It is a common phenomena for volcanoes to rapidly switch from effusive to explosive eruption, aided by the brittle failure of magma at high temperature. Our understanding of the deformation mechanisms and P-T changes associated with ascending magma are limited and the effects of porosity and crystallinity are unresolved.

Here we investigate the rheology of magma involved in the dome-building eruptions and explosions that occurred at Volcán de Colima (Mexico) since 1998. Lavas containing varied amounts of rhyolitic interstitial melt, crystals and bubbles are characterized by electron microprobe and differential scanning calorimetry. Rheological changes of the magmas are constrained by uniaxial deformation experiments at temperatures above Tg (900-1000°C), at varied applied stresses with constant Acoustic emission (AE) monitoring to constrain the ductile-brittle transition. Electron Back-Scatter Diffraction on deformed and undeformed samples has constrained textural and microstructural developments by quantifying crystal structure, boundary character and crystallographic preferred orientation.

We find that chemically similar lava types have significantly different mechanical properties, displaying a significant range of measured strain rates at a given temperature and applied stress. AE analysis suggests the ductile-brittle transition approximates two orders of magnitude of strain rate at constant temperature.

At low strain rates, the groundmass controls ductile deformation and sporadic fractures occur in phenocrysts. At high strain rates fractures dominantly initiate in phenocrysts and propagate through the groundmass. This study shows that crystal presence increases the range of strain rates of the ductile-brittle transition and that failure of magma may then become dependent on total strain.