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Volcanism and tectonics in an island-arc rift environment: proposal to drill at Christiana-Santorini-Kolumbo marine volcanic field, Greece

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Subduction-related volcanism plays an important role in society through its impact on life and the environment. Better understanding of island-arc volcanism and mitigation of associated risk requires study of the processes that drive such magmatism, the interactions and feedbacks between tectonics and volcanism, and how volcanoes interact with their marine environments.

The Christiana-Santorini-Kolumbo (CSK) volcanic field on the Hellenic Volcanic arc of Greece is a unique system for addressing these issues. It lies in a rift system 100 km long and 45 km wide, oblique to the island arc, that is one of the most volcanically and seismically active regions of Europe. The volcanoes include three polygenetic and over 20 monogenetic centers that have jointly produced over a hundred explosive eruptions over the last few hundred thousand years. The volcanoes pose an important threat to the Eastern Mediterranean region. The Santorini eruption of the Late Bronze Age (LBA) is an iconic event in volcanology and archaeology. Unrest at Santorini caldera in 2011-12 raised awareness of eruption threat at an island archipelago visited by 1.5 million tourists per year.

The results of extensive onland volcanological research, eruption dating, multi-beam sea floor mapping, shallow sediment coring and dredge sampling, combined with a high-quality site-survey database of multichannel seismic profiles and a recent seismic tomography experiment, make deep drilling at the CSK volcanic field very timely. Deep drilling is essential to identify, characterize and interpret depositional packages visible on seismic images, to chemically correlate Santorini-derived volcanic layers in the rift fills with the dated onshore stratigraphy, to provide a tight chronostratigraphic framework for marine successions, and to sample ancient shallow marine hydrothermal systems, pore waters and microbial colonies.

Some main objectives of drilling are to: (1) document the history of tectonics, subsidence, sedimentation and volcanism in an arc-rift environment, and how volcanism has evolved spatially and temporally since rift initiation; (2) determine how the genesis and compositions of magmas and their associated volatiles have evolved in time and space over the lifetime of the rift; (3) document the dynamics and environmental impacts of arc eruptions (including the LBA eruption) and calderas, including eruption frequencies, magnitudes and rates, the mechanisms of caldera collapse, and the origin of caldera unrest events; (4) document the occurrence and nature of deep caldera-hosted ecosystems. We will drill into the volcano-sedimentary fills of the rifts (up to several hundred metres thick) to access a near-continuous record of volcanism, sedimentation and basin subsidence since the onset of rifting in the Pliocene, and to seek relationships between volcanism and tectonics. Drilling inside Santorini caldera will address fundamental questions about how arc calderas form, and will investigate the nature of a unique funnel-shaped zone of low seismic velocity identified by seismic tomography beneath the focus of caldera-floor inflation in 2011-12.

The proposal arose from a MagellanPlus meeting in Athens. The participants of that meeting are coauthors on this abstract.