Geophysical Research Abstracts
Vol. 19, EGU2017-12657, 2017
EGU General Assembly 2017

Phase interactions in deforming magma: implications for strain localisation, outgassing and ascent processes using ultra fast X-ray tomography

Katherine Dobson (1), Donald Dingwell (2), Danilo Di Genova (3,2), Fabian Wadsworth (2), Federica Marone (4), Jason Coumans (1), Julie Oppenheimer (3), and Thomas Jones (1)

(1) Durham University, Department of Earth Sciences,, Durham, United Kingdom (katherine.dobson@durham.ac.uk), (2) Ludwig Maximilians University of Munich, Munich, Germany, (3) School of Earth Sciences, University of Bristol, U.K, (4) Swiss Light Source - PSI, Villigen, Switzerland

One challenge to understanding magma dynamics, the relationships between physical and chemical properties, and the nature of flow in magmatic systems is our inability to observe and quantify the processes that occur within the magma during transport. We can measure bulk non-Newtonian rheological behaviours in the laboratory, but we still do not understand the mechanisms and microphysics that lead to that behaviour. However, this is that ultimately controls the movement of crystals, bubbles and melts, and therefore local and bulk rheology and mobility. These crystal- and bubble-scale interactions therefore influence compositional, mechanical and thermal evolution of the magma on all spatial and temporal scales.

We present the first real time experimental observation of these microstructural behaviours. Use the ultra fast x-ray tomography of the TOMCAT beamline (Swiss Light Source) and a bespoke XRheo in situ rig to drive the mobilisation and flow of two- and three-phase magmas. With a variety of bubble and crystal contents we record “traditional” rheological data while simultaneously observing every crystal, bubble and interaction over the experimental run. Using this unique 4D (3D + time) data we define 3D and 4D maps of local microstructure, identify deformation & strain localisation, and quantify the evolving multi-scale heterogeneous distribution of solid, melt and gas phases through time. From this we discuss 4D models of microstructure, mechanisms and rheology that enable us to relate experimental data to the more macroscopic processes we can observe in natural system, and ultimately improve our understanding of magma reservoir behaviour.