Isotope fractionation during partial condensation

BERNARD BOURDON [1] *, CAROLINE FITOUSSI [1], XUEYING WANG [1]

[1]Laboratoire de Géologie de Lyon, ENS Lyon, CNRS, UCBL
(* correspondence: bernard.bourdon@ens-lyon.fr)

During the early stages of the protoplanetary disk or after giant impacts, it is expected that high temperatures followed by cooling lead to partial condensation of solids. The magnitude of isotope fractionation of moderately volatile elements associated with partial condensation is directly linked to the partial pressure of the element of interest as inferred by Davis and Richter [1]. Thus, observed isotope fractionation as a function of elemental depletion can be used to infer the pressure conditions during condensation, thereby providing strong constraints on astrophysical settings.

We have analyzed tin isotopes in a series of ordinary chondrites [2] using a new method for high precision measurements of Sn isotopes [3] and the results show an enrichment in light isotope correlated with the degree of tin depletion: the most volatile depleted ordinary chondrites show the largest enrichment in light isotopes. This observation is consistent with previous observations made on Zn isotopes [4]. This feature can be identified as a signature of partial condensation but the magnitude of isotope fractionation is significantly smaller than that of pure kinetic fractionation, indicating that condensation took place under moderately supersaturated conditions. While much work has been dedicated to understanding isotope fractionation during evaporation, there has been far less focus on condensation. To interpret these data we have designed a new model for isotope fractionation during partial condensation that takes into account the expected variations in partial pressure. This leads to specific trajectories in isotope composition as a function of element depletion. Furthermore we showed that the shapes of the trajectoires are highly dependent on the cooling rates. In this context, such models should in principle provide key constraints on the conditions of volatile element depletion in the early Solar System.

[1] Davis A.M., Richter F.M. (2003) Treatise on Geochem. 1, 407-430. [2] Wang et al., submitted. [3] Wang et al., in revision. [4] Luck J.M. et al. (2005) Geochim. Cosmochim. Acta 69, 5351-5363.