High-throughput high-precision Nd isotope ratios from small samples using syringe based flow injection for MC-ICP-MS

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Large datasets of high-precision $^{143}Nd/^{144}Nd$ isotope ratio measurements are required for tracing and understanding global seawater circulation patterns, for example for the GEOTRACES programme [1]. Two key challenges in generating such a datasets are: 1) the low concentration of Nd in seawater (especially in surface waters) and 2) the large number of sample analyses required.

TIMS can be the most efficient technique with respect to ion yield, backgrounds and mass fractionation, offering the highest $^{143}Nd/^{144}Nd$ precision and accuracy for the smallest sample amounts. However, MC-ICP-MS sensitivity has been improved through the combination of high-efficiency inlet systems and sampling interfaces to the point that small (ng) Nd samples can also be measured at sub-epsilon unit precision. MC-ICP-MS offers advantages in terms of sample throughput.

Here we evaluate the combination of the micro*FAST*-MC and Apex desolvating nebulizer (ESI, Omaha, USA) as a high-efficiency sample introduction system. The dual loop injection system, syringe loads sample into one loop while syringe injecting sample from the other loop to the nebulizer. Alternating loop injections avoids overhead associated with sample uptake and washout during conventional self-aspiration. This provides very efficient sample handling for a wide range of sample volumes (10s to 100s of μl) increasing both sample utilization and sample throughput.

Nd isotope ratios were measured using a NEPTUNE *Plus* MC-ICP-MS with *Jet Interface* option for highest ICP sampling efficiency (Thermo Scientific, Bremen, Germany). 10^{13} Ω amplifier technology was employed for monitoring ^{140}Ce and ^{147}Sm for ion interference corrections.

Data are reported for measurements from Nd sample amounts ranging 1 – 10 ng. Throughput of over 10 samples per hour was achieved. The external precision achieved for $^{143}Nd/^{144}Nd$ was better than 0.5 epsilon units (2s) for 2 ng samples amounts.

[1] van de Flierdt et al. (2012), *Limnol. Oceanogr.: Methods 10,*. **10** 234–51.