

## **IODP Expedition 398: Hellenic Arc Volcanic Field**

### **Site U1597 Summary**

#### **Background and Scientific Objectives**

Site U1597 (proposed Site CSK-05C) is located in the northern basin of the Santorini Caldera. It lies at a water depth of 382 meters below sea level (mbsl).

The four caldera sites (U1594–U1597) were planned to sample intracaldera seismic Units S1–S3, to test the published correlations between the two caldera basins, to penetrate below Unit S3 (seismic Unit S4), and to address scientific objectives 1, 4, 5, and 7 of the Expedition 398 *Scientific Prospectus*. The seismic units were thought probably to consist of (S1) muds and sands from cliff mass wasting, (S2) compacted (possibly lithified) sandy volcanoclastics from Kameni Volcano, and (S3) consolidated coarse blocky tuffs, landslide debris, and/or flood gravels. Seismic Unit S4 may be intracaldera tuffs. The goals were to ground truth the different seismic units, document the processes, products, and potential impacts of the Late Bronze Age (LBA) eruption, reconstruct the eruptive history of Kameni Volcano, penetrate below Unit S3, and discover the nature of Unit S4. The combined approach of drilling in the northern and southern caldera basins would enable us to test several hypotheses regarding the LBA caldera-forming eruption of Santorini. By drilling both caldera basins and exploiting our dense seismic reflection coverage, we would gain access to the 3D architecture of the entire caldera fill and better understand the relative roles of downfaulting and downsagging in the LBA caldera collapse. We would also target the question of why the northern basin is 100 m deeper than the southern one, with a thicker seismic Unit S1 but thinner seismic Unit S3. Finally, we would be able to test whether seismic Unit S3 consists of flood debris from the caldera-flooding event or whether it represents LBA intracaldera tuffs. The intracaldera sites would be used for the microbiological work of objective 7.

#### **Operations**

Hole U1597A (36°26.2494'N, 5°22.7326'E) was spudded on 24 January 2023 at 1240 h. Core U1597A-1H recovered 5.6 m and the depth of the seafloor was calculated as 382.3 mbsl. Coring continued with the advanced piston corer (APC) to Core 5H, at a final depth of 43.6 meters below seafloor (mbsf). Excessive torque started building in the pipe. The drill string was tripped up with the top drive and the bit cleared the seafloor at 1547 h. The bit cleared the rotary table at 1728 h and the rig floor was secured for transit. The thrusters were raised starting at 1815 h. The vessel was switched to bridge control at 1818 h. All thrusters were up and secure and the start of the sea passage began at 1824 h, ending Site U1597 (proposed Site CSK-05C).

## Principal Results

Cores from Site U1597 recovered a coherent stratigraphy from 0 to 42.62 mbsf. The recovered material is unlithified sediment, dominated by volcanic material with minor amounts of mud and tuffaceous mud in the upper 8 m. Smear slides for microscopic analyses were prepared to confirm macroscopic descriptions of distinct lithology changes at the section level, such as identification of vitric particles in tuffaceous lithologies or crystals in ash layers.

It was not possible to measure any structures at Site U1597. Although some bedding planes were observed, core-induced disturbance prevented the measurements.

No calcareous nannofossils or benthic foraminifers were found in core catcher samples; however, very rare planktic foraminifers were found in the forms of *Globoturborotalita rubescens* and *Globigerinoides ruber*. Additionally, rare ostracods were found, though biological remains were of insufficient quantity to permit paleoenvironmental analyses.

As only one hole was drilled, no stratigraphic correlation was possible at Site U1597.

Seven automated vane shear (AVS) measurements were made on working half sections. Because volcanoclastic materials are not suitable for these measurements, few measurements could be made. A total of 127 *P*-wave velocity measurements were conducted on working half sections. Discrete measurements of *P*-wave velocity on working half core sections are similar to those measured by Whole-Round Multisensor Logger (WRMSL) measurements on whole-round cores. For lapilli and larger-sized clasts, the particle size was a substantial fraction of the distance between the two calipers used to make the measurements and hence the measurements may not be representative of true bulk properties.

A total of 14 discrete samples were collected for moisture and density (MAD) measurements. Bulk density derived by MAD measurements on discrete samples should be more reliable than gamma ray attenuation (GRA) data from WRMSL measurements on whole-round cores; however, in both cases, coring and recovery disturbances may have impacted measured values.

To determine the geochemistry of the volcanic and tuffaceous materials, three tephra and ash samples were handpicked from various layers within Hole U1597A. Following cleaning, grinding, fusion, and dissolution, the materials were analyzed shipboard for major (Si, Al, Fe, Mg, and Ca), minor (Ti, Mn, Na, K, and P), and trace (Sc, V, Cr, Co, Ni, Cu, Zn, Rb, Sr, Y, Zr, Nb, Ba, Ce, and Nd) elements using inductively coupled plasma–atomic emission spectroscopy (ICP-AES). Of the volcanoclastic units sampled, all three were classified as dacites. Bulk chemistry values are less evolved than glass chemistry.

To determine the inorganic constituents of IW, a total of five water samples were taken from the mudline and whole-round squeezing of sediment intervals at Site U1597. Aliquots of IW were used for shipboard analyses, and the remaining water was taken for shore-based analysis. The retrieved pore waters were analyzed shipboard for salinity, alkalinity, pH, major anions ( $\text{Cl}^-$ ,

SO<sub>4</sub><sup>2-</sup>, and Br<sup>-</sup>), major cations (Ca<sup>2+</sup>, Na<sup>+</sup>, Mg<sup>2+</sup>, and K<sup>+</sup>), and major (S, Ca, Mg, K, and Na) and minor (B, Ba, Fe, Li, Mn, P, Si, and Sr) elements.

Headspace gas analyses were performed at a resolution of one sample per full-length core (9.5 m advance) throughout Hole U1597A. The aim was to monitor the presence and abundance of C1–C3 hydrocarbons as part of the standard IODP safety protocol. A total of nine headspace gas samples from this hole were analyzed by gas chromatography (GC). Methane, ethane, and propane concentrations are below the detection limit through all of Hole U1597A.

Concentrations of heavier hydrocarbons (*iso*-butane, *n*-butane, and *n*-pentane, etc.) were below the detection limit throughout Hole U1597A.

None of the cores recovered at this site were suitable for paleomagnetic analysis.

Due to the instability of the formations encountered, downhole logging was not conducted at Site U1597.