High precision Neodymium isotopic analysis of very small (1-10ng Nd) aliquots

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We have developed an improved method for Nd isotopic analysis of small (1-10ng) aliquots of Nd using the NdO^+ method with a Triton TIMS at Boston University. Analyzing Nd as the oxide usually involves an oxygen bleed valve [1], SiO_2 gel [2], or in one report, a TaCl activator [3]. Here, we load samples with a Ta_2O_5 slurry in phosphoric acid. Oxygen isotope fractionation for small samples is not observed during runs of typical duration, though for large loads (>100ng) and/or large beam sizes (>10 volts) oxygen isotopic fractionation can become a factor. 4ng loads of Nd easily yield stable 2.0-2.5 volt beams resulting in internal precisions as good as 8ppm (2σ RSE) and external precision ranging from 13ppm to 21ppm (2σ RSD) for standard solutions and Nd separated from natural samples. This precision is a factor of 3 to 10 improvement over published NdO+ analyses of similarly small samples [e.g. 1-3]. Blanks and column chemistry remain limiting factors in precise and accurate isotopic measurement of natural samples. Poorer ionization is observed for large samples with low Nd concentrations (<<1ppm), suggesting that an ionization inhibiting element is not being completely removed during column chemistry.

Precise Nd isotopic data from small samples has applications across the Earth sciences as illustrated below. When used as an Sm/Nd geochronometer, this method permits higher precision ages (< ±1Ma) on smaller samples, or microdomains within zoned crystals (e.g. garnet). When used as a tracer of planetary evolution, this method improves analysis of the tiniest recorders of the differentiation of the early Earth & solar system (e.g. zircons, chondrules) as well as samples of the mantle (e.g. orthopyroxenes, melt inclusions). When used as a tracer of Earth surface processes & provenance, this method improves analysis of small quantities of Nd extracted from materials which may have low Nd concentrations (e.g. aerosols, surface waters, and salts). Sample data from several garnets will be presented to illustrate the utility of the Ta_2O_5 loading method.

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Hf and Nd isotopes in marine sediments: Constraints on global silicate weathering

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The combined use of Lu-Hf and Sm-Nd isotope systems offers a promising tool for investigating silicate weathering. During continental weathering, a large proportion of the Hf inventory in crustal rocks remains locked in zircons, a mineral with very low Lu/Hf that is highly resistant to alteration, and which tends to be sorted into coarse sand fractions during sediment transport. This ‘zircon effect’ leads to Hf-Nd decoupling in the sedimentary system [1, 2]. Little is known however about whether, and to what extent, Hf-Nd isotope compositions of fine-grained sediments may be sensitive to silicate weathering. While zircon-rich sand fractions are generally sequestered on continents or on continental margins, fine particles can be exported efficiently to the ocean via river or atmospheric transport. Hence, Hf-Nd isotope systematics in deep-sea sediment records could provide useful information on past weathering conditions on continents.

Here, we report major element, Hf-Nd concentration and isotope data for a series of marine muds, leached Fe-oxide fractions and turbiditic sands collected in the southeast Atlantic Ocean. Our results suggest a direct relationship between ε_{Hf} of secondary clay minerals and chemical weathering intensity. Fine sediments define a diffuse array in the ε_{Hf} vs. ε_{Nd} diagram, which lies between the correlations defined by most crustal and mantle rocks (i.e. the ‘terrestrial array’) and deep-sea Fe-Mn precipitates (i.e. the ‘seawater array’). Finally, we show that the global Hf-Nd isotope variability observed in igneous rocks, sands, fine-grained sediments and Fe-oxide precipitates can be reconciled with a simple erosion model of the upper continental crust.

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