

Experiments on Ruthenium isotope fractionation between liquid metal, silicate and sulfide

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The abundances of highly siderophile elements (HSE) in Earth's mantle are generally assumed to reflect late accretion of broadly chondritic material to Earth's mantle after the cessation of core formation. Yet, for some HSE (e.g. Ru) it has also been suggested that their mantle abundances reflect metal-silicate equilibration during core formation, and not late accretion. To distinguish between these two possibilities mass-dependent isotope fractionations of some HSE can be used.

To quantify the magnitude and direction of any mass-dependent Ru isotope fractionation during core formation, we performed metal-silicate partitioning experiments in a piston cylinder apparatus at 1 GPa and temperatures between 1300 °C and 1600 °C. We determined Ru partitioning and the fractionation of stable Ru isotopes as a function of temperature, composition and fO_2 . For the determination of Ru concentrations and isotopic compositions a double spike MC-ICP-MS [1] analysis was used, as well as LA-ICP-MS for additional Ru concentration measurements.

As expected, the Ru isotopic compositions of the metal phases are uniform and are indistinguishable from the isotopic composition of the starting material. Silicates display no variation in Ru isotopic compositions which is in good agreement with [2] who did not find any variation between chondrites and mantle rocks. However, there is resolvable mass-dependent Ru isotope fractionation between liquid metal and liquid sulfide as well as between metals of different compositions, including a change of fractionation direction.

Fractionation factors of $\Delta^{102/99}Ru = -0.1$ to 0.2% are small, and might not solve the Ru-mantle excess problem. Nevertheless, they give insight into isotope fractionation processes between immiscible metal, silicate and sulfide melts. Formation of these melts and their impact on isotope fractionation should be taken into account for future experiments of this type.

[1] Hopp et al. 2016, *J. Anal. At. Spectrom.* **31**, 1515-1526.

[2] Hopp and Kleine 2018, *EPSL* **494**, 50-59.