Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28483

Tracking Middle Crustal Magmatic Evolution Using Amphibole and Apatite Geochemistry

GIULIANO CAMILLETTI AND OLIVIER BACHMANN
ETH Zürich

Apatite and amphibole are key tracers of magmatic evolution, recording changes in melt composition and physical conditions throughout differentiation and migration in transcrustal systems. The Valle Fértil mountain range (Argentina) provides a ~14 km vertical exposure of the Famatinian arc's middle crust, revealing a compositional stratigraphy with an intermediate unit (57–70% SiO_2) underlying a silicic unit (65–77% SiO_2). This unique exposure allows for a detailed investigation of how mid-crustal reservoirs evolve through differentiation, melt extraction, and geochemical stratification.

All lithologies exhibit magmatic foliation defined by amphibole and plagioclase alignments. EPMA maps reveal clusters of amphibole and plagioclase surrounded by quartz pockets, which appear isolated in intermediate rocks but transition into interconnected networks in more evolved lithologies. Amphibole composition get more evolved towards the silicic unit. The Al-Tschermak substitution, a proxy for pressure, shows a negative correlation in the intermediate unit but stabilizes in the silicic unit, suggesting shallower storage pressure for the more chemically evolved units.

Amphiboles display negative Eu anomalies and form distinct clusters in trace element co-variation diagrams. LREEs are more enriched in amphiboles from the intermediate unit compared to the silicic unit. Apatite inclusions within plagioclase, amphibole, or quartz show no intra-sample compositional differences either in major or trace elements. However, apatite from the intermediate unit is Ce-enriched and negatively correlated with CaO, whereas apatite in the silicic unit exhibits flat, depleted Ce pattern. The close geochemical correlation between amphibole and apatite suggests co-crystallization under similar conditions.

Apatite Ce depletion indicates increasing oxygen fugacity during differentiation, consistent with mineral assemblages transitioning from Fe-Ti oxides in intermediate rocks to Fe-oxide and titanite in the silicic unit. These observations suggest a vertically stratified magmatic column controlled by fractional crystallization and melt extraction, where sequentially emplaced magma batches followed a bottom-up differentiation trend. As melts evolved, they migrated upwards, forming increasingly silicic domains and ultimately shaping the middle crust architecture of the Famatinian arc.