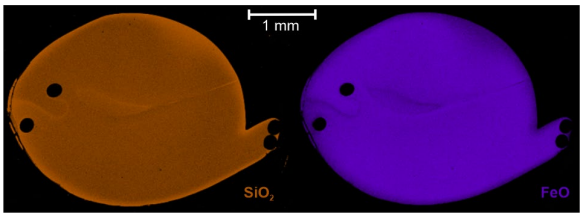
Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28246



Crystal clear or a crystal ball? Major element profiles created by devitrification of picritic glass prior to melting in volatile-loss experiments

MATTHEW R. J. VARNAM[1], GEOFFREY DAVID BROMILEY[1], SIOBHAN E. L. KINGHAM[1] AND LEE SAPER[2]

[1]University of Edinburgh
[2]Jet Propulsion Laboratory, California Institute of Technology

The timing and composition of volcanic degassing provides insights into magmatic and eruptive dynamics. Studying this degassing can be challenging on Earth, yet it is substantially more difficult on a volcanically extinct body like the Moon where the gas is not available for study. Instead, experimental studies of planetary volcanic degassing create synthetic magma to characterize the speed and magnitude of volatile and moderately volatile element loss. We created beads of synthetic lunar magma using six major-element components: SiO_2, FeO, Al_2O_3, MgO, CaO and TiO_2, then dosed them with ~1000 ppm Cl and Zn. The beads were placed in a 1 bar, 1350 °C H_2-CO_2 gas-mixing furnace, then drop-quenched into water after 10–60 minutes. All beads degassed for ≤40 minutes displayed gradients in major elements from the edge up to 600 µm into the interior, as evident in BSE and EDS maps, and EPMA profiles. These profiles were most apparent in shorter duration experiments, which displayed a decrease in FeO (up to 6 wt%) and enrichment in SiO_2 (up to 7 wt%) towards bead edges, but smaller magnitude gradients were still apparent at 40 minutes.

We propose that the starting synthetic glass rapidly devitrifies (<1 min) concomitant with rapid heating, then the crystalline material melts. We show the composition of the bead edge approximately matches a partial melt using MELTS. This gives rise to the prominent gradients in FeO and SiO_2, though gradients are also present in other components. Previously, crystallization of natural basalt during reheating was observed when heating at 20 °C per minute (Burkhard, 2001), but rapid element redistribution noted here is a previously unknown issue for volatile-loss experiments. Recrystallisation and element redistribution are likely inherent processes in short-duration high-temperature experiments, the effects of which should be considered when extrapolating data on volatility and degassing processes. A similar process could also occur naturally in lunar glass beads if they are remelted, providing an alternative explanation for ‘ingassing profiles’ of Na_2O and K_2O observed in 74220 volcanic beads and Chang’e impact beads.

Burkhard, D.J. (2001). *J. PETROL*, *42*(3), pp.507–527.