The neodymium stable isotope composition of oceanic basalts

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Neodymium (Nd) stable isotope analyses allow radiogenic $^{143}Nd/^{144}Nd$ and stable $\delta^{146/144}Nd$ isotope compositions to be obtained from a single measurement [1]. Thus it is possible to simultaneously acquire information on the the sources of these magmas as well as constraining the processes involved their genesis. Recent work has shown that the Nd stable isotope compositon of chondrites ($\delta^{146/144}Nd = -0.025 \pm 0.004‰$) and an initial estimate of the Bulk Silicate Earth ($-0.022 \pm 0.006‰$) are indistinguishable at the 95% confidence level [1]. Based on these results the mismatch of ^{142}Nd between the Earth and chondrites was best explained by a higher proportion of s-process Nd in the Earth [2-3].

New analyses of a comprehenisive suite of mid-ocean ridge basalts from the Atlantic, Indian and Pacific Oceans show a homogenous compostion of $\delta^{146/144}Nd = -0.008 \pm 0.003‰$ ($n = 33$). Thus the MORB mantle is resovably heavier than chondrites by 10 ppm. Experimental work suggests that the Earth's core contains a significant proportion of sulfide [4], and under reducing conditions sulfide can incorporate substantial quantities of refractory lithophile elements [including Nd; 5]. As 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), this new data opens up the possibility that the residual mantle following planetary differentiation is isotopically heavy as a result of the partitioning of a sufide or S-rich metal in the core.

This data will be complemented with analyses of a range of ocean island basalts, so far these magmas are significantly more variable and isotopically lighter than the MORB source mantle. The variablility of stable Nd relative to some distinctive mantle endmembers components (EM1, EM2 and HIMU) will be discussed.

[1] McCoy-West et al. (2017) EPSL 480, 121; [2] Burkhardt et al. Nature 537, 394 (2016); [3] Bouvier & Boyet, Nature 537, 399 (2016); [4] Labidi et al. Nature 501, 208 (2013); [5] Wohlers &Wood, Nature 520, 337 (2015)