Constraining melt storage and transport beneath Nabro volcano, Eritrea using seismic anisotropy

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Seismic anisotropy, the variation of seismic wavespeed with the direction of propagation, is often observed beneath volcanoes. It can highlight dominant fracture orientations, show regions of preferential melt alignment and can even highlight changes in strain during periods of unrest. Thus it is a useful technique in understanding how melt is stored and transported beneath a volcano.

In this study we utilise shear-wave splitting to constrain seismic anisotropy beneath Nabro volcano, Eritrea, the site of a large eruption in June 2011. This eruption, the first in the historical recorded emitted significant sulphur into the atmosphere and resulted in a ~15km long lava flow, showing the potential for these large caldera systems to erupt without warning. We use two months of seismic data recorded at 8 broadband seismic stations deployed in the months following the June 2011 eruption. In total we record 548 splitting results from earthquakes accurately located not beneath the volcano and the surrounding regions.

Initial results show that anisotropy increases for raypaths that travel directly beneath the volcano (~5% anisotropy) compared to those raypaths that sample the region outside the volcano (~1% anisotropy). Fast directions show more northwest-southeast orientations outside the volcano, but are much more variable beneath the volcano itself. These results suggest that the presence of magma in the upper crust may enhance anisotropy beneath Nabro.

The large dataset, covering a wide spatial and depth range means that we have numerous crossing raypaths beneath the volcano. As a result we are uniquely placed to use newly developed shear-wave splitting tomography techniques. We plan to invert the dataset for a number of anisotropic domains that will constrain the dominant anisotropic mechanisms beneath the volcano. These inversions will highlight differences between the strain field inside and outside the caldera and can highlight regions of preferential melt orientation, possibly indicative of magma transport.