Nucleosynthetic Nd isotope anomalies in angrites and eucrites

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Identifying the building blocks involved in the accretion of the terrestrial planets is a fundamental goal of cosmochemistry. Nucleosynthetic isotope anomalies are a promising means to shed light on this issue as they fingerprint the source material of extraterrestrial samples and are not easily overprinted. Recent work has shown that various types of chondritic meteorites contain nucleosynthetic anomalies in Nd (as well as in other elements [1]), and heterogeneous distribution of isotopically anomalous presolar matter is the primary reason for measured differences between "chondritic" and terrestrial ^{142}Nd abundances [2-4].

In this work, we employ a 4-line measurement routine to obtain high-precision Nd isotopic compositions of achondritic meteorites. Using this method, we achieve uncertainties of <5ppm (2SD, external reproducibility) for the isotopes ^{142}Nd, ^{145}Nd, and ^{148}Nd. With this, we show that relative to terrestrial samples, angrites and eucrites exhibit resolved excesses in ^{145}Nd, ^{148}Nd, and ^{150}Nd. Furthermore, after correction of radiogenic ingrowth from ^{146}Sm, all achondrite samples show uniform ^{142}Nd depletions compared to terrestrial Nd. Collectively, these isotopic signatures are consistent with a deficit in *s*-process Nd nuclides that slightly exceeds those of enstatite and ordinary chondrites [2-4]. These data reveal that nucleosynthetic Nd isotope variability is not restricted to chondritic meteorites, and Earth continues to represent an endmember composition with the highest proportion of *s*-process Nd known. When layered with isotopic data from other elements [5-7], no combination of the presently available meteorite samples can reproduce the nucleosynthetic signature of the Earth, and terrestrial building blocks appear to not be present in our current meteorite collections. Intriguingly, the evident *s*-process heterogeneity in Solar System materials appears to scale with inferred heliocentric distance [6-7], permitting spatial distinction of meteorite accretion orbits. Nucleosynthetic isotope signatures such as these can thus be used as a tool to reconstruct the primordial architecture of the early Solar System.

[1] Dauphas & Schauble (2016) *Annu. Rev. Earth Planet. Sci.* **44**, 709. [2] Bouvier & Boyet *Nature* **537**, 399. [3] Burkhardt et al. (2016) *Nature* **537**, 394. [4] Fukai & Yokoyama (2017) *EPSL* **474**, 206. [5] Burkhardt et al. (2011) *EPSL* **312**, 390. [6] Render et al. (2017) *GPL* **3**, 170. [7] Fischer-Gödde & Kleine (2017) *Nature* **541**, 525.