Seismic source determination on volcanoes: lessons from high resolution field experiments

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Determining the locations, mechanisms and source time histories of volcano seismicity are key goals towards a better understanding of volcano processes. This is especially true of shallow low frequency events which may hold the key to dynamic interactions that are the immediate preludes to eruptions. Whilst it is clear that knowledge of the velocity structure of the edifice is important for the absolute location accuracy of seismic events, what is not so obvious is the role that knowledge of the velocity structure plays in determining the mechanism and source time history. A seismogram is the convolution of the source with the path and the instrument response. The volcanic edifice can exhibit extreme mechanical heterogeneity which can lead to very strong path effects for seismic frequencies as low as 0.5 Hz, and perhaps lower. In the near surface this mechanical heterogeneity is poorly constrained and can lead to strong but unknown path effects. This makes the details of the source difficult to determine. Using very high resolution temporary networks we investigate this problem in detail.In-depth field data analysis is complemented by full wavefield numerical simulations in quasi-realistic edifice models in order to calculate numerical Green's functions and to test source locations algorithms. Using this approach is it possible to separate some artefacts from real effects, leading to more robust source locations and models. However we still suggest that the general lack of (difficult to determine) detailed velocity models which include strong spatial derivatives not normally seen in tomography velocity models, and especially in the near surface where velocity coverage is poor, is hampering detailed quantification of shallow volcano seismic sources.