Geophysical Research Abstracts
Vol. 16, EGU2014-12910, 2014
EGU General Assembly 2014

Analysis of volcanic long-period events with quasi-static displacements from high-density seismological networks

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Volcanic long-period (LP) events are commonly thought to be related to fluid pressure fluctuations in cracks and conduits beneath volcanoes. Sudden pressure fluctuations can generate slow/crack waves that can propagate along the fluid-solid boundaries between the fluid-filled source and the surrounding medium and thus sustain the resonance of the source. Although there are different variations of this model proposed in the literature, all of them include the source resonance sustained by crack waves. An alternative model (Bean et al., 2014) involves slow-slip fracturing of the shallow volcanic edifice.

One of the difficulties in confirming or disproving these models lies in the limited frequency band in which moment tensor inversions of seismic LP signals are typically carried out in order to obtain acceptable solutions. In order to remove low-frequency noise and the high-frequency part of signals, which is difficult to model with numerical simulations, signals are band pass filtered in their most energetic frequency band before the inversions. However, this means we are only recovering a narrow band of the source-time history and any information outside this range is lost. Furthermore, as possible lower frequency components are less sensitive to the complex (and usually poorly known) velocity structure in the shallow edifice, they are particularly interesting for inversions.

In this study we are investigating possibilities to include a broader frequency spectrum of the observed displacement signals into moment tensor inversions. In particular, we have observed quasi-static displacement steps for numerous LP events on different volcanoes. These are visible mostly on stations near the summit area and have amplitudes of a few micrometres. We are exploring possibilities to use these signals and distinguish them from noise (e.g. induced by tilting of the instrument). For our analysis we use a combination of numerical simulations and laboratory data to constrain the signals observed in the field experiments on Turrialba Volcano (Costa Rica) and Mt Etna (Italy) and to test the performance of applied methods.

Using these modified routines for moment tensor inversions will lead to a more complete image of the source-time history and therefore add to the understanding of LP source processes.