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Matching high-resolution seismic and electrical resistivity profiling to infer the shallow structure of Solfatara Volcano (Italy)

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Two coincident high-resolution seismic reflection and electrical resistivity profiles were acquired in the Solfatara tuff cone in May and November 2014, along with CO_2 flux and surface temperature measurements. The acquired data are a subset of the MedSuV - RICEN dataset, which also includes a wider series of time-lapse geophysical and geochemical experiments carried out within Solfatara volcano, with the aim of studying changes in the properties of the medium at small scales through repeated high-resolution multi-parameter observations over time.

Seismic reflection data were processed using the Common-Reflection-Surface stack, a fast and cost-effective alternative to standard reflection processing which allows to greatly improve signal-to-noise ratio in settings where structural complexity and high levels of ambient noise make it challenging to obtain a reliable seismic image. The reflection profiles provide the first high-resolution seismic images of Solfatara crater, depicting an asymmetrical structure filled by volcanoclastic sediments and whose bottom is found at about 400 ms TWT.

Seismic data also display several narrow zones with distinctive anomalous of very low amplitude located in several areas within the crater, which were interpreted as gas chimneys created by intersection of NE- and NW-trending sets of sub-vertical fault and fractures and filled by fluids (both in gas and liquid phases) escaping from the deeper hydrothermal source. The imaged degassing pathways terminate against a strong horizontal reflector at about 100 ms TWT. Just above those structural pathways, electric data show the presence of a dome-shaped electrically conductive structure, buried in the centre of the volcano at a minimum depth of 50 m and interpreted as the upper end of the hydrothermal plume. The plume projection at the surface of the crater matches with high CO_2 flux and soil temperature anomalies.

Our results provide a solid framework to constrain the near-surface geological interpretation of Solfatara area and to better understand and relate temporal changes of geophysical and geochemical measurements to the shallow geological structure of the most active volcano of Campi Flegrei Caldera, Italy, which it is presently characterized by an activity renewal, resulting in an enhanced hydrothermal activity and fumarolic emission increase.