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High-resolution spatio-temporal source inversion of a long-period (LP) sequence recorded by a dense broadband network

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Since physical processes within a volcano generate seismological signals on its surface, seismology plays an important role in determining the internal volcano dynamics. Long period (LP) events (f=0.2 – 2 Hz), often occurring in swarms, are of particular interest to achieve this task as their repetitive nature provides a good basis for monitoring the temporal changes of the upper part of a volcano on different time scales (from days to years). The similarity of the waveforms within a swarm suggests that they are generated by non-destructive repetitive or slowly changing source process. Although the proposed LP source models relate this type of events to resonance of fluid-filled cracks, dykes and conduits, their exact origin is still under debate. Consequently, in an effort to better understand the exact origin of LP seismicity, inverting seismic waveform for LP source mechanisms is becoming increasingly common. The most critical aspect in such modelling procedures lies in the accurate calculation of the Green's functions. It was shown in the recent literature that a fine scale shallow structure (hundred metres) which lies below the resolution limits commonly exhibited by 3D velocity models of volcanic interiors can lead to apparently stable, but erroneous source models. In addition, the simultaneous search for a source location may also converge in a considerably wrong solution ($\sim$ 1 km). Such unreliable (and possibly misleading) solutions are particularly pronounced when a dataset is limited to the records obtained from a sparse network placed in the far-field of the source ($\sim$ 5-10 km). Our recent results suggested that this issue can be overcome by using a dense broadband network, placed directly above the source. Therefore, in this study we use 30 broadband stations placed within 2 km from the Etna summit. The LP activity recorded by this network in June 2008 was located using the relative time delays between all station pairs, obtained by the cross-correlation of similar waveforms across the network. This lead to an unprecedented high-resolution short-term spatio-temporal image of the LP source zone. In this study we perform a simultaneous inversion for source mechanism and locations, using the same high resolution near-field dataset. The aims of this exercise are (i) to test our ability to reconstruct a consistent image of the source zone by using different methods (source inversion vs. cross-correlation location technique), and (ii) to constrain the source mechanisms of the recorded LP sequence. This may lead to an improved spatio-temporal image of the shallow internal dynamic of Etna volcano.