Expanding the isotope geochemist's toolbox – Measurements on sub-ng sample loads of Nd, Sr and Ca using 10^{13} Ω amplifier technology

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The precise and accurate measurement of low intensity ion beams is required by numerous applications in isotope geochemistry. Such conditions are challenging when sample amounts are limited, the element concentrations or isotope abundances are low or when interfering isotopes need to be monitored in order to accurately apply interference corrections. Conventionally, small ion beams are measured either on ion counters or Faraday cups connected to 10^{11} Ω amplifiers. Ion counters are characterized by exceptionally low noise levels, but are limited in their dynamic range and ion yield stability. 10^{11} Ω amplifiers benefit from the long-term stability of the gain factors, but have high noise levels.

The analytical range can now be expanded by using 10^{13} Ω amplifier technology. The static multicollection of low intensity ion beams using 10^{13} Ω amplifiers overcomes the limitations of sequential single collector measurements by enabling low noise 100% duty cycle measurements and derives further benefits from the Faraday cup technology with its proven long-term stability.

We have tested the performance of a Thermo Scientific™ Triton Plus™ Thermal Ionization Mass Spectrometer (TIMS) equipped with 10^{13} Ω amplifiers on sub-ng Nd, Sr and Ca loads. Accurate results with a precision level of better than 100 ppm (2 RSD) were recovered. This level of precision is at least a factor ten better than measurements using 10^{11} Ω amplifiers or ion counters. The measurements also took advantage of a software-based gain calibration procedure that determined highly precise gain factors. This external reproducibility demonstrates that the 10^{13} Ω amplifiers produce accurate data with a precision that matches the theoretical limit given by counting statistics even for loading sizes as low as 100 pg. The Triton Plus utilizing the 10^{13} Ω amplifier technology significantly expands the isotope geochemist's toolbox for measurements down to sample sizes which previously were inaccessible for high precision measurements.