Nucleosynthetic anomalies in chondrites relative to the Earth: the debate over the ^{146}Sm-^{142}Nd systematics

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In 2005 the first high-precision ^{142}Nd measurements on chondrites revealed a difference of 20 ppm with the modern terrestrial samples. Since ^{142}Nd is a radiogenic isotope partly produced by the decay of ^{146}Sm ($T_{1/2}$=103 Ma), a very early differentiation event of the silicate Earth had been proposed to explain this offset (1,2). This scenario has been challenged by the discovery of variations in stable Nd isotope ratios in chondrites (3-6).

As shown for Nd as well as for most elements, stable isotope compositions measured in carbonaceous chondrites are the furthest from the Earth's composition (3-7) whereas a unique refractory inclusion (NWA 6991) shares a simililar ^{146}Sm–^{142}Nd isotopic evolution with Earth at a chondritic Sm/Nd and does not have any nucleosynthetic anomalies in Nd (5). Finally, based on deviations measured on the 145, 148 and 150 Nd stable isotopes in ordinary chondrites, the excess in ^{142}Nd in the accessible silicate Earth has been explained by a higher proportion of s-process Nd (6).

For enstatite chondrites (EC), the deviation in stable Nd isotopes is very small and not clearly resolved with the current level of measurement precision. We will compare previous Sm-Nd isotope measurements in EC in order to discuss the small measured deviations in ^{142}Nd/^{144}Nd within this group relative to the Earth. EC have a unique mineralogy because they were formed under extreme reducing conditions. Half of the Sm and Nd elemental budget is in oldhamite, which is easily altered to Ca-sulphate by weathering (8). We note that the isotope studies of EC are still limited and with a clear over-representation of the EL6 subgroup that has fractionated refractory-lithophile element patterns (9).

We will present a perspective for increasing analytical precision based on a new method of acquisition by TIMS.

(1) Boyet & Carlson, Science 2005; (2) Caro et al., Nature 2008; (3) Carlson et al., Science 2007; (4) Gannoun et al., PNAS 2011; (5) Bouvier & Boyet, Nature 2016 ; (6) Burkhardt et al., Nature 2016; (7) Warren, EPSL 2011; (8) Gannoun et al., CGA 2011; (9) Rubin et al., GCA 2009.