Conditions of volatile element depletion in the solar nebula using tin isotopes

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Terrestrial planets and meteorites are in general depleted in volatile elements compared with the solar composition. This depletion could have been produced by partial condensation while the protoplanetary disk was still hot or by evaporation during thermal events or due to the migration of volatile rich material into hotter regions. Last, it could result from volatile loss during impacts or planetary magmatism.

Humayun and Clayton [1] reported no K isotope fractionation in planetary materials. This lack of isotopic fractionation has later been interpreted as the result of the relatively high K partial pressure in the environment. Hence, the isotopic fractionation of volatile elements can be a measure of whether condensed phase was in thermodynamic equilibrium with the vapor phase [2].

In contrast with K isotopes, high precision isotope measurements of Zn in chondrites showed that elemental depletion correlates with lighter Zn isotope compositions [3], suggesting the role of partial condensation.

This study focuses on tin (Sn) whose condensensation temperature (704 K) is similar to that of Zn. Seven Sn isotopes have a natural abundance above 4%, making it a very reliable system to measure with high precision. The determination of Sn isotopic composition were performed with a ^{117}Sn-^{122}Sn double spike technique on the Neptune Plus MC-ICPMS equipped with Jet cones. A three ion-exchange column procedure were designed to separate and purify Sn from matrices and interfering elements (such as Cd, In and Te). An Sn elemental standard was passed through the whole procedure and showed no isotope fractionation and yielded analytical uncertainties of 0.03 ‰ (2 SE, n=12) for δ^{124}Sn. The Sn isotopic compositions in terrestrial samples and meteorites were analyzed to constrain the conditions of volatile element loss in the solar nebula.

[1] Humayun and Clayton (1995) *GCA* **59**, 2131. [2] A.M. Davis et al. (2003) *Treatise on Geochemistry* **1**, 407. [3] J. Luck et al. (2005) *GCA* **69**, 5351.