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Tin isotope variations in chondrites and Earth: mass-independent isotope fractionation and the ^{115}In-^{115}Sn decay system

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We investigated Sn isotope variations in terrestrial materials and bulk chondrites [1]. A new chemical separation procedure and a novel MC-ICP-MS measurement protocol were developed to determine isotope variations among the ten stable isotopes of Sn.

Both terrestrial basalts and chondrites show deviations from the reference Sn standard (NIST SRM 3161a). The correlated variations in two odd isotopes (^{117}Sn and ^{119}Sn) and sometimes in the two heaviest isotopes (^{122}Sn and ^{124}Sn) suggest the occurrence of two mass independent isotope fractionation processes. The two mass independent isotope fractionation patterns are consistent with experiments and theoretic predictions for magnetic isotope and nuclear volume effects [2, 3]. Although the Sn isotope pattern of the carbonaceous chondrite Murchison (CM2) resembles to some extent a s-excess pattern [4], our data are better reproduced by the nuclear volume effect. Overall, we find no evidence for nucleosynthetic variations at the bulk sample scale.

Mass independent isotope fractionation induced during sample preparation cannot be fully excluded but seems unlikely because different groups of chondrites show distinct patterns. Therefore, the observed Sn mass independent isotope variations point towards unknown geo/cosmochemical processes.

In chondrites, ^{115}Sn/^{120}Sn broadly correlates with the elemental ratio In/Sn, which is consistent with the β^- decay of ^{115}In to ^{115}Sn over the age of the solar system. This represents the first evidence of the ^{115}In-^{115}Sn decay system in natural samples. Relative to carbonaceous chondrites, terrestrial samples show an excess in ^{115}Sn/^{120}Sn of ca. 200 ppm, suggesting that the BSE has a superchondritic In/Sn ratio due to the segregation of ca. 50% of Sn into the Earth's core.

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