with depth and represents one or more tilting events. Normal faults observed generally show only a few millimeters offset. In some sections of the carbonate breccia, we observed foliation of limestone clasts, all oriented to the same direction. Similar to Hole U1589A, the most common drilling disturbances in the APC and HLAPC cores of Hole U1589B

were soupy and slurry, suck-in, and uparching. RCB cores showed several instances of heavy biscuiting and fall-in.

Biostratigraphy

The Biostratigraphy group analyzed 97 core catchers, multiple discrete (toothpick) samples, and one thin section for planktic and benthic foraminifers as well as calcareous nannofossils. Biostratigraphic markers identify crucial individual Pleistocene ages that enabled a precise age-depth correlation throughout the holes. The thin section from the bottom of Hole U1589C identified Eocene nummulitic limestone that is in good agreement with basement outcrops on surrounding islands. Most samples show a significant amount of reworked Pliocene material, most likely coming from outcrops on the surrounding islands. Microfossil preservation across all groups is very good, in general. Due to the volcanogenic nature of the cored sequences, residues from washed samples contain significant amounts of volcaniclastic particles. In addition, pyrite, carbonaceous plant-derived matter, bivalve and gastropoda shell fragments, pteropoda, scaphopoda, bryozoa, arthropoda, echinoid spines and plate fragments, radiolarians, ostracods, ooliths, and fish teeth were identified.

Paleomagnetism

Natural remanent magnetization (NRM) was measured on archive half core sections from Holes U1589B and U1589C. This week's focus was on improving the data quality of our records. Thus, disturbed core sections were no longer measured to allow more time for the detailed analysis of several intervals. In total, the Paleomagnetism group produced 21,200 demagnetization plots. As this amount exceeds the number of measurements an individual or a group of three can analyze, an automated approach was developed. This algorithm weighs the quality of measurements and automatically rejects measurements of poor quality. The detailed analysis revealed several instances of so-called gyro-remnant magnetization that point to the presence of greigite (Fe_3S_4), a characteristic diagenetic mineral. Identifying and understanding these intervals significantly helped to gain a better overview of intervals with true magnetic excursions and reversals vs. intervals with a diagenetic overprint. In addition, detailed analyses on 196 discrete samples were conducted.

Geochemistry

In Hole U1589B, the focus was on filling gaps in the interstitial water (IW) record recovered in Hole U1589A. The 10 cm whole-round samples were processed by squeezing immediately after core retrieval and aliquoted for shipboard and shore-based analyses. Total organic carbon (TOC) was calculated using total carbon and inorganic carbon values. Following convention set forth by Kidd et al. (1978), units with TOC values higher than 2.0 wt% were identified as sapropels and units with TOC values between 0.5–2.0 wt% were identified as sapropelitic. Following the identification and classification of sapropel layers, the group is now working on identifying sapropel units and their ages.

Headspace sampling resumed in Hole U1589C, below the depth previously covered in Holes U1589A and U1589B.

Physical Properties

On all core sections of Holes U1589B and U1589C (with the exception of Cores U1589C-24R and 26R–28R), the Physical Properties group measured gamma ray attenuation (GRA) density and magnetic susceptibility (MS). *P*-wave velocity was only measured on core from Hole U1589B as the RCB core sections did not fully fill the liners, rendering *P*-wave measurements useless. MS, GRA, and *P*-wave records for Hole U1589B were similar to those from Hole U1589A, with MS peaking in volcaniclastic intervals and GRA peaking in nannofossil oozes. The near complete record of physical properties for the site enabled us to reevaluate the seismic velocity models for this site as well as for Site U1590 and potentially all other upcoming sites of Expedition 398.

The APCT-3 tool was run during Core U1589B-14F and the SET2 tool was run at the bottom of Cores U1589B-54F and 70F. Preliminary interpretation of the collected temperature data point to a control on subbottom temperatures by changes in ocean temperatures and sedimentation rates.

Downhole Logging

Downhole wireline logging characterizes subseafloor lithologies and their structures. It is especially important to fill gaps at depth intervals where XCB and RCB coring may retrieve cores of lower recovery in stiff sediments, boulder deposits, and basement rocks. A suite of downhole logging tools provides continuous physical properties data in situ at sampling intervals ranging from 2.5 mm to 0.15 m. These data help with the interpretation of whole-hole lithostratigraphy, formation fluid properties, and measured temperatures. Downhole logs are ultimately used to conduct multiscale correlations of data acquired throughout and beyond Expedition 398 by bridging measurements on discrete sample/whole and/or half core and various regional-scale data, including seismic reflection records. After drilling operations in Hole U1589C, we deployed the triple combo logging string, equipped with the Hostile Environment Natural Gamma Ray Sonde (HNGS), the Hostile Environment Litho-Density Sonde (HLDS), the High-Resolution Laterolog Array (HRLA) tool for electrical resistivity, and the Magnetic Susceptibility Sonde (MSS). For all sensors, we got one complete downhole log to 544.9 mbsf, as well as two partial uphole log runs. The tool got stuck at 227.7 mbsf and was successfully recovered several hours later. Preliminary analysis of all data—measured at a 5 cm interval—shows a very high degree of correlation to shipboard logging track data and provide a nearly complete record for Hole U1589C. All data were sent to the Lamont Doherty Earth Observatory (LDEO) at Columbia University in the US for further processing.

Stratigraphic Correlation

The Stratigraphic Correlators' main activity focused on the correlation of Holes U1589A and U1589B to identify coring gaps and create a first, tentative splice between both holes. All core

sections of Hole U1589B were run through the Special Task Multisensor Logger (STMSL) at a 10 cm interval. STMSL GRA bulk density and MS data were correlated to the record of Hole U1589A and was used to facilitate real-time adjustments of drilling depth and intervals. As the drilled interval of Hole U1589C did not significantly overlap with the other holes, no correlation was attempted.

Education and Outreach

We hosted one live tour with students at Kobe and Kyoto Universities and reached ~40 students. We also conducted a live TV interview with *Action24 Greece*, the third largest TV station in Greece. Across all our social media platforms we had 31,244 impressions, and an average engagement rate of 9.23%. This week we created the first animations for Twitter and posted our first Instagram reels. The reel and the animated tweet were the highest performing posts this week on their platforms. In addition to those activities, the Outreach Officer wrote and posted the first blog.

Technical Support and HSE Activities

Laboratory Activities

- Staff processed cores and samples from Holes U1589A through U1589C, and U1590A.
- SET2 tool was deployed successfully twice in Hole U1589C.
- The water temperature continued to rise in the Haskris water chiller, a necessary component for the superconducting rock magnetometer (SRM). The inline filter was removed, cleaned, and left uninstalled. The heat exchange unit in the Haskris was removed and cleaned.
- The inductively coupled plasma–atomic emission spectroscopy (ICP-AES) plasma would not light. The Argon gas was bad and connecting the instrument to a new argon bottle solved the issue.
- N_2 generator pre-filters were found to be full of grease. This set of filters was last replaced in October 2022. Filters were again replaced.
- TAS staff helped split scientific pilot samples into several personal samples.
- Ship electricians installed new LED lights on the catwalk.

IT Support Activities

- Ship laptops were updated with current patches and software updates.
- Assisted TAMU with fixing issues with email servers that hindered sending attachments.
- Set up a new network “share” folder to store previous expedition data on a longer-term basis.

Application Support Activities

- Penetrometer data upload support, including data corrections and rejecting observations where whole-rounds were taken.
- Made minor revisions to penetrometer LIMS reports. They were distributed on ship and will be updated on shore.
- Code repository mirroring from ship to shore was reestablished.

Health, Safety, and Environment Activities

- Emergency shower and eye wash stations were tested.
- Scheduled reminder of the JRSO Code of Conduct sent to Expedition 398 personnel.