Equilibrium Tin Isotope Fractionation during Metal-Sulfide-Silicate Differentiation: A NRIXS Approach

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Metal-silicate differentiation was recently addressed through the insight of the isotopic composition of siderophile elements (mainly Fe, Si and Cr isotopes) of planetary and extraterrestrial bodies. A key limitation of this approach is however the knowledge of equilibrium fractionation factors between coexisting phases (metal alloys, silicates and sulfides) used to interpret data on natural samples

In this context, tin is generally classified as a chalcophile element but it is also siderophile and volatile. We applied a synchrotron-based method to circumvent difficulties related to determination of equilibrium isotope fractionation. The nuclear resonant inelastic x-ray scattering (NRIXS) was used to measure the phonon excitation spectrum and then to derive the force constant and finally the fractionation factors of Sn-bearing geomaterials. Spectroscopic measurements were carried out at room pressure at Sector 30-ID (APS, USA). A range of Fe-Ni alloys, rhyolitic and basaltic glasses and iron sulfides containing isotopically enriched ^{119}Sn were synthesized. The tin content and the redox conditions prevailing during the synthesis were varied.

A strong effect of the redox state was measured. In addition, the composition of the silicate glasses was found to be another important factor determining the tin isotope metal-silicate-sulfide fractionation factors. Our results are consistent with trends previously observed in the case of iron isotopes. We will discuss the implications of our experimental results in terms of tin isotope planetary signatures.