# When magma breaks - the source mechanisms of low frequency events at volcanoes

Sandra Karl, Jurgen W. Neuberg

School of Earth and Environment, The University of Leeds, United Kingdom

E-mail: eeskar@leeds.ac.uk

Low frequency (LF) events have been observed in many volcanic settings worldwide. In a number of cases, this type of seismic signal has been successfully used to forecast volcanic eruptions. LF seismicity in volcanoes is associated with a stable, non-destructive and repeatable process such as fluid movement in, or resonance of a fluid-filled conduit. Both magmatic and hydrothermal origins of the fluid have been proposed. In-depth investigation of the trigger of LF events, as well as their spatial and temporal extent, is crucial to gain a better understanding of the sub-surface dynamics leading to, or preventing, volcanic eruptions. Neuberg et al. (2006) proposed a conceptual model for the trigger of LF events at Montserrat involving the brittle failure of magma in the glass transition in response to high shear stresses during the upwards movement of magma in the volcanic edifice.

For this study, synthetic seismograms were generated following the proposed concept of Neuberg et al. (2006) by using an extended source modelled as an octagonal arrangement of double couple sources approximating a ring fault. The model adopts the seismic station distribution and velocity structure as encountered on Soufrière Hills Volcano, Montserrat.

In an attempt to gain a better quantitative understanding of the driving forces of LFs, inversions for the physical source mechanisms have become increasingly common. Therefore, we performed moment tensor inversions using the synthetic data as well as a chosen set of seismograms recorded on Soufrière Hills Volcano. The inversions were carried out under the common (but wrong) assumption of a point source rather than an extended source triggering the low frequency seismic events. For comparison we interpreted the same data in terms of a ring fault structure.

We discuss these inversion results and differences between the synthetic and real data, and how to interpret the moment tensor components (double couple, isotropic, or CLVD), which were based on a point source in comparison to an extended source. Due to interference, the amplitude of the seismic signals of a ring fault is greatly reduced when compared to a single double couple source. Furthermore, best (but misleading) inversion results yield a solution comprised of positive isotropic and compensated linear vector dipole components. Thus, the physical source mechanisms of volcano seismic signals may be misinterpreted as opening shear or tensile cracks when wrongly assuming a point source. If interpreted as magma movement the reduced amplitudes will lead to an underestimation of magma ascent rate by an order of magnitude, and finally the time history of the magma motion will be distorted as well.

References:

Neuberg, J.W., Tuffen, H., Collier, L., Green, D., Powell, T., and Dingwell, D., 2006, The trigger mechanism of low-frequency earthquakes on Montserrat: Journal of Volcanology and Geothermal Research, v. 153, p. 37-50

 