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Quantitative analysis of tremor wavefield at Mt. Etna during 2012 eruptive activity of Bocca Nuova Crater (Mt. Etna).

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Volcanic tremor is difficult to interpret, due to the lack of clear body-wave phase arrivals, and the rapid loss of signal coherence with increasing station spacing. This characteristic makes impossible to retrieve the tremor source location by means of the hypocenter determination techniques. Nevertheless, location of the tremor source is important to improve our knowledge in the source processes leading to the volcanic tremor generation and to enhance our ability in reconstructing the geometry of the plumbing system.

During the summer of 2012, the Bocca Nuova Crater produced discontinuous Strombolian activity and intra-crateric lava flows. We temporally augmented the permanent monitoring system in the summit area of Etna with a small-aperture broadband seismic array. This array was composed by six digital broadband stations, distributed with an aperture of about 400 m. It was deployed about 1 km SW of the summit craters, at an altitude of about 3000 m. This array operated continuously for 102 days, between July 10 and October 19.

During the analyzed period, we observed that the tremor behavior follows two different patterns. During periods of scarce/absent eruptive activity, the tremor amplitude is small and the frequency content spans the 1-5 Hz band, with a main peak at about 1-2 Hz.When explosive/effusive activity occurs, the volcanic tremor shows higher energy that is distributed on a wider frequency band, with a main peak at 3 Hz.

Our results suggested that multiple sources are present in the wavefield. The most representative values of ray parameter are in the 0.5-1.2 s/km range, corresponding to apparent velocities between 0.8 and 2 km/s. Propagation azimuths cluster around two main back-azimuths of $\sim 60°$ and $\sim 30°$, which matches the direction of the South-East and of the Bocca Nuova Crater respectively. We found a clear correlation between the behavior of the apparent slowness vectors and the tremor amplitude, suggesting the existence of a link between two spatially distinct sources.

To corroborate our results, we also retrieved source locations using the spatial distribution of tremor amplitudes, recorded by both permanent and temporary seismic networks. Also in this case we obtained two different sources, located beneath the Bocca Nuova and South-East Craters.

These results evidence the ability of the exploited techniques to provide information on the characteristics of the shallow plumbing system.