Moment-tensor solutions for Long-Period (LP) volcanic sources: do they validate existing LP source models?

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Long period (LP) events on volcanoes are thought to be related to the fluid pressure fluctuations in cracks and conduits beneath volcanoes. Sudden pressure fluctuations give rise to the generation of slow/crack waves propagating along the fluid-solid boundaries between the source region and surrounding medium, and in turn sustain the resonance of the source. There are several variations of this model proposed in the literature, but all of them include the source resonance sustained by crack waves.

The difficulty in definite validation (or rejection) of this model stems from the facts that (i) physical properties of the source region (bulk modulus of the fluid, rigidity of the solid, geometry of the source and intrinsic attenuation of the medium) are poorly known, so their favourable (but not necessarily real) combination allows for the reconstruction of almost any type of the oscillating signature, (ii) moment-tensor (MT) inversions of LP signals are extremely sensitive to (usually poorly known) shallow volcano structure, and (iii) due to the very noisy volcanic environments and small-amplitude LP signals, it is generally not possible to obtain an acceptable MT solution unless the observed seismograms are filtered within their most energetic frequency range. An unfortunate consequence of the last two points is that the true source-time history is exceedingly difficult to recover and consequently we are left with a band-limited view of the source. Hence we ask the question: If we band limit alternative models for LP generation, are they consistent with observed data?

Therefore in this study we investigate how the signals generated by alternative possible sources map into MT solutions. Specifically, we use full waveform numerical modelling and analytical solutions for the wave propagation in an unbounded homogeneous medium to simulate signals generated by kinematic extended tensile crack sources. We then invert these signals for source mechanisms, using the standard assumption about the point-source moment tensor. We highlight the differences in the MT solution produced by the standard crack resonance model and this new model and demonstrate that it is equally consistent with field data. The aim of this exercise is to improve our understanding of MT solutions obtained for real data and to help either further validate or falsify existing LP source models.