MIMiC: A NEW PROGRAM TO MODEL VAPOR BUBBLE GROWTH IN OLIVINE-HOSTED MELT INCLUSIONS

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Melt inclusions probe the depth of magmatic processes, track magma degassing paths, and record volatile budgets of magmas. Their utility depends on our ability to obtain accurate determinations of volatile contents of inclusions in their initial states (upon entrapment), while working with inclusions in their final states (following quench). During the transition from initial to final state, several processes (e.g., cooling and crystallization, host deformation) often cause a decrease in internal pressure, sometimes resulting in the nucleation and growth of a vapor bubble. Time permitting, diffusion of volatiles (especially CO_2) into the bubble will follow. Several methods exist that attempt to address the effects of bubble growth, but the methods yield inconsistent, and possibly inaccurate, results.

We developed the Melt Inclusion Modification Correction (MIMiC) program to recreate the initial state of melt inclusions. Inclusions are corrected for post-entrapment crystallization/melting and Fe-Mg exchange. Vapor bubble growth is accounted for by modeling vapor bubble volume, determining the mass of CO_2 in the bubble using the Redlich-Kwong equation of state, and adding that CO_2 to the inclusion composition by mass balance. A Monte Carlo approach is employed to assess uncertainty. No knowledge of melt inclusion morphology is required for the correction, enabling MIMiC to model bubble growth in numerous bubble-bearing inclusion data in the literature.

To test its accuracy, we compare MIMiC results to results of rehomogenization experiments using melt inclusions from Seguam (Fo_{81-84}) and Fuego (Fo_{74-78}) volcanoes. Experiments were conducted with a piston cylinder apparatus at 500-800 MPa and 50-100 °C above the trapping temperatures (determined with unheated inclusions) under hydrous conditions (4-7 wt.% H_2O) with run durations of 10-120 minutes. Heated inclusions form well-defined CO_2-S degassing paths, which are elevated in CO_2 relative to unheated inclusions by a factor of ≤6. Results from MIMiC produce CO_2-S paths that are broadly consistent with those of the heated inclusions, demonstrating the viability of MIMiC.