Application Note 30281

TIMS: Accuracy of La Jolla Nd Isotopic Data Acquired Using the Thermo Scientific TRITON *Plus* TIMS

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Key Words
Neodymium, TRITON *Plus*, TIMS, Static Mode, Virtual Amplifier, $10^{11}\Omega$ Amplifier, La Jolla

Goal
To show the performance of Thermal Ionization Mass Spectrometry (TIMS) for the resolution of Nd isotopic anomalies at ppm levels for the investigation of fundamental relations in geochronology, geochemistry, cosmochemistry and environmental sciences.

Introduction
Neodymium is a rare earth metal with seven naturally occurring isotopes ^{142}Nd (27.2%), ^{143}Nd (12.2%), ^{144}Nd (23.8%), ^{145}Nd (8.3%), ^{146}Nd (17.2%), ^{148}Nd (5.7%) and ^{150}Nd (5.6%). The ability to resolve Nd isotopic anomalies at the ppm level in materials with a wide range of Nd concentrations is essential for investigating fundamental relations in geochronology, geochemistry, cosmochemistry and environmental sciences. Neodymium isotope Thermal Ionization Mass Spectrometry (TIMS) has proven successful in running Nd as Nd^+ on multiple filament assemblies[1,2] (300–500 ng). With the advent of second-generation TIMS instruments in the late 1990's, the reproducibility of Nd isotopic analyses improved by an order of magnitude, down to 2 ppm/amu (ref.1). Subsequent publications show a gross inter-laboratory consensus on a typical external reproducibility on the order of 2–5 ppm/amu on 500 ng Nd^+ loads. However, the variability of reference standards limits interlaboratory comparison. Following an assessment of precision and reproducibility over 1 year on the Merck # 170335 standard on a Thermo Scientific™ TRITON *Plus*™ Thermal Ionization Mass Spectrometry (TIMS),[3] the present study assesses the accuracy of 500 ng Nd^+ load analyses on La Jolla Nd reference standard. Neodymium analyses are run on double filament assemblies, using $10^{11}\Omega$ amplifiers, the virtual amplifier,[3] automated mode and analytical runs of about 1.5 hr.

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Analytical Protocol

Neodymium Static Analysis with Virtual Amplifier	
Isotopic Standard	La Jolla $^{142}Nd/^{144}Nd = 1.1418387 \pm 102$ (2SD, ref.4)
Filament Assembly	Zone refined rhenium double filaments
Outgasing	40 minutes at 3.2 A; 10 minutes at 4.5 A
Loading	Nd in 6M HCl
Additives	1 µL 0.3M H_3PO_4 Dull red glow for 5 s
Amount and Signal	500 ng, 9 V ^{142}Nd
Acquisition Mode	Static, Virtual Amplifier: 3 cycles of rotation (480 ratios), sequence
Baseline	105 s before each block
Temperature	1650 °C on the ionization filament
Normalized to	$^{146}Nd/^{144}Nd = 0.7219$, exponential correction

Table 1. Cup configuration.

Line No.	Mass Set	L3	L2	L1	RPQ/ IC1 C	H1	H2	H3	H4	Integration Time(s)	Number of Integrations	Idle Time(s)	Control Cup Peakcenter	Control Cup Focus
1	Main	^{142}Nd	^{143}Nd	^{144}Nd	^{145}Nd	^{146}Nd	^{147}Sm	^{148}Nd	^{150}Nd	8.389	1	5.000	^{145}Nd	^{142}Nd

External Reproducibility

La Jolla reference standard Nd isotope ratios corrected for instrumental mass bias are plotted in Figure 1. Nd^+ analyses of 500 ng on double Re filament assemblies in static mode with rotation of the amplifier-cup association ("virtual amplifier") yield indistinguishable isotopic ratios.

Comparison with Literature

This study yields $^{142}Nd/^{144}Nd = 1.1418357 \pm 46$ for La Jolla standard, in agreement within uncertainty with $^{142}Nd/^{144}Nd = 1.1418387 \pm 102$ (ref.4). However, due to the reported inter-laboratory fractionation of La Jolla that hampers inter-laboratory comparison, next study will present accuracy based on Nd analyses of the readily available JNdi-1 standard[5] that shows high purity for interfering contaminants.

Conclusion

Twice faster Nd isotopic analyses compared to literature can be achieved in static mode with virtual amplifier. Less than 90 minute long analyses of La Jolla reference standard yield 2SD external reproducibility of 2 ppm/amu, similar to external reproducibility obtained in literature. The $^{142}Nd/^{144}Nd$ obtained in this study agrees within uncertainty with literature.[4] This validates the stability of the current amplifier system and the Faraday cup multiple collection system thus supporting routine analysis to high precision.

References

(1) Caro *et al.* **2003** *Nature 423*, 428-432.

(2) Boyet and Carlson. **2005** *Science 309*, 576-581.

(3) Trinquier. Thermo Scientific Application Note 30280.

(4) O'Neil *et al.* **2008** *Science 321*, 1828-1831.

(5) Tanaka *et al.* **2000** *Chem. Geol. 168*, 279-281.

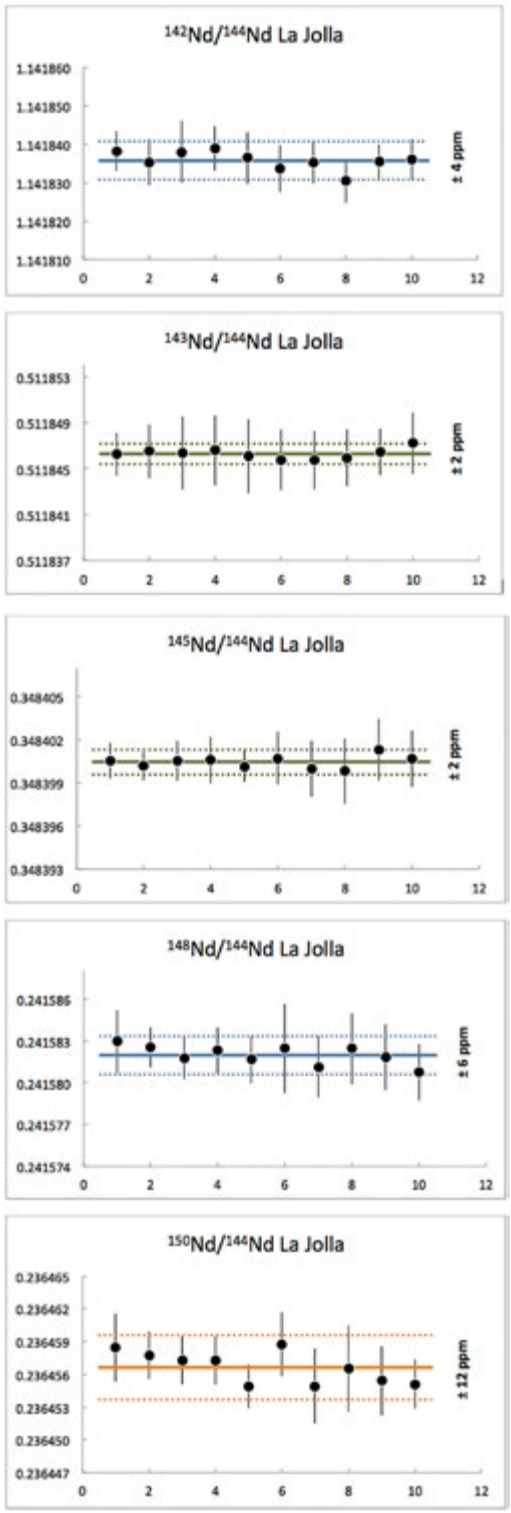

Figure 1. $^{}Nd/^{144}Nd$ 2SD external reproducibility of La Jolla Nd metal analyses using the virtual amplifier. 2RSD reproducibility on 500 ng loads: 2 ppm/amu (n=10, no outlier, 9 V $^{142}Nd^+$, 3 cycles of amplifier-cup rotation). Error bars are 2se.

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