The stable neodymium isotope composition of the silicate Earth

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Initial observations of a resovable ~20 ppm excess of ^{142}Nd in terrestrial materials relative to chondirtes [1, 2], suggested either the existence of complementary hidden reservoir within the deep Earth or loss of early crust through collisional erosion. However, more recently this difference has been attributed to nucleosysthetic anomalies and the heterogenous distrubtion of s-process radionuclides in the Solar System [3-5].

Experimental work suggests that the core contains a significant proportion of sulfide, added during the final stages of accretion and recent data indicates that at high pressures sulfide can incorporate substantial quantities of refractory lithophile elements [including Nd; 6]. If there is in fact a sulfide-rich missing reservior, Nd stable isotopes have the potential to trace sulfide segregation, because there is a significant contrast in bonding environment between sulfide and silicate, where heavy isotopes should be preferentially incorporated into high force-constant bonds involving REE^{3+} (i.e. the silicate mantle).

Here we present ^{146}Nd/^{144}Nd values, obtained using double spike techniques, for chondrites (n = 33) and terrestrial magmatic rocks (n = 15). Carbonaceous, Enstatite and Ordinary Chondirtes have broadly similar compositions. The Enstatite chondrites have remarkably uniform compositions Δ^{146}Nd = 0.03‰, with significantly more variabilty is observed for the Carbonaceous meteorites Δ^{146}Nd = 0.14‰ potentially resulting from aqueous alteration. The data for chondritic meteorites and preliminary data for terrestrial igneous rocks suggest that the Earth has a Nd stable isotope composition that is indistinguishable from that of chondrites. Overall, these results indicate that the mismatch of ^{142}Nd between the Earth and chondrites is best explained by a higher proportion of s-process Nd in the Earth, rather than partitioning into sufide or S-rich metal in the core.

[1] Boyet & Carlson, Science 309, 576 (2005) [2] Carlson et al. Science 316, 1175 (2007); [3] Burkhardt et al. Nature 537, 394 (2016); [4] Bouvier & Boyet, Nature 537, 399 (2016); [5] Saji et al. JAAS 31, 1490 (2016); [6] Wohlers &Wood, Nature 520, 337 (2015).