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Constraining Magma Storage Beneath Glacier Peak Volcano, USA, Using Mineral Zoning, Melt Inclusions, and Vapor Bubbles

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Glacier Peak (Washington, USA) is one of the most active and explosive volcanoes in the Cascade arc, producing two Plinian eruptions ~13.6 ka. The resulting G and B tephra deposits serve as stratigraphic markers in the western United States and Canada, yet magmatic evolution, storage, volatile budget, and eruption triggering remain poorly constrained, limiting interpretation of modern monitoring signals at this hazardous yet comparatively understudied volcano.

From a single stratigraphic section ~3 km from the summit of Glacier Peak, where both G and B tephra are present, we collected two samples from different levels within each unit. We conducted 103 Energy Dispersive Spectroscopy linescans across plagioclase, pyroxene, and amphibole from both G and B. Plagioclase exhibits normal (An80 to An30), reverse (An40 to An80), and flat (~An40) zoning. Reverse zoning is most common in the earliest erupted B deposit (base of the section) and may indicate injection of primitive magma or thermal recharge into an evolved reservoir. Crystals from this deposit show the greatest chemical variability. In contrast, pyroxene and amphibole are largely homogeneous in Mg#, with <5 Mg# variation from rim to core.

No prior studies have measured melt inclusions in evolved samples from Glacier Peak. Preliminary SIMS measurements of 26 plagioclase- and 27 pyroxene-hosted melt inclusions yield ~3–6 wt% H_2O and a median CO_2 content of 255 ppm. Plagioclase-hosted melt inclusions each commonly host 1 to 12 vapor bubbles, whereas vapor bubbles are less common in pyroxene. Raman spectroscopy of 321 vapor bubbles shows that only 34 (10%) contain measurable CO_2 densities, equivalent to an additional 2–393 ppm CO_2 (median = 22 ppm) dissolved in the silicate melt at the time of entrapment. This reveals that at Glacier Peak, bubbles in silicate melt inclusions are not such a significant CO_2 reservoir as olivine-hosted melt inclusions in basaltic systems, where bubbles can host 40–99% of the total CO_2 budget. Future work will characterize major and trace element characteristics of melt inclusions to supplement volatile contents and determine magma storage depths; provide evidence for magma mixing to support mineral chemistry; and assess likely eruption triggers of these Plinian events.