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In-Situ Ultrafast 3D Imaging of Magma Vesiculation at High Temperature

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We present new experimental results on magma vesiculation at high temperature. During in situ high temperature (400-1100 ℃), room pressure experiments, the evolving 3D structure was captured by ultrafast synchrotron-based X-ray tomographic microscopy performed at the TOMCAT beamline at SLS (PSI, Villigen), with a pixel size of 2.96 microns and 1 complete tomographic dataset acquired in 1 s. Sample heating was manually controlled with a class 4 laser heating system. Hydrous crystal- and bubble-free magmatic glasses from natural obsidians were employed for the experiments. We observed four main 3D microstructures: "low porous plinian pumice" with low amount of bubbles (40 vol%), showing a narrow range in bubble size and generally spherical shape of the bubbles; "normal plinian pumice" with high content of bubbles (80 vol%), showing a range of sizes, shapes and extent of coalescence; "pseudo-reticulite" (85 vol%), showing a polyhedral cell network; "gas slug", generated by expansion of one single bubble. The real-time three-dimensional analyses provide novel insights on the nucleation and exsolution mechanisms of volatiles that occur during ascent of magmas in volcanic conduits.

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