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Fluid flow as a source mechanism for ground motion at volcanoes

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At active volcanoes, ascending magma is dominated by silicate melt in terms of mass, but may become dominated by water vapour in terms of volume as pressure declines. The flow of such mixtures of compressible gas and liquid is especially prone to become unsteady, with accelerations of dense liquid creating fluctuating pressures and forces. The results may be detectable as ground motion on a range of time scales, and secondary processes such as resonance may be stimulated. This raises the possibility that ground motion could be interpreted in terms of fluid-flow processes, a goal that would improve the forecasting of changes in volcanic activity. We present an overview of experiments carried out at Lancaster University that seek to measure fluctuating pressures and forces, then link these to field measurements of ground motion at volcanoes.

Strombolian eruptions occur frequently and are considered relatively uncomplicated; the basic mechanism being the rise and burst of a large volume of gas that has separated from the silicate melt. Extensive ground deformation measurements have been made at Stromboli. Inversion of very-long-period seismic data, associated with a specific highly repeatable eruption, yields a source mechanism in terms of conduit deformation and geometry [Chouet *et al*. 2003]. Unfortunately, because seismic signals result from motion of the conduit wall, the underlying flow cannot be imaged. Experimental investigation of scaled gas-slug flow reveals a range of mechanisms for creating pressure and force changes. We look at straightforward rise of gas-slugs in vertical and inclined tubes, investigate the effects of decompression as the gas-slug rises, and

illustrate the importance of conduit geometry in the generation of large changes in pressure and force.

The degassing style of dome-building eruptions differs from strombolian activity, largely because magma viscosity is higher. This results in different flow processes, including the onset of brittle fracture, and a range of different ground-motion signals ensues. Perhaps the most characteristic of these was demonstrated at the Soufrière Hills Volcano (SHV), Montserrat, West Indies, where sequences of tilt cycles were measured [Voight *et al*. 1998]. Using a fluid system analogous to a degassing silicate melt, we present experimental insight into the tilt cycle source mechanism, and indulge in speculation on the causes and forecasting of transition to explosive behaviour.