Water retention in quartz-hosted melt inclusions

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Pre-eruptive H_2O contents of rhyolites are difficult to determine directly because most is lost by degassing during ascent. Quartz-hosted melt inclusions (MIs) are potential recorders of pre-eruptive H_2O contents. The main uncertainty is whether the MIs retain their pre-eruptive H_2O, or some is lost via diffusion through the host crystal during ascent and degassing of the host magma. Results from the experimental study of Severs et al. [1] suggest that diffusive loss is possible, but the mechanism of H_2O loss was not unambiguously identified. We revisited this problem by conducting dehydration experiments and measuring both H_2O concentration and the deuterium-to-hydrogen ratio (D/H or δD_{VSMOW}) of the MIs by secondary ion mass spectrometry. Fractionation of D/H with increasing dehydration provides an unambiguous indication that H_2O loss occurred via diffusion of hydrogen through the host crystal [2]. Our results show no evidence for diffusive loss at 750 °C for experimental durations up 336 hours. The MIs in which H_2O decreased showed evidence for decrepitation. Experiments were conducted by placing a single Bishop Tuff quartz crystal into a Vernadsky heating stage and raising the temperature to 750 °C. Crystals were held in high purity helium for durations ranging from 24 to 336 hours. Within the first ~12 hours, some of the inclusions formed vapor bubbles while others remained bubble free. The concentration of H_2O in bubble-free inclusions remained unchanged, indicating no diffusive H_2O loss. The concentration of H_2O in MIs containing bubbles decreased by ~50 %, but with no corresponding increase of δD_{VSMOW}. This demonstrates that H_2O was not lost by hydrogen diffusion through the crystal. Our results indicate that the lower H_2O contents in the bubble-bearing MIs result from decrepitation of the host quartz. While our results indicate that diffusive H_2O loss from quartz-hosted MIs is not significant at low pressure on timescales of days, further work is needed to reconcile the difference between our results and those of [1] and experimental studies of quartz hydration and reequilibration of fluid inclusions [3].

[1] Severs et al. (2007) *Chem Geol* **237**, 358-371. [2] Gaetani et al. (2012) *Geology* **40**, 915-918. [3] Bakker (2009) *Lithos* **112**, 277-288.