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Molybdenum behavior during subduction zone metamorphism in the Catalina Schist

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Molybdenum (Mo) serves as a valuable geochemical tool due to its redox sensitivity and isotopic fractionation in ocean basins, producing distinct isotope signatures within sediments and altered oceanic crust. The often contrasting Mo isotope compositions between subducting slabs and resultant arc rocks encourages research that aims to understand Mo cycling and isotopic behavior during subduction-related metamorphism. Molybdenum isotope compositions and concentrations of 21 metasedimentary samples and 10 block-rind mélange samples from the well-characterized Catalina Schist (California, USA) were examined to determine Mo behavior and mineral residency during HPLT subduction zone metamorphism, which ranged from lawsonite-albite to amphibolite facies. The higher-grade units of the Catalina Schist formed during anomalously warm subduction displaying open system behavior and a significant degree of devolatilization. Bulk-rock Mo isotope data and mineral budgets were used to establish elemental residency; host minerals will later be separated by grade and analyzed for Mo isotope compositions, ultimately providing insight into Mo behavior during HPLT metamorphism.

Preliminary data for this metasedimentary suite indicate a trend of decreasing Mo concentrations and a shift to more negative δ^{98}Mo values with increasing metamorphic grade. The Mo concentrations range from 0.20 to 1.41 ppm and δ^{98}Mo values range from -0.50 to +0.09‰ (relative to NIST-3134). The observed trends in concentration and δ^{98}Mo are consistent with fractionation and loss of Mo during progressive metamorphism, although the effects of provenance and sedimentary protolith also must be considered. Correlation between isotope composition and the chemical index of alteration (CIA) may indicate a link to sedimentary provenance rather than metamorphic processes but, given the narrow range of CIA values of these samples (55-65), more data are required for greater certainty. The preliminary data for the block-rind mélange traverse display a trend of higher Mo concentration at the outer rind and lower concentrations nearer the core, ranging from 0.18 to 0.53 ppm. These results demonstrate the behavior of Mo in HPLT metamorphic systems, suggesting that Mo is isotopically fractionated when released from subducting slabs, retaining isotopically light Mo. This study aims to authenticate this hypothesis and establish whether this proposed fractionation is partially modulated by underlying mineralogy.