

Bubble coalescence in magmas: Insights from in-situ high-temperature synchrotron-based X-ray tomographic microscopy

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The possibility of removing gas from magma during its rise to the surface decreases the probability of an explosive volcanic eruption to occur. In this respect, bubble coalescence and the achievement of a permeable network play a pivotal role in favouring magma degassing and limiting the explosivity of eruptions. Significant growth and interaction between bubbles occur in natural volcanic systems during ascent of the magma to the surface. Thus, we performed real time, 4D, high-temperature experiments at atmospheric pressure using laser heating and synchrotron-based X-ray tomographic microscopy at the TOMCAT beamline of the Swiss Light Source (SLS). We forced gas exsolution in natural magmas and observed bubble nucleation and growth in situ. The experiments were performed from room temperature up to 1300 K on two different types of crystal-free rhyolitic samples: one vesicle-free obsidian and one obsidian containing pre-existing vesicles. We characterized the main textural variations (bubble volumes, size distributions, shapes, and bulk textures) during the nucleation and growth of bubbles in these highly viscous systems, and tracked the evolution of parameters such as viscosity and overpressure in the foaming samples, which are essential for retrieving information on the processes preceding an eruption from the interpretation of the textures observed in eruptive products. The microstructural features of the starting material, nominally the presence of initial vesicles, strongly influence the dynamics of bubble coalescence. The presence of bubbles in the starting material tends to limit coalescence, therefore increasing the possibility of bubble overpressure. A possible implication of these experiments is that volcanic systems where magma is volatile-saturated already in the subvolcanic reservoir may have a higher tendency to feed explosive volcanic eruptions.