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Mapping of alternative long-period sources into moment-tensor solutions

Ivan Lokmer, Gareth O'Brien, Louis De Barros, and Christopher Bean

University College Dublin, Seismology and Computational Rock Physics Lab., Geophysics Group, Department of Geology, Dublin 4, Ireland (ivan.lokmer@ucd.ie)

Long period (LP) events on volcanoes are thought to be related to the fluid pressure fluctuations in cracks and conduits beneath volcanoes. All proposed models include the generation of slow/crack waves on the fluid-solid boundaries between the localised source region and surrounding homogeneous medium. These waves, whose exact characteristics depend on numerous (usually unknown) physical parameters of the fluid and solid, are capable of sustaining long lasting seismic waves generated by sources of small dimensions. Although this is so far the most convincing and elegant theory, there are difficulties in its definite confirmation through the inverse modelling, in particular moment-tensor (MT) inversion. Many of these difficulties have been addressed in the recent literature. For example, a short pulse shallow point source embedded in the shallow inelastic heterogeneous volcanic structure can produce long-lasting signals at the stations which are located more than a few kilometres from the epicentre. Thus, not taking the properties of the structure into account (they are usually unknown on most volcanoes), our MT solution will reflect the path rather than the source effect. Since there have not been many experiments on volcanoes where a large number of stations (>20) were located in the close proximity of the epicentre (< 1 km), one has to be extremely cautious when interpreting MT solutions for LP events on volcanoes. In particular, it has been recommended in the recent literature that in the case of relatively small number of stations located several kilometres from the epicentre and unknown velocity model, it is a good practice to place a priori constraints on the MT solution, such as inverting for pre-assumed possible geometries, such as a crack, pipe or an isotropic source. However, with this approach the details of source mechanism remain obscured; the solution space is narrowed in order to be able to distinguish between possible solutions which comply with the existing theory. It is easy to notice that although such a routine would allow us to minimise the errors coming from mismodelling and incorrect source locations, it does not inspire the development of alternative theories. In order to overcome this barrier, we investigate in this study how the signals generated by alternative possible sources map into MT solutions. Specifically, we use full waveform numerical modelling to calculate signals in a realistic medium generated by a suite of kinematic extended sources, such as slow opening of a crack, pressure dipole, slow-slip faulting with volumetric component and pure slow shear faulting. We then invert these signals into source mechanisms, using the standard assumption about the point-source moment tensor. Such an exercise can provide valuable clues for the interpretation of the MT solutions for real observations and opens avenues for the development of new theories or the confirmation of the existing ones.