

2011

Exploration of the Kolumbo Volcanic Rift Zone

Steven Carey

University of Rhode Island, scarey@uri.edu

Katherine L. Croff Bell

University of Rhode Island, kcroff@gso.uri.edu

See next page for additional authors

Follow this and additional works at: <https://digitalcommons.uri.edu/gsofacpubs>



Part of the [Engineering Commons](#), [Oceanography Commons](#), and the [Volcanology Commons](#)

Terms of Use

All rights reserved under copyright.

Citation/Publisher Attribution

Carey, S., Bell, K. L. C., Nomikou, P., Vougioukalakis, G., Roman, C. N., Cantner, K., Bejelou, K., Bourbouli, M., & Martin, J. F. (2011). Exploration of the Kolumbo Volcanic Rift Zone. In K. L. C. Bell and S. A. Fuller (eds.), *New Frontiers in Ocean Exploration: The E/V Nautilus 2010 Field Season*. *Oceanography* 24(1), supplement, pp. 24-25.

doi: [10.5670/oceanog.24.1.supplement](https://doi.org/10.5670/oceanog.24.1.supplement)

This Article is brought to you for free and open access by the Graduate School of Oceanography at DigitalCommons@URI. It has been accepted for inclusion in Graduate School of Oceanography Faculty Publications by an authorized administrator of DigitalCommons@URI. For more information, please contact digitalcommons@etal.uri.edu.

Authors

Steven Carey, Katherine L. Croff Bell, Paraskevi Nomikou, Georges Vougioukalakis, Christopher N. Roman, Kathleen Cantner, Konstantina Bejelou, Maria Bourbouli, and Julie Fero Martin



New
Frontiers in
Ocean Exploration

The E/V *Nautilus* 2010 Field Season

GUEST EDITORS |
KATHERINE L.C. BELL AND
SARAH A. FULLER



Exploration of the Kolumbo Volcanic Rift Zone

By Steven Carey, Katherine L. Croff Bell, Paraskevi Nomikou, Georges Vougioukalakis, Christopher N. Roman, Kathleen Cantner, Konstantina Bejelou, Maria Bourboulis, and Julie Fero Martin

The seafloor northeast of Santorini volcano in Greece consists of a small, elongated rifted basin that has been the site of recent submarine volcanism (Sakellariou et al., 2010). This area lies within the Cyclades back-arc region of the present Hellenic subduction zone where seafloor of the eastern Mediterranean Sea is descending beneath the Aegean microplate. The Cycladic region and the Aegean Sea as a whole are known to be locations of southeasterly back-arc extension and continental crust thinning. Nineteen submarine volcanic cones occur within this small rift zone (Figure 1).

Previous SeaBeam multibeam bathymetric mapping and seismic studies indicate that many of the smaller volcanic

cones are built above the present seafloor, while others are partly buried, indicating a range of ages for activity along this volcanic line. None of the cones to the northeast of Kolumbo had been explored in detail prior to the 2010 E/V *Nautilus* cruise. The ROV *Hercules* explored the slopes, summits, and craters of 17 of the 19 volcanic centers identified on multibeam maps of the area. The submarine volcano's summits ranged from 18–450-m water depth. In general, the domes/craters northeast of Kolumbo were sediment covered and showed little evidence of recent volcanic activity. We found volcanic rock outcrops in the crater walls and slopes of some of the cones, but they typically consisted of pumice and lava fragments that had

been cemented together by biological activity, indicative of the lack of recent eruptions. One cone, target 68 (Figure 1), showed evidence of low-temperature hydrothermal circulation on the summit and upper flanks in the form of stream-like manganese precipitates emanating from pits and fractures. Geochemical analysis of samples collected on the northeast cones will provide insights into the sources of magmas to these centers and their relationship to the nearby Santorini volcanic complex.

Unlike the smaller cones of the northeast rift zone, Kolumbo exhibits dramatic evidence of recent volcanic activity and the potential for future eruptions. Kolumbo is a 3-km-diameter cone with a 1500-m-wide crater, a crater rim as shallow as 15 m in the southwest, and a crater floor 500 m below sea level (Figure 1). ROV explorations of the crater walls revealed a fascinating underwater landscape of pumice deposits up to several hundred meters thick. These deposits formed as a result of the

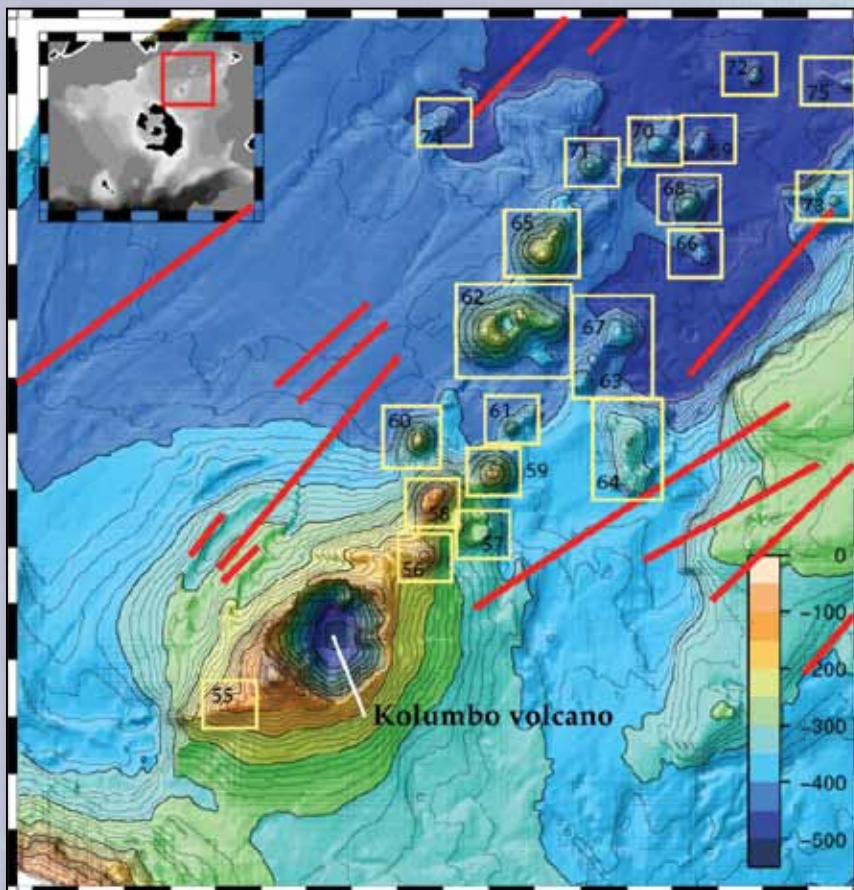
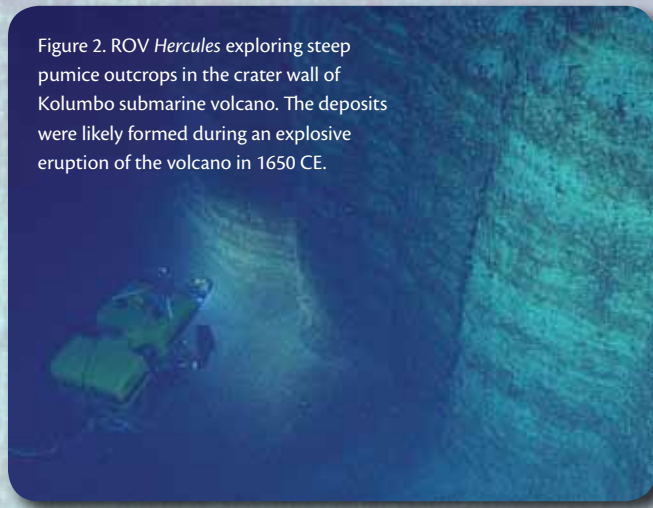


Figure 1. Bathymetric map of Kolumbo and other submarine cones in the Kolumbo volcanic rift zone northeast of the Santorini volcano, Greece. Inset map shows the main island of Santorini and location of study area. Solid red lines are northeast/southwest-trending faults in the rift basin. Unpublished swath bathymetric data collected in 2001 aboard R/V *Aegaeo* around Santorini, Greece, by S. Alexandri, P. Nomikou, and D. Ballas.

explosive 1650 CE eruption that caused significant damage and fatalities on nearby Santorini Island. Mass wasting since the eruption has sculptured complex scalloped outcrops with knife-edge promontories that extend outward from the crater walls (Figure 2; see page 16, Figure 3). Observations and samples from this sequence will provide important information about the processes of shallow-water explosive volcanism and the hazards that it poses to island and coastal communities.

On the floor of Kolumbo's crater (500-m depth) is an active hydrothermal vent field, first discovered in 2006 (Sigurdsson et al., 2006), where a Kuroko-style massive sulfide deposit is currently forming (Figure 3a). Only a handful of such deposits have been identified in the world's ocean and they are of great interest because of their higher gold and silver contents compared with the well-known black smoker vents found along mid-ocean ridges (Tivey, 2007; Figure 3b). New ROV explorations of the Kolumbo hydrothermal field led to the discovery of the largest vent structure yet found at the volcano. In the northern part of the crater, a 6-m-high, bacteria-draped vent, nicknamed Poet's Candle, rises above the sediment-covered floor (Figure 3c). An interesting characteristic of Kolumbo's hydrothermal vents is the active discharge of gas bubbles

Figure 2. ROV *Hercules* exploring steep pumice outcrops in the crater wall of Kolumbo submarine volcano. The deposits were likely formed during an explosive eruption of the volcano in 1650 CE.



together with high-temperature fluids. This feature is unique to relatively shallow-water volcanic centers in subduction zone environments. Samples of these gases were collected on cruise NA007 using special gas-tight sampling bottles (Figure 3d). Ongoing analyses of the samples by John Lupton (NOAA/PMEL) and Marv Lilley (University of Washington) will determine gas composition and enable interpretations to be made about its origin. In addition, detailed mapping of the hydrothermal field using photomosaics and multibeam data is the first attempt to construct an integrated, high-resolution image of this type of vent system at a subduction zone volcano (see page 15). Such a map will be valuable in assessing the complete distribution

of vents and their sizes, as well as their contribution to the total mineral resources of the deposit.

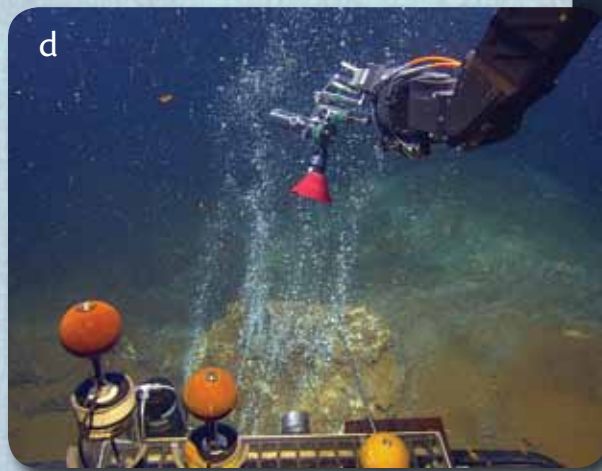


Figure 3. The northern part of the Kolumbo volcano's crater floor has an extensive hydrothermal vent field where massive sulfide chimneys are venting high-temperature fluids (> 200°C) and gases. (a) ROV sampling massive sulfide chimney. (b) Broken vent chimney revealing zonation of hydrothermal minerals. (c) Six-meter-high "Poet's Candle" hydrothermal vent with bacterial covering. (d) Sampling gases being given off by hydrothermal vent using a gas-tight container.