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Deciphering magma transfer processes from mafic to silicic reservoirs in the Famatinian Arc: the Sierra Valle Fertil - La Huerta section case study (northwestern Argentina)

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Deciphering how deep mafic and shallow silicic reservoirs are physically and chemically connected in trans-lithospheric magmatic arc systems is crucial for understanding the key thermo-mechanical and thermo-chemical processes governing polybaric differentiation columns. However, its full comprehension remains challenging and unsatisfactory due to the scarcity of exposed deep crustal sections. The Sierras Valle Fertil - La Huerta in the Famatinian Arc (northwestern Argentina) offers an exceptionally well-preserved and accessible exposure of the crust of an Ordovician continental magmatic arc. This section ranges from a gabbronorite- and diorite-dominated lower to mid-crust in the west to a tonalitic and granodioritic mid- to upper crust in the east, with metasedimentary sequences interlayered throughout.

Here, we present a detailed study of a 3-km-wide, E-W oriented cross-section within the lower-to-mid mafic crust. This region is dominated by steep-dipping amphibole gabbros and norites with up to 900 meters large bodies of hornblendite, amphibole gabbronorite, tonalite and quartz tonalite. At the outcrop scale, large melanocratic amphibole-rich gabbro bodies are intermingled with millimeter- to meter-thick leucocratic plagioclase-dominated bands, which coalesce to form large tonalitic bodies. Although many of these rocks show equilibrium textures and relatively homogeneous whole-rock compositions, subtle textural heterogeneities and mineral chemistry trends provide evidence for reactive flow processes and melt/fluid migration pathways within the mafic crust. Plagioclase crystals display resorption textures and patchy zoning with bimodal composition (An_{55} – An_{80}), while amphibole and pyroxene crystals preserve equilibrium textures but exhibit significant compositional variations. These variations in mineral chemistry correlate with preserved magmatic banding and diking at outcrop-scale providing evidence of melt/fluid migration across multiple scales in deep arc levels.

Large tonalitic bodies within the mafic lower crust exhibit the same textures and compositions as the mid-crustal main tonalites further in the east, indicating that they represent evidence of intermediate melts caught in the lower crust. Our preliminary results suggest that part of the lower crust functions as an open melt transfer system, shaped by a kilometric network of domains governed by melt-rock reactions and zones of melt accumulation/extraction. This system initiates and sustains melt migration, ultimately contributing to the formation of the upper silicic reservoirs.