Fe isotopes in serpentinites: A positive Fe isotopic reservoir in the oceanic crust

SEAN R. SCOTT[1], KENNETH W.W. SIMS[1], B. RONALD FROST[1], PETER B. KELEMEN[2], KATY A. EVANS[3] AND ESTHER M. SCHWARZENBACH[4]

[1]Department of Geology and Geophysics, University of Wyoming, Laramie, WY 82071, USA
[2]Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964, USA
[3]School of Applied Geology, Curtin University, GPO box 1987, WA 6845, Australia
[4]Departmet of Geosciences, Virginia Tech, Blacksburg, VA 24061, USA

Hydration of mantle peridotites on the ocean floor produces hydrogen (protons), which is a key enabling constituent for life. The source of hydrogen in these fluids is oxidation of Fe^{2+} during hydration of olivine. In this study we measured Fe isotopes in mineral separates from a partially serpentinized harzburgite from New Caledonia to better understand mobilization and oxidation of Fe during the serpentinization process. Isotopic data demonstrate that Fe isotopes fractionate during serpentinization and indicate the existence of a positive Fe isotopic reservoir in the oceanic crust. Petrographic and geochemical work on the rock chosen for this study places additional constraints on Fe isotopic measurements, and reveals the presence of magnetite- barren (type 1) serpentine veins and magnetite-bearing (type 2) serpentine veins (with native Fe-Ni alloys). Olivine and pyroxene in the protolith possess $\delta^{56}Fe$ values within error of 0.0 ‰. Type 2 serpentine veins possess negative $\delta^{56}Fe$ (~ -0.33 ‰), while magnetite and awaruite contain positive $\delta^{56}Fe$ (~ 0.75 ‰ and ~ 0.35 ‰, respectively). Mixing relationships between phases involved in type 2 vein formation indicate that Fe in serpentine and magnetite can be explained by closed-system redistribution of Fe from olivine. Awaruite cannot be explained by this trend, and is inferred to represent the positive Fe isotopic complement to negative isotopic Fe observed in hydrothermal vent fluids.