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Open-system magma evolution in post-collisional setting: Insights from trace element mapping of phenocrysts

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Mineral-scale investigations, particularly high-resolution geochemical mapping, provide critical insights into magmatic processes operating in highly porphyritic systems, where crystal cargos derived from multiple crustal levels can obscure whole-rock signatures and complicate petrogenetic interpretations. The Neogene magmatism of the South Apuseni Mountains offers a compelling example. This predominantly arc-like, calc-alkaline suite of intermediate porphyritic andesites, with minor basaltic andesites and dacites, was emplaced in an extensional tectonic setting and locally exhibits elevated Sr/Y ratios and adakitic affinities. The origin of this adakitic signature remains debated, with proposed mechanisms including melting of a metasomatized subcontinental lithospheric mantle and variable mixing between mantle- and crust-derived components [1].

We present major element compositions of amphibole, clinopyroxene, and plagioclase from both adakite-like and normal calc-alkaline suites, together with trace and rare earth element distributions derived from detailed geochemical mapping of phenocrysts from two high-Sr/Y samples.

Thermobarometric estimates indicate that most amphiboles crystallized at mid- to upper-crustal levels, with no systematic pressure–temperature differences between high and low Sr/Y suites. This similarity suggests that the elevated Sr/Y signature is unlikely to reflect significantly different storage depths. In contrast, clinopyroxene records lower pressures and slightly higher temperatures, consistent with late-stage recharge by a hotter, relatively dry melt.

Plagioclase textures and compositions provide further evidence for open-system processes. Complex zoning patterns, skeletal growth textures with melt or glass inclusions enclosed by fresh rim overgrowths indicate disequilibrium conditions. In several crystals, rim domains show higher An and FeO contents relative to cores, supporting episodes of mafic recharge.

Amphiboles from adakite-like rocks display systematically higher Sr/Y ratios than those from normal calc-alkaline suites, driven by both Sr enrichment and Y depletion. Zoning patterns characterized by low Sr/Y cores and high Sr/Y rims point to late-stage modification of the melt toward more adakitic compositions. Similarly, plagioclase Sr contents broadly track whole-rock values, with Sr-enriched feldspars restricted to high Sr/Y samples. One high-Sr/Y microdiorite contains plagioclase with low-Sr cores overgrown by high-Sr, high-An rims, providing direct mineral-scale evidence for possible recharge by a Sr-rich melt.

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