p-Process Sm and Nd Isotope Variations in Chondritic Meteorites

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High precision Sm and Nd isotope measurements on bulk samples of chondritic meteorites reveal the presence of anomalous ^{144}Sm and ^{142}Nd relative to terrestrial abundances. All analyzed chondrites have negative ^{142}Nd anomalies ranging from -14 to -41 ppm while anomalies in ^{144}Sm are variable. The carbonaceous chondrites have ^{144}Sm deficits ranging from -84 to -16 ppm while the ordinary chondrites show both deficits and excesses in ^{144}Sm ranging from -45 to +74 ppm. An enstatite chondrite has a negative anomaly of 47$\pm$24 ppm while a Rumuruti chondrite has a 69$\pm$40 ppm ^{144}Sm excess. ^{144}Sm is produced exclusively by p-process nucleosynthesis while ^{142}Nd has a small p-process contribution. The ^{144}Sm and ^{142}Nd isotope anomalies thus clearly point towards a heterogeneous distribution of p-process Sm and Nd nuclides in the solar nebula. This is confirmed by the lack of correlation between ^{142}Nd and the Sm/Nd, an indication that the ^{142}Nd variations in chondrites cannot be explained by radiogenic production from the β-decay of ^{146}Sm. The ^{142}Nd anomalies do not correlate with variations in ^{144}Sm, an indication that p-process Sm and Nd isotope sources were not coupled. Variations in the abundances of p-process Sm and Nd isotopes has significant implications for the use of the short-lived ^{146}Sm-^{142}Nd radiometric system because a heterogeneous distribution of ^{144}Sm implies that the now extinct ^{146}Sm, another p-process nuclide, must also have been non-uniformly distributed in the solar nebula. The use of this radiometric system in understanding early planetary processes can be seriously compromised by the heterogeneous distribution of both the radioactive parent (i.e., ^{146}Sm) and the radiogenic daughter (i.e., ^{142}Nd). Under such conditions, the ^{146}Sm-^{142}Nd system can be meaningfully used for deciphering early planetary differentiation only if the ^{146}Sm and ^{142}Nd abundances of bulk planetary bodies can be precisely constrained. These observations put a question mark on the suitability of chondrites as a reference relative to which ^{146}Sm-^{142}Nd isotope variations in planets can be characterized.

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