High-precision Nd isotope analysis by MC-ICPMS: Implications for early Earth silicate differentiation

NIKITHA SUSAN SAJI*[1], DANIEL WIELANDT[1], CHAD PATON[1] AND MARTIN BIZZARRO[1]

[1]Centre for Star and Planet Formation, Natural History Museum of Denmark, Øster Voldgade 5-7, 1350 DK (correspondence: nikitha.saji@snm.ku.dk)

The ~20 ppm excess in the $^{142}Nd/^{144}Nd$ ratio of modern terrestial mantle relative to chondrites is interpreted to reflect an early global silicate differentiation on Earth during the lifetime of ^{146}Sm ($\lambda_{1/2}$ = 104 or 68 Myr) [1]. However, significant variability exists in $^{142}Nd/^{144}Nd$ ratios within chondrite groups, opening the possibility that a component of the terrestrial excess reflects nucleosynthetic heterogeneity [2]. Distinguishing between the two interpretations of Earth's ^{142}Nd excess requires a better understanding of the Nd isotopic composition of chondrites, including the stable $^{145}Nd/^{144}Nd$, $^{146}Nd/^{144}Nd$, $^{148}Nd/^{144}Nd$ and $^{150}Nd/^{144}Nd$ ratios.

Although the traditional TIMS technique provides an external reproducibility of ~5 ppm for $^{142}Nd/^{144}Nd$, the reproducibility for other stable Nd isotope ratios is typically 5-10 times worse. In addition, inaccuracies of up to ~20 ppm have been reported for the $^{142}Nd/^{144}Nd$ ratio possibly due to reservoir mixing effects during analysis [3]. To address these issues, we developed novel chemical purification and mass spectrometry techniques that allow the measurement of all Nd isotopes with unprecedented accuracy and precision by MC-ICPMS. Repeat analyses of 15 separately processed aliquots of the BCR-2, BHVO-2 and GSP-2 rock standards yield Nd isotope compositions identical to the JNdi reference standard, with typical external reproducibilities of ~2, 2, 2 and 4 ppm (2SD) for $^{142}Nd/^{144}Nd$, $^{145}Nd/^{144}Nd$, $^{146}Nd/^{144}Nd$ and $^{150}Nd/^{144}Nd$, respectively, using $^{148}Nd/^{144}Nd$ = 0.241578 for internal normalization. The high chemistry yields (>99%) allow us to determine the mass dependent $^{145}Nd/^{144}Nd$ ratio with a typical precision of 10 ppm. Our terrestrial standards define a mean stable $^{145}Nd/^{144}Nd$ of -28±7 ppm (2SE) relative to JNdi. Analysis of 5 Allende (CV3) aliquots show that the magnitude of the ^{142}Nd deficits is shifted by ~10 ppm using $^{148}Nd/^{144}Nd$ or $^{145}Nd/^{144}Nd$ instead of $^{146}Nd/^{144}Nd$ for internal normalization. We speculate that a possible anomaly in *s*-process dominated ^{146}Nd may also affect the *s*-process rich ^{142}Nd nuclide, hinting that Earth's ^{142}Nd excess may not be solely due to ^{146}Sm decay. Using our new methods, we will report additional Nd isotope data for other chondrite groups as well as Martian meteorites and early Earth samples.

[1] Boyet & Carlson, 2005, *Science* **309**, 576 [2] Gannoun *et al*., 2011, *PNAS* **108**, 7693 [3] Andreasen & Sharma, 2011, *IJMS* **285**, 49.