# Frictional processes in glass and ash gouge

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The ascent of high-viscosity magma in upper conduits proceeds via the development of shear zones, which commonly fracture, producing fault surfaces that control the last hundreds of meters of ascent by frictional slip. Frictional slip in conduits may occur along magma-rock, rock-rock and magma-magma interfaces, with or without the presence of gouge material. During slip, frictional work is converted to heat, which may result in strong geochemical disequilibria as well as rheological variations, with important consequences on the dynamics of magma ascent.

Here, we present a thermo-mechanical study on the ability of glass and ash gouge (with different fractions of glass and crystals) to sustain friction, and in some cases to melt, using a high-velocity rotary apparatus. The friction experiments were conducted at a range of slip velocities (1.3 mm/s to 1.3 m/s) along a (fault) plane subjected to different normal stresses (0.5-5 MPa). We observe that the behaviour of volcanic rocks during slip events varies remarkably, and unlike rocks which undergo comminution during slip, the inability of glass asperities to comminute induces thermal stressing and commonly results in catastrophic failure within the elastic regime or upon the glass transition. Notably, samples heated at more than 400 K/s fully liquefied but subsequently failed nonetheless. Thermo-mechanical analysis illustrates that beyond the calorimetric glass transition, slip continued in the elastic regime before the samples relaxed and underwent viscous remobilization. We conclude that during slip events, comminution, volumetric fluctuations and the viscous remobilisation temperature distinguish the frictional behaviour of glass from that of crystalline rocks. Increasing damage along the slip zone contributes to the development of a cataclasite.

Slip in cataclastic ash gouge generally obeys Byerlee's rule at low velocity, but shows an exponential decrease of the friction coefficient with increasing slip velocity. An increase in slip velocity further increase the localisation of deformation and development of shallow C/S fabrics in the gouge. The experiments do not produce significant heat compared to glass-on-glass friction, and brings into question the capability for frictional melting when cataclasite is present along the fault zone. We discuss the implications of our findings to case studies of lava dome eruptions.