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Explaining multiple active seismic sources in ascending magma

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Low frequency seismic events observed on volcanoes such as Soufriere hills, Montserrat are now routinely linked to magma movement at depth. These events often occur in swarms of repeating families with distinct waveforms. Since events with similar waveforms must originate from the same location, this suggests that the sources must be stationary. The sources must also be both non-destructive and repetitive as the event families are persistent through time.

A proposed mechanism for such a source is brittle failure of the magma in glass transition. Such a mechanism can indeed meet all of the required criteria for the source and is now widely accepted, backed up by a wealth of field, laboratory and modelling data. However, what is yet to be explained is how several families can be active at the same time.

Presented here are the results of new conduit flow models solved through a Finite Element approach in COMSOL Multiphysics, using fully compressible Navier-Stokes equations. These results suggest that there may be an entire region within the conduit that is susceptible to brittle failure of the magma rather than a single point, allowing several sources to be active within this region at the same time. In addition, by allowing frictional controlled slip at the conduit walls, altering the conduit flow velocity or introducing asperities to the conduit geometry, the location of this possible region of failure can change. Since any of the above changes effect the whole of the conduit, this may result in the enlargement of or the creation of new areas susceptible to failure without destroying the original source region. This offers an explanation as to the apparent migration of sources through time, while allowing previous sources to remain active.