plasma 3

Accurate and precise determination of Nd and Hf isotope abundance ratios

The accurate and precise determination of Nd and Hf isotope abundance ratios are well-established standard applications for multi-collector mass spectrometry. This application note demonstrates the high precision and measurement trueness for Nd and Hf isotope abundance ratios measured on a Nu Plasma 2 MC-ICP-MS. The new generation of Nu Instruments MC-ICP-MS, Plasma III and Sapphire, can achieve similar or better results.

A 500 ng/ml JNdi-1 Nd standard solution and a 500 ng/ml JMC- 475 Hf standard solution in aqueous 2 % HNO_3 media were used throughout the measurements. The solutions were introduced into the mass spectrometer using a standard cyclonic spray chamber with concentric glass nebuliser. Data was collected in static acquisition mode. Each analysis consisted of 50 cycles with 10 s integration time, and baselines were measured by ESA deflection prior to each run. No tuning of the instrument or nebuliser was made in either case once the sequence had begun.

For each isotope system, mass-dependent instrumental fractionation was corrected for by internal normalisation ($^{146}Nd/^{144}Nd$ = 0.7219 and $^{179}Hf/^{177}Hf$ = 0.7325, respectively) using the exponential mass fractionation law. Sensitivities were 47 V/ppm for Nd and 61 V/ppm for Hf for a 100 µl/min solution uptake rate.

Repeated measurements (N = 45) of the JNdi-1 Nd standard yielded $^{142}Nd/^{144}Nd$ = 1.14175 ± 0.000016 ($2\sigma_s$ SD) and $^{143}Nd/^{144}Nd$ = 0.512086 ± 0.000006 ($2\sigma_s$ SD; Figure 1). The measurement precision ($2\sigma_s$) of individual runs is < 14 ppm for either ratio, and the repeatability ($2\sigma_s$ SD; N = 45) is < 14 ppm for $^{142}Nd/^{144}Nd$, and < 12 ppm for $^{143}Nd/^{144}Nd$. Detailed results are displayed in Table 1.

Ten repeated measurements of the JMC-475 Hf standard achieved $2\sigma_s$ measurement precision for individual runs < 12 ppm and a repeatability < 12 ppm ($2\sigma_s$ SD) over ten runs (Table 1). The mean $^{180}Hf/^{177}Hf$ = 1.88667 ± 0.00002 (Figure 1) is in good agreement with an average published $^{180}Hf/^{177}Hf$ = 1.88673 ± 0.00021 (GeoReM database; https://georem.mpch-mainz.gwdg.de).

Combined, the results of repeated Nd and Hf isotope abundance ratio measurements demonstrate the high precision, measurement trueness, and instrument stability for these routine applications on Nu Instruments Plasma/Sapphire MC-ICP-MS.

Nu Plasma 3

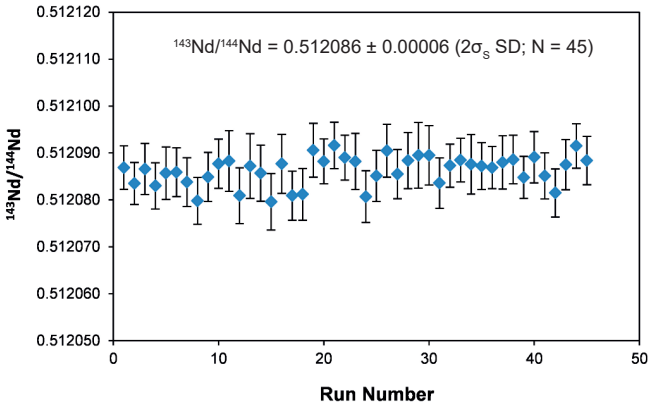

Figure 1 Internally normalised ($^{146}Nd/^{144}Nd$ = 0.7219) Nd isotope abundance ratios for 45 repeated measurements of a 500 ng/g JNdi-1 Nd standard solution. The error bars on the data points indicate the $2\sigma_s$ SE measurement precision of the individual measurements.

Table 1 Internally normalised ($^{146}Nd/^{144}Nd$ = 0.7219) Nd isotope abundance ratios for 45 repeated measurements of a 500 ng/ml JNdi-1 standard solution over the course 7.5 hours.

	$^{142}Nd/^{144}Nd$	$^{143}Nd/^{144}Nd$	$^{145}Nd/^{144}Nd$	$^{148}Nd/^{144}Nd$	$^{150}Nd/^{144}Nd$
Mean	1.14175	0.512086	0.348422	0.241550	0.236370
$2\sigma_s$ SD	0.000016	0.000006	0.000004	0.000006	0.000008
$2\sigma_s$ SD [ppm]	14	12	12	24	34

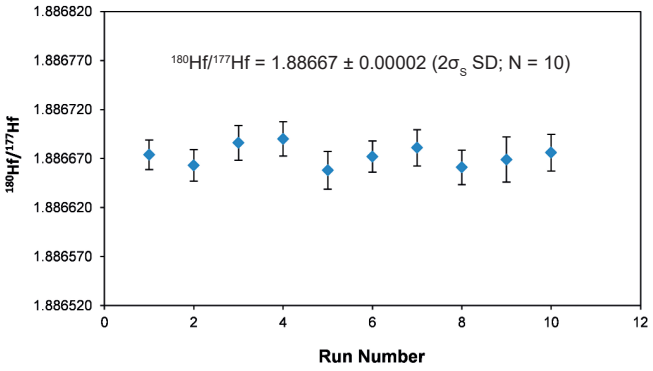

Figure 2 Internally normalised $^{180}Hf/^{177}Hf$ abundance ratios for 10 repeat ed measurements of 500 ng/ml JMC-475. The error bars on the data points indicate the $2\sigma_s$ SE measurement precision of the individual measurements.

Table 2 Internally normalised ($^{179}Hf/^{177}Hf$ = 0.7325) Hf isotope abundance ratios for ten repeated analyses of the 500 ng/ml JMC-475 solution. Each analysis lasted approximately 10 minutes, equating to 100 minutes of data collection.

	$^{176}Hf/^{177}Hf$	$^{178}Hf/^{177}HF$	$^{180}Hf/^{177}Hf$
Mean	0.282158	1.46721	1.88667
$2\sigma_s$ SD	0.000005	0.00001	0.00002
$2\sigma_s$ SD (ppm)	18	8	12