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Effects of topography and crustal heterogeneities on the inversion of long period volcanic sources

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The interpretation of volcanic sources generating long period (LP) events is still a matter of debate and several source models have been proposed, often associated with the resonance of fluid-filled cavities and cracks of different geometries. The problem of source inversion is of high interest due to the fact that LP events may be directly generated by fluid transfer and could be indicators of the level of activity in the volcano and in some cases could act as precursor to eruptions. Apart from the complex time-dependent behavior of the source, the crustal structure may play a major role in the generation of the observed waveform (e.g., ringing, monochromatic frequency content, etc.). In particular, effects related to the volcanic topography and the presence of shallow low-velocity layers may affect the seismic waveform. As a consequence, the source inversion of LP signals may lead to significantly different results when including the effects of 3-D heterogeneous models. We focus the study on a LP event observed in 2001 at Kilauea volcano, Hawaii. The forward problem of Green function generation is solved numerically following a pseudospectral approach, assuming 3-D models including topography and different velocity structures. The inversion is realized in the frequency domain, reducing computational requirements. The resulting source mechanism is represented by the sum of two time-dependent terms: a full moment tensor and a single force. The source of the LP signal is retrieved, assuming different crustal structures, and an analysis is carried out on the effects of topography and crustal heterogeneities on the generation of synthetic seismograms and on the inversion results. While results for different crustal structure are consistent in pointing to a sub-horizontal crack as source mechanism for the LP event, the source time function and its duration are significantly different for different models. Results indicate that the crustal layering is partially responsible in the generation of the LP signal.