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Tracing tungsten mobility and isotope fractionation in subduction zones

IMOGEN ADDIS[1], HANIKA RIZO[2], EMMANUEL A. CODILLO[3], RICH M. GASCHNIG[4] AND GRAY E. BEBOUT[5]

[1]Carleton Univeristy
[2]Carleton University
[3]Stanford Univeristy
[4]University of Massachusetts - Lowell
[5]Lehigh University

Subduction zones have modified the chemical composition of Earth's interior, by increasing the concentration of fluid-mobile elements in the upper mantle. Tungsten (W) is inferred to be a fluid-mobile element in subduction zone settings. Recent studies have shown that arc lavas have W isotope values (δ^{186}W) higher than those of the upper mantle [1] but the processes responsible for generating the related isotope fractionations remain debated. Here, we will present new isotope-dilution W concentrations and δ^{186}W values for well-characterized exhumed HP/UHP metabasaltic rocks and metasediments from three settings: the Voltri Massif (Ligurian Alps, Italy), Schistes Lustrés and Lago di Cignana (Western Alps, France), and the Catalina Schist (California, USA), to better understand W cycling at subduction zones. The Voltri Massif samples represent an ideal analog for investigating the controls on W mobility along the slab-mantle interface. Tungsten concentrations in mafic and ultramafic whole-rocks range from 3.8 to 32.6 ppb. LA-ICP-MS analyses showed that 89% of the W budget is hosted in rutile, which contains up to 3.4 ppm W. In comparison, rutiles from the Schistes Lustrés and Catalina Schists have W concentrations of ~1000 ppm and 60 ppm, respectively. Phengite contains up to 30 ppm and 10 ppm W in these units. The difference in W concentration between mineral phases in the metabasalts and the metasediments could explain why arcs with high sediment inputs are more enriched in W than lavas generated from subducted oceanic crust alone. Our studies of the Voltri Massif rocks suggest that W can be released from the subducting slab into fluids when rutile breaks down due to fluid-rock interactions at high pressures and temperatures. Arc magmas show depletions in HFSE, commonly attributed to rutile in the subducted slab retaining these elements during dehydration. However, if W is similarly hosted in rutile, it suggests that during slab dehydration rutile must be destabilized. Our results will clarify the processes responsible for W mobility and isotope fractionation in subduction zones, which is critical to understanding W cycling between the surface and deep Earth reservoirs.

1. Kurzweil, F. *et al.* (2019) GCA 251, 176–191.