NUCLEOSYNTHETIC Nd ISOTOPE ANOMALIES IN METEORITIC MATERIALS: IMPLICATIONS FOR ^{146}Sm-^{142}Nd SYSTEMATICS AND THE RELATION OF CHONDRITES AND EARTH.

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Introduction: The use of chondrites as proxies for the isotopic and elemental composition of the bulk Earth (and other terrestrial planets) forms the basis for using radiogenic isotope systems and partitioning studies to investigate the differentiation of planets into crust, mantle, and core. In this 'chondritic Earth' paradigm, the finding of a ~20 ppm ^{142}Nd/^{144}Nd excess in the accessible Earth relative to chondrites was interpreted to indicate an early global differentiation of the silicate Earth, resulting in a higher-than-chondritic Sm/Nd of the accessible mantle, and a complementary enriched reservoir with lower-than-chondritic Sm/Nd; this enriched reservoir that must have been isolated from the accessible silicate Earth within the first 30 My of the solar system, either by sequestration to the deep Earth [1] or by loss to space through collisional erosion [2]. These findings severely impacted our fundamental understanding of the Earth's geodynamical evolution and bulk composition, and lead to the postulation of 'hidden reservoir' and 'non-chondritic' Earth models [1-3]. However, the conclusions reached in these prior studies are based on a chronological interpretation of the ^{142}Nd excess in the accessible Earth, *i.e.*, the assumption that this excess reflects an early Sm/Nd fractionation and ^{146}Sm decay. Here, we investigate an alternative explanation for the ^{142}Nd variations, namely nucleosynthetic isotope heterogeneity between chondrites and the Earth.

Materials and Methods: To quantify and correct any nucleosynthetic contribution to observed ^{142}Nd variations, we performed high-precision Nd and Sm isotope measurements on several ordinary and enstatite chondrites, the carbonaceous chondrite Allende, the ungrouped brachinite-like achondrite NWA 5363, and the Allende Ca,Al-rich inclusion (CAI) A-ZH-5 by TIMS at LLNL.

Results: After correction to a common ^{147}Sm/^{144}Nd = 0.1960, the μ^{142}Nd (ppm deviation relative to the JNdi-1 standard) values range from -9±5 (95% conf.) for enstatite chondrites to -31±1 for the Allende carbonaceous chondrite. This is consistent with prior observations [4-6] and indicates that the ^{142}Nd/^{144}Nd of chondrites does not soley reflect Sm/Nd fractionation and ^{146}Sm decay. In addition to the variations in ^{142}Nd, our new data show resolved systematic and correlated anomalies in non-radiogenic Nd isotopes.

Discussion: The anomalies in non-radiogenic Nd isotopes plot along mixing lines between terrestrial Nd and *s*-process Nd, indicating that the meteorites are characterized by variable depletions in *s*-process Nd relative to the Earth: This finding is consistent with observations for other elements [*e.g.*, 7]. In contrast to the bulk meteorites, CAI A-ZH-5 is enriched in *s*-process Nd, in agreement with data for other Allende CAIs [8]. Since CAIs host about half of the Nd (and Sm) in Allende, mass balance implies that a CAI-free carbonaceous chondrite composition would exhibit a s-deficit significantly larger than those observed for enstatite and ordinary chondrites. The μ^{142}Nd values of the meteorites are inversely correlated with μ^{145}Nd, μ^{148}Nd and μ^{150}Nd and enstatite and ordinary chondrites, as well as NWA5363, plot on single mixing lines between the terrestrial composition and *s*-process Nd; Allende deviates from these lines due to the admixture of CAIs. Correction of the measured μ^{142}Nd values for nucleosynthetic isotope variations using either linear regressions of the bulk meteorite data, or the slopes of the *s*-process mixing lines yield μ^{142}Nd values that are indistinguishable from the modern terrestrial mantle composition at the current level of analytical precision.

Conclusion: The Nd isotopic data show that compared to chondrites, the Earth accreted from material enriched in Nd isotopes produced by the *s*-process of nucleosynthesis. Once this nucleosynthetic effect is taken into account, the Earth and chondrites have indistinguishable ^{142}Nd compositions. Thus, our results remove the evidence for an early global silicate differentiation of the Earth, obviate the need for 'hidden reservoir' and 'non-chondritic' Earth models, and imply a chondritic Sm/Nd ratio for the bulk Earth. Consequently, while our data demonstrate that chondrites are not the actual building blocks of the Earth, they highlight that chondrites are nevertheless the most appropriate proxy for the elemental composition of the Earth, at least for refractory elements like Sm/Nd or Lu/Hf.

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