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Linking observations at active volcanoes to physical processes through conduit flow modelling

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Low frequency seismic events observed on volcanoes such as Soufriere hills, Montserrat may offer key indications about the state of a volcanic system. To obtain a better understanding of the source of these events and of the physical processes that take place within a volcano it is necessary to understand the conditions of magma a depth. This can be achieved through conduit flow modelling (Collier & Neuberg, 2006). 2-D compressible Navier-Stokes equations are solved through a Finite Element approach, for differing initial water and crystal contents, magma temperatures, chamber overpressures and geometric shapes of conduit. In the fully interdependent modelled system each of these variables has an effect on the magma density, viscosity, gas content, and also the pressure within the flow. These variables in turn affect the magma ascent velocity and the overall eruption dynamics of an active system.

Of particular interest are the changes engendered in the flow by relativity small variations in the conduit geometry. These changes can have a profound local effect of the ascent velocity of the magma. By restricting the width of 15m wide, 5000m long vertical conduit over a 100m distance a significant acceleration of the magma is seen in this area. This has implications for the generation of Low-Frequency (LF) events at volcanic systems. The strain-induced fracture of viscoelastic magma or brittle failure of melt has been previously discussed as a possible source of LF events by several authors (e.g. Tuffen et al., 2003; Neuberg et al., 2006). The location of such brittle failure however has been seen to occur at relativity shallow depths (<1000m), which does not agree with the location of recorded LF events. By varying the geometry of the conduit and causing accelerations in the magma flow, localised increases in the shear strain rate of up to 30% are observed. This provides a mechanism of increasing the depth over witch brittle failure of melt may occur.

A key observable of the Low frequency events observed on Montserrat is their tightly confined source region. The high degree of similarity of the waveforms from such events indicates a stationary common source within a finite volume of 150m x 150m x 150m (Neuberg et al., 2006). By modelling the physical processes that occur at depth within the volcano it has been possible to identify a potential source region of these events caused by the shape of the conduit, that has a fixed position and will have the potential cause repeatable events whenever magma is moving within the system. Making links of this type is essential to form a better understanding of what the observations made by monitoring systems actually relate to in terms of the volcanoes activity.

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