GSA Data Repository 2019256

Befus, K.S., and Manga, M., 2019, Supereruption quartz crystals and the hollow reentrants: Geology, https://doi.org/10.1130/G46275.1

Supplemental Information

SI Methods

μXRT was performed on beamline 8.3.2 at the Advanced Light Source at Lawrence Berkeley National Laboratory, USA (e.g., Fauria et al. 2017). μXRT scans used 23-25 keV monochromatic X-rays with a voxel length of either 0.6 or 1.3 μm. Images were reconstructed with TomoPy and processed with Avizo. Four of those quartz were then embedded in epoxy and ground to produce a flat polished crystal surface intersecting the plane of the reentrant. We analyzed those crystal surfaces in CL with a Gatan PanaCL detector on the environmental scanning electron microscope at the University of Texas at Austin.

A limited suite of high temperature experiments were performed to test the interpretation that reentrants can be produced by accelerated dissolution at the contact between quartz and supercritical fluid bubbles (e.g., Busby and Barker, 1966; Gutmann, 1974; Donaldson and Henderson, 1988). To perform experiments, we used a starting material composed of crushed rhyolitic obsidian powder from Solfatara Plateau, Yellowstone Caldera (e.g., Befus and Gardner, 2016). The powder was sealed within 3 mm O.D. Au tubes and enough water to ensure the synthetic melt was oversaturated in H_2O at experimental conditions. We ran experiments in cold seal pressure vessels at 800 °C and 1500 MPa at an oxygen fugacity of NNO+1. These conditions were chosen to be above the quartz liquidus, anneal the glass powder, but sufficiently short duration to preserve quartz antecrysts. After 24 hours we removed the pressure vessels from the furnaces, blew on them with compressed air for ~30 seconds, and quenched them in a bucket of water. We then prepared a thin section using a portion of each sample.

Bubbles are abundant in each sample, demonstrating that the experiments were H_2O-saturated. Many bubbles are attached to quartz antecrysts. Quartz displays curved, cuspate indentations along its interface with bubbles (Fig. DR2 panels B and D). In places the bubbles penetrate into the quartz crystal (Fig. DR2 panel D). The experimental textures are similar to reentrant features recognized on quartz from the Lava Creek Tuff. This demonstrates that quartz may indeed preferentially dissolve when in contact with bubbles. Our experiments lend credence to the drilling and dissolution interpretation reached by previous authors (e.g., Busby and Barker, 1966; Gutmann, 1974; Donaldson and Henderson, 1988). We acknowledge that our experiments were limited in scope, and we recommend that they be considered as a conceptual demonstration.

SI Package captions

Data Repository File Figure DR1 – Representative quartz crystals from the unwelded basal ignimbrite of Lava Creek Tuff A sampled at Purple Mountain, Yellowstone National Park. Empty reentrants are arrowed in red.

Data Repository File Figure DR2 – Photomicrographs of natural (A, C) and experimental (B, D) textures produced in quartz. The comparison is provided to build the argument that reentrants may be produced by accelerated dissolution at the interface between quartz and supercritical fluid bubbles. Panels A shows a corrugated surface of quartz marked with channels (arrowed). In B, similar channels or indentations are caught in the act of forming on the surface of the experimental quartz at the interface of attached bubbles. One indentation (arrowed) no longer has a bubble, which may have detached. Panel C shows an example of a reentrant in natural quartz. In

D an experiment is shown in which a synthetic reentrant is actively being drilled into the quartz by a significantly larger bubble attached to the quartz surface.

Data Repository File Figure DR3 – Magmas become increasingly compressible as gas content increases. The bulk modulus of quartz and melt are from Dong et al. (2015) and Lesher and Spera (2015), respectively, and bulk properties are computed using the Reuss average (Mavko et al. 1989).

Data Repository File Video DR4-7 – 3D video reconstructions of μXRT of quartz crystals from Lava Creek Tuff A. The letters A-D refer to panels A-D in Figure 2 in the main text. Briefly, the quartz crystal is shown in blue. Initially the crystal surface is fully opaque. We then make the front surface transparent in order to look at the crystal interior. We then make all surfaces translucent wireframes. Animation speed slows in response to computer processing speed. Reentrant pathways appear as blue tubes with irregular forms. Red domains in all videos are magnetite crystals. Green domains in DR6 and DR7 are rhyolite glass. Each crystal is approximately 2 mm in length.

Data Repository File Video DR8 – A different visualization of the quartz crystal in Panel D and DR-7. Here we show the individual μXRT slices in context of the entire 3D reconstruction. The grayscale values correspond to material density. The light gray is quartz surrounded by air (dark gray). Veneers of glass and tiny magnetite crystals occur as lighter gray and white colors. Some bright domains are artifacts produced by edge effects and should be ignored.

SI Package references

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