Tracing the evolution of silicic mantle melt using high-Mg# orthopyroxene in Guespalapa monogenetic volcano, Trans-Mexican Volcanic Belt.

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Silicic arc melts can produce catastrophic eruptions, yet the processes responsible for their silica enrichment remain contentious. Are these melts generated by the infiltration of slab-derived silicic components into the mantle wedge, or are they derived from mafic mantle melts via crustal differentiation? Because arc magmas commonly undergo crustal-level mixing, tracing individual component melts relies on early-forming phenocrysts like pyroxenes or olivine. Orthopyroxenes are ideal for this purpose because they crystallize over a wide compositional range, and high-Mg# [= molar ratio of $Mg/(Fe^{2+}+Mg)$] varieties reflect early crystallization from primitive, high- Mg# silicic melts.

In this study, we investigated orthopyroxenes from an olivine- and orthopyroxene-phyric, high-Mg# (68) hybrid andesite flow (61.2 wt% SiO_2) from the Quaternary monogenetic Guespalapa Volcanic Complex, Trans-Mexican Volcanic Belt. Previous He-Os-O isotope studies on olivine from this flow confirmed the presence of mantle-derived component melts (Ahmadi et al., 2025, *Chem. Geol.*). We selected euhedral orthopyroxene crystals (500-1000 µm) for EPMA elemental mapping, alongside spot analyses for major elements (Si, Mg, Fe) and selected trace elements (Ni, Al, Ca) via EPMA and LA-ICP-MS.

The high-Mg# of the orthopyroxenes (~84 to 88, corresponding to the melt Mg# of ~ 66 to 79) and high Ni concentrations (>1000 to ~2000 ppm) suggest that orthopyroxene crystallized coevally, and even slightly prior to, olivine. Furthermore, the variable Mg# range in orthopyroxene reveals a broader spectrum of primitive melt compositions than indicated by the bulk rock. Normal, reverse, and complex zoning patterns indicate that these phenocrysts record the assembly and mixing of multiple distinct batches of silicic mantle melts. Altogether, our data demonstrate that the Guespalapa andesite originated via the hybridization of andesitic component melts formed directly in the mantle wedge through melt-rock reactions between peridotite and infiltrating silicic slab components. These findings confirm that primary silicic melts can generate within the mantle wedge.