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P- and S-wave models and statistical characterization of scatterers at the Solfatara Volcano using active seismic data from RICEN experiment

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RICEN (Repeated and InduCed Earthquakes and Noise) is an active and passive experiment organized at the Solfatara volcano, in the framework of the European project MEDSUV. It was aimed to reveal and track the variations in the elastic properties of the medium at small scale through repeated observations over time. It covered an area of 90m x 115m by a regular grid of 240 receivers and 100 shotpoints at the center of the volcano. A Vibroseis truck was used as seismic source .
We cross-correlated the seismograms by the source time function to obtain the Green's functions filtered in the frequency band excited by the source. To estimate the phase and the group velocities of the Rayleigh-waves we used the coherence of the signal along the seismic sections. In subgrids of 40m x 40m we realigned the waveforms or their envelope in different frequency bands, to maximize the amplitude of the stack function, the phase or the group velocities being those speeds proving this maximum. We jointly inverted the dispersion curves to obtain a locally layered 1-D medium in term of S-waves. Finally the collection of all the models provides us with a 3-D image of the investigated area. The S-wave velocity decreases toward the "Fangaia", due to the water saturation of the medium, as confirmed by geoelectric results.
Since the Solfatara is a strongly heterogeneous medium, it is not possible to localize the velocity anomalies at different scales and a description of the medium through statistical parameters, such as the mean free path (MFP) and the transport mean free path (TMFP) was provided. The MFP was recovered from the ratio between coherent and incoherent intensities of the surface waves measured in different frequency bands. It decreases with frequency from about 40m at 8.5 Hz to 10m at 21.5 Hz, this behavior being typical of volcanic areas. The TMFP was measured fitting the decay of the coda of the energy at different distances. As expected it is larger than the MFP and strongly affected by inelastic attenuation of the medium.
Finally, using a linear-array of 400 m crossing the explored area, we performed a beamforming analysis in order to infer the propagation properties of the first P-wave arrivals. From the complete array we selected subarrays of sources and receivers and, for all possible combinations of subarrays, we computed the spectrograms, and the P-wave velocity as a function of the subarray distance.