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Investigation of cortical structures at Etna Volcano through the analysis of array and borehole data.

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A continuous monitoring of seismic activity is a fundamental task to detect the most common signals possibly related with volcanic activity, such as volcano-tectonic earthquakes, long-period events, and volcanic tremor. A reliable prediction of the ray-path propagated back from the recording site to the source is strongly limited by the poor knowledge of the local shallow velocity structure. Usually in volcanic environments the shallowest few hundreds meters of rock are characterized by strongly variable mechanical properties. Therefore the propagation of seismic signals through these shallow layers is strongly affected by lateral heterogeneity, attenuation, scattering, and interaction with the free surface. Driven by these motivations, between May and October 2014 we deployed a seismic array in the area called “Pozzo Pitarrone”, where two seismic stations of the local monitoring network are installed, one at surface and one borehole at a depth of about 130 meters. The Pitarrone borehole is located in the middle northeastern flank along one of the main intrusion zones of Etna volcano, the so called NE-rift. With the 3D array we recorded seismic signals coming from the summit craters, and also from the seismogenetic fault called Pernicana Fault, which is located nearby. We used array data to analyse the dispersion characteristics of ambient noise vibrations and we derived one-dimensional (1D) shallow shear-velocity profiles through the inversion of dispersion curves measured by autocorrelation methods (SPAC). We observed a one-dimensional variation of shear-velocity between 430 m/s and 700 m/s to a depth of investigation of about 130 m. An abrupt velocity variation was recorded at a depth of about 60 m, probably corresponding to the transition between two different layers. Our preliminary results suggest a good correlation between the velocity model deducted with the stratigraphic section on Etna. The analysis of the entire data set will improve our knowledge about the (i) structure of the top layer and its relationship with geology, (ii) analysis of the signal to noise ratio (SNR) of volcanic signals as a function of frequency, (iii) study of seismic ray-path deformation caused by the interaction of the seismic waves with the free surface, (iv) evaluation of the attenuation of the seismic signals correlated with the volcanic activity. Moreover the knowledge of a shallow velocity model could improve the study of the source mechanism of low frequency events (VLP, LP and volcanic tremor), and give a new contribution to the seismic monitoring of Etna volcano through the detection and location of seismic sources by using 3D array techniques.