Relaxation-induced microstructure transition of magmatic foam

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Interfacial tension-driven relaxation is one of the elementary processes for microstructural development of magmatic foam. Its effect on permeability is, however, controversial. Relaxation of interbubble melt film widens aperture sizes of outgassing pathways [1], while tortuous pore networks might split into small rounded bubbles in the course of entire foam relaxation.

To address this problem, we conducted heating experiments of andesitic pumice cubes of the Sakurajima 1914 Plinian eruption at 800–1000°C and ≤6MPa vapor pressure for up to 32 hours [2]. In a small sample (~3 mm side), open pores connected to sample surfaces were expelled to cause self-contraction. The porosity reduction in this process was smaller at higher vapor pressure, indicating that some pores were left enclosed by rapid pinch-off of open channels due to lower melt viscosity, namely, the relaxation decreased permeability. In the larger pumice cubes (5–9 mm side), initial heterogeneity of pore distribution facilitated appearance of multiple-contraction units, which lead to formation of multiple melt globs and interglob concave- outward pores (Figure 1). Such pores mostly disappeared following 32 h of heating due to gravitational deformation and healing of the glob boundaries. This shows that permeability on a macroscopic scale was maintained through the pores between melt globs. Since timescale of these relaxation, contraction, and compaction was consistent with that of Vulcanian explosion cycles, microstructural evolution of magmatic foam may be responsible for interexplosion vent plugging.

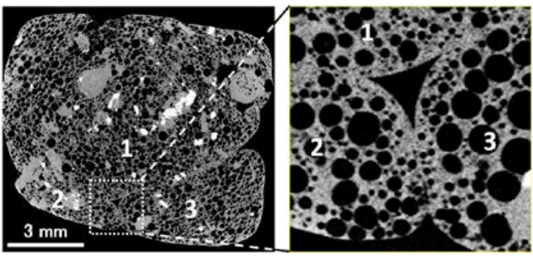

Figure 1: X-ray CT slice images of a run product heated at 2 MPa vapor pressure for 30 min. Note concave-outward pores (right) between melt globs (No.1–3).

[1] Saar and Manga (1999) *Geophys. Res. Lett.*, **26**, 111–114. [2] Otsuki et al. (2015) *J. Geophys. Res.*, **120**, 7403–7424.