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LipARi: A Novel Seismic Array to Characterize the Active Hydrothermal System Beneath Lipari Island, Italy

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This study focuses on producing a detailed 3-D shear-wave velocity model of Lipari Island (Aeolian Islands, Italy) using ambient noise to constrain the subsurface structure. Furthermore, an accurate seismicity catalog, and the character and extent of the main fault system bisecting the island will be determined to help assess the seismic hazard and understand the tectonic evolution of the volcano.

The Aeolian Islands consist of a 150-km long volcanic arc and are located between the Southern Tyrrhenian Sea backarc basin and the Calabrian Arc-Ionian Sea subduction system. The Aeolian volcanoes overlie 15 to 20 km thick continental crust and the ages of the volcanic products range from 1.3 Myr to the present. The volcanism started during the Pliocene, migrated southeastward, and is still active in the continuously erupting Stromboli Island, located in the easternmost portion of the arc, and Lipari, Vulcano and Panarea. Lipari and Vulcano are instead aligned at a high angle to the arc and are characterized by hydrothermal activity. They are interpreted as step-fault related volcanoes located at the western tip of the rolling-back slab. The Lipari fumaroles, including the St. Calogero geothermal area, are located in the western part of the island, where kaolin has formed due to the hydrothermal alteration on pre-existing lava flows and pyroclastic and lacustrine deposits. Fumaroles and active soil degassing are focussed on fractures and faults. A recent study has shown that a decrease in fluid discharge may reflect pressurization at depth that potentially precedes hydrothermal explosions.

We have recorded ambient noise, and local and regional seismicity over a time period spanning from 16 October to 14 November 2018 at a 4 ms sampling interval using 48 cable-free, self-contained seismic instruments (FairfieldNodal ZLand three-component nodes with a 5-Hz corner frequency) that were placed ∼0.1-1.5 km apart on Lipari Island. The objective of this study is to provide detailed images of the subsurface structure of Lipari Island and further our understanding of the underlying geodynamic processes. We will merge the seismic data with other geological datasets (such as lithology, faults and fractures and vents) to carry out a combined analysis of simultaneous measurements of CO_2 gas release and seismic properties, which will provide information on the dynamics of fluid ascent and pathways. Results from this study will improve our understanding of the fluid dynamics at shallow depth and the unrest episodes in active hydrothermal areas.