A robust characterisation of lava rheology is critical for understanding and forecasting lava flow behaviour. The exsolution of dissolved volatiles, during ascent in the shallow conduit and after eruption, has the potential to cause rapid, bulk rheological change in lava flows, due to undercooling-induced crystallisation.

We present the results of experiments designed to investigate the degassing and crystallisation behaviour of basaltic samples from Etna (ballistics and quietly effused lava) at temperatures up to 1250°C, using thermo-gravimetric analysis (TGA) coupled with differential scanning calorimetry (DSC) and mass spectrometry (MS). During this process, volatiles released under a controlled heating programme are identified in a mass spectrometer, while changes to sample mass and heat flow are simultaneously recorded.

Samples are subjected to two heating cycles. During the 1st cycle, the onset of degassing (mass loss) on heating is systematically followed by crystallisation (an increase in heat flow) at temperatures >1070°C. During the 2nd cycle, when the sample has been ≥95% degassed, no crystallisation occurs on heating. We have measured total volatile contents, and degassing temperatures and patterns; and identified the volatile species lost. Degassing-induced crystallisation has been quantified by measuring the enthalpies of exothermic excursions in the DSC signal. Quenching samples at different stages during the 1st heat has allowed the resulting crystal textures to be observed, and ensured that quantification of crystallisation from the DSC signal can be validated.

This work represents an important step towards quantifying degassing-induced crystallisation sufficiently robustly for incorporation into numerical models of basaltic lava flow behaviour.