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Quantative analysis of tremor wavefield at Mt. Etna during eruptive processes with the use of dense seismic arrays.

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This work focuses on the analysis of volcanic tremor recorded at Etna during the July-October 2004 time span. Data are from two small-aperture, short-period seismic arrays deployed on the N and SW flanks of the volcano, at distances of about 2 km from the summit craters. Tremor spectra show multiple peaks common to the two sites and concentrated in the band 0.5-6 Hz. Neither the amplitude or frequency content of the tremor signal showed any remarkable change in association with the opening of the eruptive fractures occurred on September 7, 2004. We estimated the polarisation properties of tremor waves applying the covariance method to three component data from the Northern array. Volcanic tremor is dominated by horizontal, linear motion oriented transversally with respect to the direction pointing to the summit craters. Also in this case, no remarkable changes in the polarisation attributes are observed with the resumption of eruptive activity. We derived propagation azimuths and apparent velocity of tremor waves by searching for those slowness vectors which maximise the multi-channel Semblance coefficient. Our preliminary test showed that contributions from the primary source were best resolved over the 0.5-1.5 Hz frequency band. We extended the analysis to short (2 s) data windows spanning the complete set of tremor recordings, thus obtaining continuous, 82-day-long time-series of propagation parameters for tremor waves recorded by the two arrays. At both arrays, the most representative values of ray parameter are in the 0.5-1 s/km range, corresponding to apparent velocities between 1 and 2 km/s. Propagation azimuths are clustered over the 240˚-270˚ and 20˚-50˚ intervals for the SW and N arrays, respectively. The eruptive phase is marked by a widening of the range of propagation azimuths, which evidences

the contribution of a second source in the analysed wavefield. Using a probabilistic approach, the two components of horizontal slowness measured at both arrays have been inverted in order to determine localization and the extension of the seismic source. In agreement with previous studies, the values cited above indicate a main persistent source of tremor, located in correspondence of the summit craters and extending from the surface down to a depth of 100-600 m. Starting at the onset of the eruption and lasting throughout the duration of the eruptive phase, a new component of the wavefield is present at both arrays. This component, whose apparent velocity is consistent with the propagation of surface waves, is located in correspondence of the eruptive fissure. Our measures thus contribute to the discrimination of the time and place at which the fracture system opened. These results evidence the ability of the multi-channel techniques to track the location of magmatic fluids, in turn offering a valuable support to volcano monitoring activities.