Evaluating Nd Nucleosynthetic Anomalies in Enstatite Chondrites

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Nucleosynthetic anomalies in Nd isotopes of enstastite chondrites (ECs) have been identified as small positive deviations from Bulk Silicate Earth (BSE) for ^{148}Nd and ^{150}Nd, and negative deviations for ^{142}Nd [1]. These deviations are interpreted as a deficiency in nucleosynthetic s-process components in ECs relative to BSE. If so, then a model where ECs and Earth were derived from the same nebular material is likely invalid. One expectation from materials with different amounts of s- and r-process Nd is that ^{145}Nd should show corresponding enrichments to those of ^{148}Nd and ^{150}Nd, as these 3 isotopes are dominated by r-process in their makeup. To evaluate this, we performed high precision Nd isotope measurements using a multistatic 3 line routine on 22 different EC's ranging from metamorphic grade 3 to 6 as independent studies in 2 different laboratories, the University of Houston (UH) and Freie Universität Berlin (FUB), respectively. Both datasets show no detectable differences in μ^{142}Nd with metamormorphic grade. With the exception of 2 samples in the UH study that gave μ^{142}Nd of -3.5±5 (±2σ and used hereon), and -1.90±7.8, samples at UH gave an average of -9.0±3.7 (n=13). The FUB study gave an average of -11.2±6.3 (n=10). Three samples were measured in duplicate at each lab and were indistinguishable in their μ^{142}Nd. Both studies also found indistinguishable μ^{145}Nd relative to BSE - the UH study obtained an average μ^{145}Nd of -0.5±4.4, the FUB study an average μ^{145}Nd of -0.03±0.22. The μ^{148}Nd and μ^{150}Nd results from both labs were more variable and consistent with results from the earlier study. The μ values for these 2 isotopes are dependent on which terrestrial standard is used for BSE normalization. Also, domain mixing effects can result in the incorrect application of exponential mass fractionation corrections and is more problematic for ^{148}Nd and ^{150}Nd than for ^{142}Nd and ^{145}Nd. Hence it is unclear whether the nucleosynthetic differences in the Nd isotopic compositions of ECs versus BSE are real and whether they were derived from different materials in the solar nebula.

[1] Burkhardt et al. Nature 537, 394-398, 2016.