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A strongly heterogeneous hydrothermal area imaged by surface waves: the case of Solfatara, Campi Flegrei, Italy

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We investigated the shallow structure of the Solfatara, a volcano within the Campi Flegrei caldera, southern Italy, using surface waves as a diagnostic tool. We analysed data collected during the RICEN campaigns, where a 3-D active seismic experiment was performed on a dense regular grid of 90 m $\times$ 115 m using a Vibroseis as the seismic source. Because of the great heterogeneity of the medium, the 1-D approximation can hold for subgrids of 40 m $\times$ 40 m, therefore we split the whole grid in 96 overlapping subgrids and for each of them we stacked all of the signals in the minigrid according to source–receiver distance bins to reduce the small-scale variability in the data. We then analysed the resulting seismic sections in narrow frequency bands between 7 and 25 Hz. We obtained phase and group velocities from a grid search, we jointly inverted the dispersion curves of the phase and group velocities to retrieve a 1-D S-wave model local to the subgrid. Assembling all the models we get a 3-D description of the S-wave model in the area. We found that the maximum penetration depth is 15 m. In the first 4 m, we can associate the changes in the S-wave field to the temperature gradient, while at larger depths, the seismic images correlate with the resistivity maps, which point to the eastern part of the Fangaia liquid-satured plume and an abrupt decrease of water-content moving towards the northeast.
Using the same dataset we investigated the area by means of statistical parameters: the mean free path (MFP) and the transport mean free path (TMFP). The first one is the mean path travelled by a seismic wave between two scatterers events, while the latter is the path needed in order that the waves lose memory of the source position. Exploiting the informations of the MFP and the TMFP in different frequency bands is possible to infer the size of the scatterers.