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Using machine learning on CTD data to assess the natural hazard of active submarine vent fields: the case of Kolumbo near Santorini Island

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Almost three quarters of known volcanic activity on Earth occurs in underwater locations. The presence of active hydrothermal vent fields in such environments is a potential natural hazard for the environment, the society, and the economy. Despite its importance for risk assessment and risk mitigation, monitoring of the activity is impeded by the remoteness and the extreme conditions of underwater volcanoes.

Kolumbo near Santorini Island is an underwater volcano featuring an active hydrothermal vent field, which has shown near-explosive dynamics in the recent years. CTD (temperature, conductivity, salinity) time series from an earlier expedition in 2010-2011, which investigated mainly the northern part of the vent field, have been used to develop an advanced mathematical model based on the Generalized Moments Method to describe the underlying mechanisms governing the hydrothermal vent activity. The model was further tested successfully in the Abyss inactive caldera near Nisyros Island.

In the present work, we report on the findings of a dedicated GEOMAR expedition in 2017, which used an Autonomous Underwater Vehicle (AUV) to investigate the evolution of the NE-trending Santorini-Kolumbo line, where it also collected CTD data (temperature, conductivity, salinity). The Santorini-Kolumbo volcanic line is one of the few places in today's oceans where submarine rifting of a continental margin arc can be studied in its earliest stages. Detailed CTD depth profiles have been reconstructed from the raw data to study Kolumbo's hydrothermal vent field to a full extent.

The mathematical model is further validated by examining the GEOMAR CTD time series. This step is crucial towards developing a supervised machine-learning algorithm able to provide a reliable description of the dynamic conditions over the hydrothermal vent field in near-real-time fashion and potentially provide the means to predict explosive conditions. The impact on developing appropriate mechanisms and policies to avoid the associated natural hazard is expected to be immense.