Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37650

Synthetic Reference Materials for Improved Volatile Quantification in Andesitic-Rhyolitic Silicate Melts: Application to the Sunset Amphitheater Eruption, Mount Rainier

SARAH C SHI[1], PENNY WIESER[2], HYUNJOO LEE[3], GUILLAUME GEORGEAIS[4], YVES MOUSSALLAM[3] AND DR. THOMAS W SISSON, PHD[5]

[1]UC Berkeley
[2]University of California, Berkeley
[3]Lamont-Doherty Earth Observatory, Columbia University
[4]Columbia University
[5]U.S. Geological Survey

Volatiles in silicate melts modulate magma viscosity, crystallization, and eruption dynamics. As the solubility of volatiles, such as H_2O and CO_2, is strongly pressure-dependent, measuring these volatiles in melts can constrain saturation pressures and thus, magma storage depths. However, quantifying volatiles in evolved arc magmas remains a challenge due to analytical discrepancies between Fourier Transform Infrared Spectroscopy (FTIR) and Secondary Ion Mass Spectrometry (SIMS), and uncertainties involving both methods (e.g. absorption coefficients for FTIR, matrix effects for SIMS). It is notable that past studies at Mount St. Helens[1] and Mount Hood[2] have reported negligible CO_2 by FTIR and abundant CO_2 by SIMS, resulting in significant differences in calculated magma storage depths.[3] The paucity of dacitic and rhyolitic reference materials with known volatile contents makes it difficult to resolve the reported offsets between techniques in the literature, and thus challenging to determine which magma storage depths are correct.

To address this, we synthesize andesite, dacite, and rhyolite silicate glasses with a range of volatile contents (0-6 wt.% H_2O, 0-1 wt.% CO_2, 0-0.75 wt.% S, 0-1 wt.% Cl, and 0-1 wt.% F) using a piston cylinder at temperatures of 1100°C and pressures ranging from 1 to 1.5 GPa, as these pressures are necessary to dissolve substantial concentrations of volatiles and to produce homogeneous volatile-bearing glasses. These reference materials for volatile analysis will be characterized by multiple independent techniques, including Elastic Recoil Detection Analysis (ERDA), Nuclear Reaction Analysis (NRA), Elemental Analyzer (EA), FTIR, SIMS, and Electron Probe Microanalysis (EPMA).

Using these standards, we will perform FTIR and SIMS measurements to investigate the volatile systematics of the dacites of Sunset Amphitheater from Mount Rainier, a “very high threat” active volcano in the Cascade Arc, located only ~100 km from the Seattle-Tacoma metropolitan area. We will integrate these volatile contents with chemical transects across host phenocrysts, and electron-backscatter diffraction maps of prominent glomerocrysts to better constrain the pre-eruptive storage conditions, eruption initiation mechanisms, and timescales of pre-eruptive unrest.

[1] Blundy et al., 2010
[2] Koleszar et al., 2012
[3] Wieser et al., 2023
[4] Moussallam et al., 2024