Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12193

Intra-experimental consistency and cautionary tales of embayment-based magma decompression rates

BEHNAZ HOSSEINI[1], MADISON L. MYERS[1] AND JAMES M. WATKINS[2]

[1]Montana State University
[2]University of Oregon
Presenting Author: behnazhosseini@montana.edu

Quartz-hosted embayments have been leveraged in silicic-caldera forming eruptions to estimate magma decompression rates, with values spanning three orders of magnitude (0.0005-0.5 MPa s^{-1}). In some cases, these order-of-magnitude variations occur within discrete airfall units, the implications of which remain ambiguous. Here we present results from two H_2O-saturated cold-seal decompression experiments, where H_2O concentration gradients in three quartz-hosted embayments from each experiment were successfully measured and modeled. We use the results of these experiments to (1) examine intra-experimental consistency or variability in recovered decompression rates and (2) test the fidelity of embayments to record decompression rates spanning roughly one order of magnitude (0.005 MPa s^{-1} and 0.015 MPa s^{-1}). Both experiments were decompressed from 150 MPa and quenched at 10-30 MPa, equivalent to ascent times of 2.22 and 7.78 hours. For the experiment decompressed at 0.015 MPa s^{-1}, best-fit recovered rates range from 0.011-0.029 MPa s^{-1}, closely bracketing the imposed rate and corresponding to ascent times of 1.15-3.08 hours (Figure 1A-B). These results confirm that embayments experiencing the same decompression histories record their pathways with remarkable accuracy and consistency. However, one additional glassy embayment from this experiment preserves a flat profile with low H_2O concentrations (1.5-1.6 wt. %), representing re-equilibration at low pressure. Modeling this flat profile yields a speciously slow best-fit decompression rate (0.001 MPa s^{-1}) and correspondingly long ascent time (37 hours). This result emphasizes that not all embayment profiles are representative of syneruptive decompression and degassing, and that flat profiles often characteristic of slow decompression require scrutiny, especially when juxtaposed with consistently faster rates within a discrete airfall unit. For the experiment decompressed at 0.005 MPa s^{-1}, best-fit recovered rates range from 0.001-0.003 MPa s^{-1}, corresponding to ascent times of 13.7-38.22 hours. Although these results are internally consistent, they underestimate the imposed decompression rate and thus greatly overestimate the ascent time. Together, these results suggest that, while embayments can record decompression rates spanning several orders of magnitude, the uncertainty in estimated rates, and especially for resulting ascent times, is much higher at slower decompression rates.