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Serpentinization of the Ronda peridotites, Spain

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Element mobility is closely linked to serpentinization processes. In the Ronda Massif (Andalusia, Spain), combined petrostructural observations and O–H isotope analyses allow identification of three successive serpentinization stages: (1) a widespread lizardite mesh texture, (2) a highly localized serpentinization developed along meter-scale corridors characterized by lizardite, bastite, and abundant magnetite, and (3) fibrous veins and coating networks within cataclastic shear zones. The structural analysis of stage 3 shear veins reveals a regional syn-serpentinization extensional deformation, corresponding to multidirectional horizontal stretching and vertical shortening (flattening). The fluid source during stage 1 was likely deep-seated, with a possible contribution from meteoric-derived fluids. Stage 3 serpentinization occurred at 170 ± 50°C, based on magnetite–serpentine isotopic equilibrium. These observations support a model of continuous serpentinization during rapid exhumation in the Early Miocene (Audran et al., *Lithos*, 2024). This structural framework provides a unique opportunity to during serpentinization (Audran et al., Chemical Geology, 2025). We analyzed bulk rock compositions of pairs of poorly and highly serpentinized peridotite rocks from the three stages were analyzed, complemented by in situ LA-ICP-MS mineral analyses. Whole-rock loss on ignition (LOI) appears to be a robust proxy for serpentinization intensity. During stage 1, Ca, Al, Cu, V, and Ti are increasingly mobilized during stage 1. Stage 2 is characterized by systematic losses of Ca, Al, Rb, Sr, REE, Hf, Ti, Cu, and V. In contrast, stage 3 involves selective leaching of only Ca and Cu. Trace element concentrations in serpentine (e.g., Ti, V, Zn) largely reflect inheritance from primary minerals, particularly olivine and pyroxenes. In contrast, Al and Ca mobility at millimeter- to meter-scales is closely linked to pyroxene-to-bastite and olivine-to-mesh-texture transformations. Depletion of Co, Ni, Zn, and Cr in vein-hosted serpentine is balanced by their strong incorporation into magnetite. Copper is consistently leached during peridotite hydration, suggesting that serpentinization represents a significant source of Cu for hydrothermal metallogenic systems in ultramafic rocks.