Insights on Decompression-Induced Crystallization and Degassing Processes Revealed by 3D Rock Textures

CICHY, S.B.[1,2,3,6], BOTCHARNIKOV, R.E.[2,4], FRIESE, K.-I.[5], CLUZEL, N.[6], HOLTZ, F.[2] & MARONE, F.[7]

[1]Inst. of Earth & Environmental Sciences, University of Potsdam, Germany, sarah.cichy@uni-potsdam.de
[2]Inst. of Mineralogy, Leibniz University Hannover, Germany
[3]GFZ German Research Centre for Geosciences, Germany
[4]Inst. of Geosciences, Gutenberg University Mainz, Germany
[5]Welfenlab, Inst. f. Mensch-Maschine Kommunikation, Leibniz University Hannover, Germany
[6]Laboratoire Magmas et Volcans, Université Clermont Auvergne, France
[7] Swiss Light Source, Paul Scherrer Institute, Villigen, Switzerland

A series of experiments on decompression of a rhyodacitic magma has been conducted at 1050 and 850°C for a range of decompression rates from 0.28 to 0.0001 MPa/s. The volatile-saturated magmas were decompressed from 300 to 50 and from 50 MPa to 0.1 MPa. Experimental run-products were investigated by non-destructive, high-resolution (0.37 µm/voxel) synchrotron-based X-ray tomographic microscopy. Two key observations are reported here: (a) preservation of liquid and gas phases inside bubbles in decompressed and quenched silicate melts at 1050°C and high P, and (b) formation of idiomorphic quartz crystals inside vesicles at decompression rates <0.001 MPa/s at low pressures and 850°C.

Processing of the tomography data allowed us to quantify the internal fluid pressure of the bubbles indicating overpressures up to 10-50 MPa relative to external pressure just prior to quench. These values are close to fragmentation threshold in silicic magmas with important implications for the mechanism of magma degassing during eruptions.

Microthermometry of fluid bubbles showed that fluids are characterized by a density higher than the density of pure water implying that fluids contain dissolved components of the silicate melt. Thus, upon decompression, fluids could be saturated with quartz resulting in the precipitation of quartz crystals within vesicles in the slowest decompressed experimental runs. This finding illustrates that aqueous fluids can effectively transport not only volatile but also melt components to shallow magmatic levels during magma ascent.