Nucleosynthetic heterogeneity and Bulk Silicate Earth Nd-isotope composition

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The ~20 ppm excess in the $^{142}Nd/^{144}Nd$ ratio of Bulk Silicate Earth (BSE) relative to chondrites is interpreted to reflect an early global silicate differentiation during the lifetime of ^{146}Sm [1]. However, significant variability that do not correlate with Sm/Nd ratio exists in $^{142}Nd/^{144}Nd$ ratios within chondrite groups, suggesting that a component of the terrestrial excess could reflect nucleosynthetic heterogeneity [2]. Distinguishing between these contrasting interpretations of Earth's $\mu^{142}Nd$ ($\mu=10^6$ deviations from JNdi-1 standard) excess necessitates a better understanding of the Nd-isotope composition of chondrites, including the $\mu^{145}Nd$, $\mu^{146}Nd$, $\mu^{148}Nd$ and $\mu^{150}Nd$ values.

Taking advantage of a novel analytical protocol using MC-ICPMS [3], we report Nd-isotope data for a number of carbonaceous, ordinary and enstatite chondrites as well as Tagish Lake acid leachates with an external reproducibility of 2.4, 1.6, 1.6 and 3.5 ppm for $\mu^{142}Nd$, $\mu^{145}Nd$, $\mu^{146}Nd$ and $\mu^{150}Nd$, respectively, when normalized to $^{148}Nd/^{144}Nd$. Carbonaceous chondrites return $\mu^{142}Nd$ values that range from –26.1±4.7 to –10.9±1.7 ppm whereas ordinary and enstatite chondrites display similar variability with $\mu^{142}Nd$ values ranging from –10.7±1.6 to –4.2±1.8 ppm. The $\mu^{142}Nd$ display a clear positive correlation with $\mu^{146}Nd$, which regresses back to the BSE composition ($\mu^{142}Nd=0$, $\mu^{146}Nd=0$) within uncertainty. The $\mu^{145}Nd$ and $\mu^{150}Nd$ are indistinguishable from JNdi-1 for most samples. Analysis of Tagish Lake leachates reveal large internal variations consistent with progressive dissolution of s- and r- process carriers. Except two *r*–process rich fractions, the leachates plot along the same $\mu^{142}Nd$-$\mu^{146}Nd$ correlation line as bulk chondrites. As ^{142}Nd and ^{146}Nd are both *s*-process dominated nuclides, we interpret this correlation as reflecting variations in the proportion of *s*–process Nd and conclude that the ~20 ppm excess of BSE relative to chondrites is purely nucleosynthetic. The *s*-process enrichment of BSE relative to chondrites that we find, is in agreement with similar inferences from Mo and Zr isotope studies [4,5].

[1] Boyet & Carlson, 2005, *Science* **309**, 576 [2] Gannoun *et al*., 2011, *PNAS* **108**, 7693 [3] Saji *et al*, 2016, *JAAS* (submitted) [4] Burkhardt *et al*, 2011, *EPSL* **312**, 390 [5] Akram *et al*, 2015, *GCA* **165**, 484