Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.33281

Molybdenum Isotopes in Metamorphic and Magmatic Rocks Record Fluid Activity in Continental Subduction Zones

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Fluids play a critical role in crust-mantle interaction and geochemical recycling in subduction zones. However, fluid activity in continental subduction zones remains poorly constrained. Molybdenum (Mo) isotopes exhibit significant fractionation during subduction zone processes, providing a powerful tool for tracing fluid activity. Here we report the Mo isotopic compositions of paired metamorphic and magmatic rocks from the Dabie-Sulu continental collision zone. The metamorphic rocks have δ^{98}Mo values of -0.51‰ to 0.12‰. The light Mo isotopic features, together with low Mo/Ce ratios and depleted fluid-mobile element contents, suggest that these rocks represent fragments of subducted continental crust that experienced substantial dehydration during subduction. The magmatic rocks have low δ^{98}Mo values of -0.24‰ to -0.05‰, low Mo/Ce ratios, and low fluid-mobile element contents comparable to those of the metamorphic rocks, indicating the subsequent incorporation of isotopically light Mo from the dehydrated crust into the mantle wedge. Collectively, the light Mo isotopic features of the metamorphic and magmatic rocks point to significant Mo isotopic fractionation during continental subduction. Metamorphic dehydration of the subducted continental crust generated high δ^{98}Mo fluids, leaving the residual dehydrated crust with light Mo isotopes, as recorded by low δ^{98}Mo metamorphic rocks. Subsequently melting of this dehydrated crust produced melts that metasomatized the overlying mantle wedge, generating the source of low δ^{98}Mo magmatism in the continental collision zone. Therefore, the Mo isotope systematics of metamorphic and magmatic rocks provide a powerful means of revealing significant fluid activity in continental subduction zones.