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Localization of volcanic tremor using array analysis and amplitude distribution.

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Volcanic tremor represents an important tool to study the volcanic activity, because of its strict relationships with eruptive mechanisms and, more generally, with fluid flows through the volcano's feeding system. Therefore, location of the tremor source is a critical aspect toward a better understanding of the evolution of the volcanic activity. Unfortunately, conventional methods used in seismology, based on phase picking, generally fail to locate volcanic tremor source. This because of sustained character of tremor and rapid loss of signal coherence with increasing source-station distance. For that reason different methods have been applied over the last years. Here we propose a preliminary analysis of the wavefield proprieties and location of the tremor recorded during the early stage of 2004 Etna Eruption. We retrieve source locations using two different approaches: (1) multichannel analysis of data from two temporary seismic arrays deployed on the NE and SW flanks of the volcano; (2) Analysis of the spatial distribution of tremor amplitudes recorded by the permanent, widely-spaced network. In the first method, a search is conducted for that slowness vector for which a multichannel measure of coherence (namely: the Semblance coefficient) is maximised. For each window of analysis, this allows obtaining apparent velocity and propagation azimuth of plane waves impinging at the array. Slowness estimates at the two arrays are eventually inverted for the source location using the intersection of back-traced seismic rays. In the second approach, we first calculate tremor amplitude ratios between a set of independent station pairs for a given frequency band. Then we grid the volume of interest and, for each grid node, we calculate the theoretical amplitude ratios under the assumption of propagation in a homogeneous medium. The source location is eventually retrieved by searching for that grid position at which the difference between

observed and expected amplitude ratios is minimized. The two different methods are applied to tremor recordings collected contemporaneously by the two arrays and the sparse network. Despite the numerous simplifying assumptions, the epicentral locations deriving from application of the two different techniques differ only slightly, thus indicating the robustness of the result. Much difficult is finding consistent results for which concerns the depth of the source, as the estimate of this parameter is subjected to marked non-linearities in both the attenuation and back-propagation procedures. Overall, these results highlight that the amplitude ratios method is an efficient and quick tool for location of the tremor source. Its main advantage resides on the fact that it may be applied to data from those large-aperture networks which are generally deployed to the purpose of earthquake analysis. More generally, these new approaches of tremor analysis in volcanic area provide an important instrument for improving the predicting capabilities of personnel in charge of public safety.