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Mineral evidence of a complex feeder system: the AD ~500-700 El Astillero and El Pedregal monogenetic cluster (Michoacán, Mexico)

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El Astillero (EA) and El Pedregal (EP) volcanoes, part of a newly identified monogenetic cluster, formed in the southwestern Michoacán Guanajuato Volcanic Field (MGVF). The ~6 year-long eruption first formed EA's scoria cone and its associated tephra and lava field, followed by the emplacement of EP's lava field [1]. Their volcanic products show a continuous progressive change from basaltic andesite to andesite, culminating in a reversal to intermediate compositions in the last two emitted lava flows from EP, which is also mirrored by their Sr-Nd-Pb-Os-Hf isotopic signatures [2]. These geochemical characteristics are consistent with those observed in other young monogenetic volcanoes in the MGVF, suggesting comagmatic evolution via magma recharge, mixing, and fractional crystallization of subduction-modified mantle melts [2].

The petrographic analysis of the cluster corresponds with its geochemical variability. The mineral assemblage, primarily comprising olivine, clinopyroxene, orthopyroxene, plagioclase, spinel, and amphibole, fluctuates temporally. The mineral phases are isolated or form cumulates and glomerocrysts, and disequilibrium textures such as sieve, resorption, reaction rims, and opacitic rims are common. Mineral-melt equilibrium tests applied to the different mineral phases allowed the identification of phenocrysts, as well as primitive and evolved antecrysts within the eruptive sequence. Thermobarometric estimates in olivine and clinopyroxene phenocrysts defined the existence of a main stagnation zone at ~14 km of depth (3.6 kbar) with temperatures ranging from 1184 to 996 °C. Furthermore, the identification of oscillatory and normally zoned olivine phenocrysts within the tephras and lavas from the cluster, akin to those observed in the historic Paricutin volcano [3,4], prompted the calculation of olivine diffusion timescales throughout the eruptive sequence. Preliminary estimates indicate timescales of less than 30 days in EA's tephras. Thus, our study highlights the complexity of EA and EP, revealing intricacies beyond their seemingly straightforward chemical evolution. This complexity is evident in the interplay of the magmatic processes controlling the geochemical variations of the cluster over time.

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[2] Larrea et al. (2023), Lithos, 456, 107302.
[3] Albert et al. (2020), Scientific Reports, 10(1), 11632.
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