Tungsten isotope fractionation during co-precipitation (calcite, scheelite) and adsorption (goethite)

NANG-HTAY YIN[1*], GHYLAINE QUITTÉ[1], & SÉBASTIEN FABRE[1]

[1]Institut de Recherche en Astrophysique et Planétologie (IRAP), CNRS, UPS, Observatoire Midi-Pyrénées (OMP), Toulouse, France

Most carbonaceous chondrites show evidence of relatively low temperature alteration with the presence of hydrous and anhydrous minerals: carbonates, clays, sulfates, oxides, oxyhydroxides and halides [1]. We recently studied alteration of anorthite and diopside minerals in the laboratory and demonstrated that W is mobile and isotopically fractionated during fluid-rock interaction. Besides, it is trapped inside secondary mineral phases [2]. The present study is complementary to the first investigations; it focuses on W isotope fractionation during co-precipitation of calcite (carbonate), scheelite (oxide) and during its adsorption onto goethite (oxyhydroxide).

Carbonate precipitation experiments were carried out with various concentrations of W in solution (0.1 to 2 ppm) along with a fixed concentration of Ca (0.01 mol L^{-1}) and organic carbon (0.1 mol L^{-1}) by incubating at 90 °C for 6 to 48 hours. Oxides were precipitated under similar conditions. Two series of adsorption experiments were performed at pH 8: a 'time series up to 72 h' and 'a series of 24 h experiments with different surface loadings'.

Element concentrations were measured with a quadrupole ICP-MS, while isotope compositions were determined using a MC-ICPMS. In parallel, SEM-EDS was used to give insights onto the morphology of mineral and its surface.

Tungsten co-precipitated with $CaWO_4$ within the first few minutes and with $CaCO_3$ within the first 24 hours. As W is a heavy mass element, it can alter the nucleation and crystal orientation of $CaCO_3$, meaning the crystal structure of aragonite is destabilized, resulting in the formation of rhombohedral calcite crystals as observed. Co-precipitation and adsorption processes are very well-known to fractionate stable isotopes for many elements, hence W stable isotopes fractionation is expected: the solid phase will get enriched in heavy W isotopes during co-precipitation while it will get lighter during adsorption.

1. Brearley et al. (1998). Chondritic meteorites: In Planetary Materials, 36, 1-398. Reviews in Mineralogy, MSA.
2. Yin N.H et al. (2017). Tungsten mobility and its isotope fractionation during alteration of anorthite and diopside minerals: an experimental approach. Submitted.