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Insights into the Magmatic Plumbing Systems of Augustine and Pakushin Through the Lens of Olivine-Hosted Melt Inclusions

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Silicate melt inclusions (MI) are important tools for reconstructing storage depths, temperatures, compositions, and volatile budgets of magma before eruption. Assessing depths of crystallization and melt inclusion entrapment depends on accurate knowledge of the CO_2 concentration of MI, but it is well documented that vapor bubbles formed post-entrapment in MI can contain up to 70-80% of the initial CO_2 dissolved in the melt at time of trapping [1]. Correction methods for this loss of CO_2 to a vapor bubble include experimental re-homogenization, Raman determination of vapor bubble CO_2 density, and modeling of post-entrapment bubble formation. The goal of our study is to compare results from these three approaches.

We investigate olivine-hosted MIs from a basaltic Pleistocene deposit at Augustine Volcano (a stratovolcano) and basaltic scoria lapilli from Pakushin (a cinder cone associated with Makushin Volcano on Unalaska) in the Aleutian Arc. MI in unhomogenized olivine from the Augustine sample have up to 7-9.2 wt% H_2O and 1100 ppm CO_2 in the glass [2,3], whereas Pakushin MI have up to 3.5 wt% H_2O and 440 ppm CO_2 [2] in the glass. H_2O variability within each suite likely results from diffusive H loss.

Modeling of published Augustine MI data [2] using MIMiC [4] to account for bubble CO_2 suggests original dissolved concentrations <3400 ppm CO_2 in the melts at time of trapping, with a median of 650 ppm [5]. Estimated trapping depths based on these restored values are ~4-21 km. Preliminary re-homogenization experiments have been successful for some Pakushin MI but have proven challenging for Augustine MI, likely due to their high H_2O. The results of this study will provide more accurate constraints on CO_2 in magmas beneath Augustine and Pakushin, olivine crystallization depth ranges, and the degassing behavior of ascending magmas.

References:

[1] Moore et al., Am. Min. (2015); [2] Zimmer et al., J. Pet., 51.12 (2010); [3] Mandeville, unpublished data; [4] Rasmussen et al., Am. Min. 105 (2020); [5] McKee et al., Bull. Volc. in review (2026).