Geophysical Research Abstracts
Vol. 19, EGU2017-13765, 2017
EGU General Assembly 2017

Degassing of basaltic magma: decompression experiments and implications for interpreting the textures of volcanic rocks

Nolwenn Le Gall (1,2,3), Michel Pichavant (3), Biao Cai (1,2), Peter Lee (1,2), and Mike Burton (4)

(1) School of Materials, University of Manchester, Manchester, UK, (2) Research Complex at Harwell, Rutherford Appleton Laboratories, Didcot, UK, (3) CNRS/ISTO, Université d'Orléans, Orléans, France, (4) School of Earth and Environmental Sciences, University of Manchester, Manchester, UK

Decompression experiments were performed to simulate the ascent of basaltic magma, with the idea of approaching the textural features of volcanic rocks to provide insights into degassing processes. The experiments were conducted in an internally heated pressure vessel between NNO–1.4 and +0.9. H_2O-only (4.9 wt%) and H_2O-CO_2-bearing (0.71–2.45 wt% H_2O, 818–1094 ppm CO_2) melts, prepared from Stromboli pumice, were synthesized at 1200°C and 200 MPa, continuously decompressed between 200 and 25 MPa at a rate of either 39 or 78 kPa/s (or 1.5 and 3 m/s, respectively), and rapidly quenched. Run products were characterized both texturally (by X-ray computed tomography and scanning electron microscopy) and chemically (by IR spectroscopy and electron microprobe analysis), and then compared with products from basaltic Plinian eruptions and Stromboli paroxysms (bubble textures, glass inclusions).

The obtained results demonstrate that textures are controlled by the kinetics of nucleation, growth, coalescence and outgassing of the bubbles, as well as by fragmentation, which largely depend on the presence of CO_2 in the melt and the achievement in chemical equilibrium. Textures of the H_2O-only melts result from two nucleation events, the first at high pressure ($200 < P < 150$ MPa) and the second at low pressure ($50 < P < 25$ MPa), preceding fragmentation. Both events, restricted to narrow P intervals, are driven by melt H_2O supersaturation. In contrast, textures of the H_2O-CO_2-bearing basaltic melts result from continuous bubble nucleation, which is driven by the generation of melts supersaturated in CO_2. This persistent non-equilibrium degassing causes the bubbles to evolve through power law distributions, as small bubbles continue to form and grow. This is what is observed in Plinian products. From our results, the evolution to mixed power law–exponential distributions, as found in Stromboli products, is indicative of the prevalence of bubble coalescence and an evolution toward chemical equilibrium. In line with this, a strong correlation was found between experimental and natural bubble textures (bubble number densities, shapes, sizes and distributions), having implications for interpreting bubbles in volcanic rocks and quantifying magma ascent rates.

Next step will be to perform in situ decompression experiments to simulate both degassing and crystallization of basaltic magma during ascent in the shallow volcanic conduit ($P < 50$ MPa), using synchrotron X-ray imaging. The obtained 4D (3D + time) data will help us refine our understanding of magma ascent processes. This experimental programme requires first technology adaptation and development, which is in progress.