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Volcanic Conduits: comparison of the driving parameters on degassed magmas.

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Magma in volcanic conduits may flow in a solid, liquid or gas state. Owing to the complexity of the processes in volcanic conduits, rheological models and transitions are typically simplified. While useful for exploring and understanding controls of eruption properties, feedbacks between processes, and the role of transitions in rheology, simplification in rheological models may not capture some key processes.

Here we focus on developing a constitutive law that captures rheological transitions in crystal bearing melts. The model accounts for the effect of crystal fraction on magma viscosity. It also evaluates the onset of the brittle regime where crystal-bearing melts suddenly switch from viscous deformation to brittle behaviour. Accompanying this transition, crystals also break and gouge forms.

We applied the model to two dome-forming systems, Mt Unzen (Japan) and Mt St Helens (USA). During the 1990-1995 eruptive events on Mt Unzen volcano, the growth of several lobes and the final spine were monitored. At Mt St Helens the 2004-2005 only spines were extruded. Observations of the spines allow us to identify the region where gouge forms and hence we can determine the strain undergone by the magma.

Combined with experimental measurements and field observations, the numerical model allows us to constrain the parameters which allow a margin to form that lubricates the volcanic conduit. Conduit radius has the largest effect. However, we also show that if we do not account for the effect of crystals on brittle deformation, neither eruption would have entered the brittle regime, yet in both cases the eruption clearly did.