IODP Expedition 398: Hellenic Arc Volcanic Field

Week 2 Report (18–24 December 2022)

During the second week of the International Ocean Discovery Program (IODP) Expedition 398, we completed our transit from Tarragona, Spain, to our working area in the Greek Aegean Sea.

Merry Christmas from everyone aboard Expedition 398.

Operations

Week 2 of Expedition 398 began on 18 December 2022 with the vessel in transit to Site U1589 (proposed Site CSK-01A). The ship arrived on site at 0715 h on 21 December. The transit, including pilotage, covered 1237.4 nmi over 113.7 h, for an average speed of 10.9 kt. The thrusters were lowered and secured at 0736 h. The vessel was switched from cruise mode to dynamic positioning (DP) mode at 0745 h, officially starting Site U1589 and Hole U1589A. The drill string was assembled, consisting of a 5 inch drill pipe and an advanced piston corer/extended core barrel (APC/XCB) bottom-hole assembly (BHA). After assembling the BHA, it was lowered to 452.1 meters below rig floor (mbrf). The nonmagnetic sinker bar assembly was picked up, the Icefield MI-5 orientation tool was loaded, and the sinker bars were installed.

Hole U1589A was spudded at 1435 h with Core U1589A-1H recovering 2.2 m. From the shot depth of 488.0 mbrf, the seafloor was calculated at 495.3 mbrf (484.3 meters below sea level [mbsl]). The outer seals on the APC were changed out following Core 5H. The advanced piston corer temperature (APCT-3) probe was run on Cores 4H, 7H, 10H, and 13H. The results from the temperature measurements were useable, but not of the highest quality. APC coring continued into 22 December, when 45,000 lb overpull was observed following Core 15H at 125.7 meters below seafloor (mbsf). The core was drilled over and retrieved at 0500 h. Coring was switched over to half-length advanced piston corer (HLAPC) with Core U1589A-16F. HLAPC coring continued to Core 65F at 360.8 mbsf at 1130 h on 23 December. The core became stuck after firing, with an overpull of 40,000–50,000 lb. It took a drillover of approximately 4 m to free the barrel. Coring was switched to XCB with Core U1589A-66X. Coring continued into 24 December; the final XCB core retrieved was Core U1589A-76X. The final depth of Hole U1589A is 446.7 mbsf.

At 0600 h on 24 December, the trip to mudline commenced, with the drill string being pulled up to 420.7 mbsf and the top drive racked back. The pipe was pulled up to 481.3 mbrf, clearing the seafloor at 0820 h, ending Hole U1589A. At 0830 h the top drive was made up and the vessel offset 20 m east. Hole U1589B was spudded from 492.0 mbrf with Core U1589B-1H at 0950 h. The recovery was 7.9 m, with a calculated water depth of 493.6 mbrf (482.6 mbsl). Coring

continued from Cores U1589B-2H to 12H at 96.2 mbsf. Core 5H was shot from a slightly higher position to attempt to fill a stratigraphic gap in Hole U1589A.

Core U1589B-11H was also shot from a higher depth to fill a stratigraphic gap. Before Core 12H, the bit was advanced by recovery (0.62 m) after an apparent misfire on 11H. The APCT-3 was run on Cores 5H, 6H, and 11H, all collecting good data.

The week ended at midnight on 24 December while taking Core U1589B-12H, with a bit depth of 96.2 mbsf.

Science Operations

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

Lithostratigraphy

The Sedimentology group described Cores U1589A-1H to 76X and U1589B-1H and 2H. Based on the main lithofacies encountered, the recovered sequence of Hole U1589A was subdivided into three major lithostratigraphic units. Unit I is characterized by dark gray to black volcaniclastic and siliciclastic lithologies of ash, centimeter- to meter-thick beds of white lapilli pumice, tuffaceous muds, lapilli ash, and ash-bearing muds. The dominant contact between volcaniclastic intervals and muds is sharp, with some intervals showing a gradual transition or erosional surfaces. An interval of pelagic to hemipelagic mud and silty clay marks the transition to Unit II. This unit is dominated by light gray calcareous oozes with ash, sapropel layers, and nannofossil-rich muds. The ooze facies are moderately bioturbated and relatively homogenous. Only one volcaniclastic interval is present in this unit, consisting of tuffaceous sand, ash, and lapilli. Below, Unit III's lithofacies becomes more dominated by hemipelagic and shelf sediments consisting of sand and silt intervals with high amounts of shells, rare fish bones, and foraminifera. The base of this unit is marked by fully terrestrial sediments of reddish-brown breccia and sandstones.

The main structures identified by the Structural Geology group were horizontal and subhorizontal beds that developed a faint inclination toward the bottom of Hole U1589A. Volcanic-related units tend to develop smaller inclinations than pelagic units. In addition, some core sections contained sediment faults that correspond to the main basin structures.

Different types of drilling disturbances were identified during core description. In APC and HLAPC cores, the most common disturbances identified were soupy and slurry, suck-in, and uparching. XCB cores showed some instances of minor biscuiting.

Biostratigraphy

In order to attribute the ages of the recovered sediments, the biostratigraphy of planktic and benthic foraminifers as well as calcareous nannofossils was analyzed for all core catcher samples in Hole U1589A and for selected core catchers in Hole U1589B. Eleven biostratigaphical ages from species of the upper Pleistocene to the Pliocene have been identified. Most samples show a significant amount of reworked Pliocene material, most likely coming from outcrops on the surrounding islands. Microfossil preservation across all groups was very good in general. Only the lowermost intervals that are dominated by shallow paleowater depths show poor preservation.

Paleobathymetry, based on benthic foraminifera, indicates several pulses or basin development. Toward the bottom of the record, water depths progressively shoal toward terrestrial environments. The intervals described as terrestrial breccias and sandstones did not contain any microfossils.

Paleomagnetism

Paleomagnetic analyses during Expedition 398 focused on measurement of the remanent magnetization of archive-half sections on the superconducting rock magnetometer (SRM) before and after alternating field (AF) demagnetization. Natural remnant magnetization (NRM) of archive-half core sections from Hole U1589A were measured to provide the magnetostratigraphy of Site U1589 and followed stepwise demagnetization of the archive halves using the SRM. Throughout Hole U1589A, five steps of demagnetization and six measurements were conducted. The high sedimentation rates in the Anhydros Basin complicate the analysis of magnetic reversals. Thus, at the end of the week, several reversals have been identified, yet the paleomagnetists are not confident to determine which reversals the detected signals represent.

Analyses of the archive-halves were complemented by experiments on discrete cubic specimens taken from working-half core sections. These were subjected to stepwise AF demagnetization, thermal demagnetization (up to 700°C), or a combination of low-temperature demagnetization (down to 77 K) followed by either AF or thermal treatment (up to 700°C). Two intervals with promising signals of potential magnetic excursions were subsampled with three discrete cubic specimens, instead of one.

Geochemistry

In Hole U1589A, interstitial water (IW) samples for geochemical analyses were taken as 5 to 15 cm long whole-rounds from the bottom of Section 4 and headspace samples for hydrocarbon monitoring from the top of Section 5 in every APC core. Sampling intervals were reduced by half when using the HLAPC and XCB systems, resulting in one sample every ~10 m. Samples were processed by squeezing immediately after core retrieval and aliquoted for shipboard and shore-based analyses. IW samples were analyzed for salinity, chlorinity, alkalinity, and pH. In addition, water and rock samples were prepared for inductively coupled plasma–atomic emission

spectrometry (ICP-AES) analysis of major and minor elements (Fe, Mn, K, Ca, Ba, Sr, Si, and P).

Analysis of headspace samples reveals only minor amounts of methane (up to 4 ppmv) between Cores U1589A-40F and 60F and no significant amounts of ethane in any sample. IW analyses show an increase in alkalinity in the first 75 m to about 9 mM, decreasing values to a depth of 175 m, and more variable values below 250 m. These values are in good agreement with the remineralization of organic matter, the internal variability with the occurrence of sapropel layers. Pore water salinities are consistent in the range of 38 to 40 PSU with one exception in the lower half of the hole.

Physical Properties

On all core sections, the Physical Properties group measured core density (gamma ray attenuation [GRA], magnetic susceptibility [MS], and *P*-wave velocity) using the Whole-Round Multisensor Logger (WRMSL). WRMSL measurements were taken in 2.5 cm increments. In Hole U1589A, compressional wave velocity (V_P) was measured via the caliper of the Section Half Measurement Gantry (SHMG) on every other section (unless the sections were too soupy); in Hole U1589B, the interval was reduced to one measurement per core. Natural gamma radiation (NGR) was measured in 10 cm increments on whole-round cores. Measurements for thermal conductivity were conducted with the puck tool once every core in Hole U1589A and once every other core in Hole U1589B. Downhole temperature measurements were performed in Hole U1589A with the APCT-3 at 30.7, 59.2, 87.7, and 116.3 mbsf, and in Hole U1589B at 43, 52.5, 71.5, and 85.7 mbsf. MS measurements have proven to be an important tool in recognizing even small centimeter-scale ash layers and can be used for fingerprinting these as well as for hole-to-hole correlation. In general, MS patterns are anticorrelated with GRA densities. Throughout Hole U1589A, GRA values increase in pelagic and hemipelagic oozes and decrease in the more porous ash and pumice lapilli layers. V_P data are in very good agreement with the main seismic reflectors of the Anhydros Basin and are a valuable tool in the adjustment of seismic velocity models.

Stratigraphic Correlation

The main activities of the Stratigraphic Correlators began with Hole U1589B, assessing the overlap between Holes U1589A and U1589B and developing a preliminary correlation and stratigraphy for Cores U1589A-1H to 11H and U1589B-1H to 12H. The Stratigraphic Correlators ran all core sections from Hole U1589B through the Special Task Multisensor Logger (STMSL). Within only 2 min, the STMSL provides MS and GRA-density data that are used for core-to-core correlation. The correlations between both holes informed the drilling strategy and was used to close some smaller core gaps that are present in the record of Hole U1589A.

Education and Outreach

This week, the Outreach Officer and the Expedition Project Manager (EPM) conducted one live ship-to-shore tour. The bulk of the tour was in German and reached 24 students. Across all social media platforms, we had 45,217 impressions and an average engagement rate of 6.70%. Our impressions increased from the 29,325 we had last week. In addition to those activities, the Outreach Officer finished writing a tour script for translation by scientists and staff members giving tours in languages other than English. We pitched eight US-based journalists about work on the expedition and started compiling a list of schools to reach out to about live tours once the holidays are over. The Outreach Officer used extra holiday down time without scheduled tours to get ahead on drafting and scheduling blogs and social media posts.

Technical Support and HSE Activities

Laboratory Activities

- G-guns, 2 arrays, were set up and ready to deploy for use with the Versatile Seismic Imager (VSI).
- Laboratory training continued for scientists.
- A sediment trap was properly installed in the Core Laboratory to prevent drainage issues.
- Fo'c's'le deck: water quality stabilized once the ship departed Tarragona. The quality is still at borderline of 0.1 MΩ. Genpure is working properly, producing 18.1 MΩ water.
- JRSO staff are busy with processing cores and samples. Cores are on deck every 20–30 min.
- Core orientation tools were run in both Holes U1589A and U1589B.
- Aeris X-ray diffraction (XRD) is being used for all XRD samples.
- ICP-AES samples were taken from pumice.

IT Support Activities

- Linux servers were updated.
- Tested and installed patches on Windows servers and workstations and Apple workstations.
- Tested and installed Office and Adobe product updates.
- Installed blocks for TikTok on all IT assets in accordance with TAMU directives.
- Internet outage cause was determined to be a vendor "AS Negotiation" problem in California data center.

Application Support Activities

- The use of the “data append” in Correlator software leads to poor software performance and (under a condition to be identified) corruption of the Correlator database such that duplicate plots of sections and “stray” data points occur.
- Hole U1589B operations led to explicit overlap of driller top depths and bottom depths. Core top depths and advancements were edited.

Health, Safety, and Environment

- Emergency shower and eye wash stations were tested.
- COPE mitigation period ended on 19 December.