PROBING NEODYMIUM ISOTOPIC VARIATIONS IN THE INNER SOLAR SYSTEM.

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Introduction: One of the key problems in planetary science is the identification of the building blocks of Earth, and whether they exist within our current collection of meteorites. Stable mass independent isotopic anomalies, usually nucleosynthetic in origin, are a key tool in fingerprinting material coming from different accretionary regions within the protoplanetary disk. For a number of isotopic systems such as O[1], Ni[2], Ti and Cr [3], enstatite chondrites (EC) appear to be the strongest candidates for Earth's building blocks, despite their low Mg/Si ratios relative to the bulk Earth. It has been proposed that Earth, the Moon-forming impactor and enstatite chondrites all were originally sourced from the same reservoir in the protoplanetary disk, but subsequently experienced divergent chemical evolution pathways [4]. This was recently challenged by [5] who used the correlation between Mo and Nd isotopes in bulk meteorites to argue that such a reservoir does not exist as the isotopic composition of enstatite chondrites is resolvable from Earth. However, in detail the Nd isotopic ratios of EC (^{142}Nd/^{144}Nd, ^{148}Nd/^{144}Nd, ^{150}Nd/^{144}Nd) show considerable variability, and overlap significantly with the isotopic composition of both the bulk Earth and ordinary chondrites (OC). [6] previously identified Nd isotopic variability in EC, linking it to the degree of equilibration the meteorite had experienced, however they only focused on collecting high precision ^{142}Nd/^{144}Nd, which also has contributions from the decay of the short-lived ^{146}Sm nuclide ($t_{1/2}$ ~103 Myr), making identification of nucleosynthetic anomalies less clear. While the study of [5] reports all the Nd isotopic ratios measured at high precision, only equilibrated EC were analyzed. Therefore, with the currently published data it is unclear to what extent thermal equilibration in the EC is responsible for the variation observed in the stable Nd isotopic ratios, and whether the EC reservoir can be resolved from Earth.

In order to better understand the genetic relationship between enstatite chondrites and the Earth we are carrying out a more systematic study including both equilibrated and unequilibrated enstatite chondrites, focusing on high precision analysis of all the stable Nd isotopic ratios.

Method: Approximately 1.8 g of sample was dissolved using acid digestion with the Nd being separated using ion-exchange chromatography. A Triton-Plus TIMS was used for the isotopic analysis with Nd analyzed as Nd^+ using a multi-static routine after [7]

Results and Discussion: Our data for EC are consistent with [5-6,8] in showing that equilibrated EC are resolvable from Earth in their ^{142}Nd/^{144}Nd ratios. However, unlike [6], the ^{142}Nd/^{144}Nd ratios of the unequilibrated enstatite chondrites are not similar to the terrestrial values, weakening the arguments for ascribing ^{142}Nd/^{144}Nd variations to petrologic grade and the thermal processing. We also observe significant variability in the stable ratios such as ^{145}Nd/^{144}Nd and ^{148}Nd/^{144}Nd, which do not appear to correlate with petrologic grade.

Taking the EC together as whole, at the 95% confidence interval, student t-tests show that the modern convecting mantle, EC, and OC form three distinct populations with respect to their ^{142}Nd/^{144}Nd. However, in comparing the average ^{145}Nd/^{144}Nd, ^{148}Nd/^{144}Nd, and ^{150}Nd/^{144}Nd compositions (which do not have a radiogenic contribution) of EC with either OC or the modern convecting mantle, this distinction breaks down. At the 95% confidence interval, the EC data overlap with both Earth and OC. While our initial data would argue against the model of [4], where the Earth and enstatite chondrites are sourced from the same isotopic reservoir, it is clear that precise Nd stable isotopic composition of the enstatite chondrite reservoir has yet to be properly understood and constrained.

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