

Nd Isotope and Sm/Nd Ratio Measurements by Multi-collector Inductively Coupled Plasma Mass Spectrometry

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We have measured Nd isotope and Sm/Nd ratios on mixed REE solutions using a VG AXIOM multi-collector inductively coupled plasma mass spectrometer (MC-ICPMS). The analysed samples include synthetic Sm-Nd mixtures prepared from AMES standards and also bulk REE separates from dissolved rock samples that were collected in concentrated HNO₃, off cation exchange columns, after Sr separation. The chemical and mass spectrometric procedures we have followed are a modification of those developed by Luais et al. (1997). Sample introduction was via a CETAC Aridus desolvating nebuliser with a sensitivity of 100-150 V/ppm Nd, at a sample uptake rate of 0.03-0.05 ml/min. Data was acquired statically over a period of ca. 15 minutes consuming ≤ 100 ng Nd. The typical ¹⁴⁴Nd ion beam intensity was 2.5-5.0 V and the internal precision on ¹⁴³Nd/¹⁴⁴Nd at the end of a run was ca. ± 0.000005 (2 se). Raw isotopic data was exponentially corrected for mass fractionation using ¹⁴⁶Nd/¹⁴⁵Nd = 2.071943, and the ¹⁴⁴Sm peak-stripped using ¹⁴⁴Sm/¹⁴⁷Sm = 0.20632. After this procedure, the raw data can be fractionation corrected to ¹⁴⁶Nd/¹⁴⁴Nd = 0.7219. ¹⁴³Nd/¹⁴⁴Nd ratios measured on pure AMES Nd and the mixed AMES Sm-Nd standards are identical (0.5121292 ± 67 ; 2 sd; n = 40) over a ¹⁴⁷Sm/¹⁴⁴Nd range from 0 to 1.2 which encompasses much of the Sm/Nd fractionation range likely to be observed in rocks and minerals, including garnet. We obtained the following reproducibility on Nd isotope ratios over analytical periods of several days separated by several weeks: ¹⁴²Nd/¹⁴⁴Nd ± 33 ppm, ¹⁴³Nd/¹⁴⁴Nd ± 13 ppm, ¹⁴⁵Nd/¹⁴⁴Nd ± 21 ppm (all 2 sd). This reproducibility is comparable to the best obtainable by thermal ionization mass spectrometry and was achieved without daily changes in Faraday collector cup efficiencies and the Sm isotope ratio used for peak stripping. Faraday collector cup efficiencies appear to not require changing, except after periods of major machine maintenance. Replicate analyses of diluted bulk REE samples separated from BCR-1 yielded ¹⁴³Nd/¹⁴⁴Nd ratios of 0.512637 ± 0.0000015 (2sd; n = 12), in good agreement with the accepted value for this standard. The somewhat poorer reproducibility for BCR-1 than the synthetic Sm-Nd mixtures is a function of

smaller sample sizes (< 50 ng total Nd) and hence worse internal precision (± 0.0000010 ; 2 se). REE samples of eight flood basalts from Yemen that had been previously been analysed by TIMS at Royal Holloway University of London yielded ¹⁴³Nd/¹⁴⁴Nd ratios that were identical given the reproducibility of Nd standards run in both laboratories. While Nd isotope ratios determined by MC-ICPMS on mixed REE solutions are identical to TIMS determinations, measured ¹⁴⁷Sm/¹⁴⁴Nd ratios are typically 0-10% higher than values measured by TIMS isotope dilution analysis or known to be correct in the case of the gravimetrically prepared synthetic solutions. Experiments have indicated that Sm-Nd fractionation is largely dependent on torch position and, in particular, the Z position. Sm-Nd fractionation induced by the Aridus is less significant, but appears to be influenced by gas flows and whether nitrogen is also used as a sweep gas. However, by utilising operating conditions that minimise Sm/Nd fractionation, maintaining a fixed torch position, and running interspersed internal standards of known Sm/Nd ratio (for short analytical durations of ca. 1-2 min), it is possible to produce a calibration curve and determine Sm/Nd ratios on unknowns to $\leq \pm 1\%$. The VG AXIOM MC-ICPMS offers a rapid alternative to conventional TIMS analysis for precise and accurate determination of Nd isotope ratios and to a lesser extent Sm/Nd ratios. This is achieved with greatly reduced chemical preparation, and with little or no loss of data quality. However, further improvements in sensitivity are still needed to be able to produce high quality data on sub-10 ng samples. Work is in progress to test application of this technique as a rapid Sm-Nd geochronological tool, without the need for isotopic spiking to determine elemental concentrations. However, we also intend to utilise a mixed ¹⁴⁹Sm-¹⁵⁰Nd spike to obtain high quality Sm and Nd concentration data in tandem with Nd isotope ratios on bulk REE separates.

Luais B, Telouk P & Albarede F, *Geochimica et Cosmochimica Acta*, **61**, 4847-4854, (1997).