Spinel-olivine-pyroxene equilibrium iron isotopic fractionation and applications to natural peridotites

M. ROSKOSZ[1], C.K.I. SIO[23], N. DAUPHAS[2], W. BI[4], F.L.H. TISSOT[2], M.Y. HU[4], J. ZHAO[4] AND E.E. ALP[4]

[1]UMET, Université Lille 1, France, mathieu.roskosz@univ-lille1.fr

[2]Origin Lab., University of Chicago, USA

[3]Geophysical Lab., USA

[4]APS, Argonne Natl. Lab., USA

Nine spinel-group minerals were synthesized by a flux-growth method. The bulk compositions, iron contents and redox states were controlled during the synthesis to obtain compositions that are representative of the diversity encountered in rocks. The mean force constants of iron bonds in these minerals were determined by synchrotron Nuclear Resonant Inelastic X-ray Scattering (NRIXS). The mean force constants are strongly dependent on the Fe^{3+}/Fe_{tot} of the spinel but are independent, or weakly dependent on other structural and compositional parameters. These force constants are used to predict equilibrium Fe isotopes fractionation factors between spinels and silicates (olivine and pyroxenes). Our predictions are in excellent agreement with independent determinations for the magnetite-fayalite and the magnetite-hedenbergite couples. Our calibration applies to the entire range of Fe^{3+}/Fe_{tot} ratios found in natural spinels and provides a basis for interpreting iron isotopic variations documented in mantle peridotites. Except for a few exceptions, most of the samples measured so far are in isotopic disequilibrium, reflecting metasomatism and partial melting processes.