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Mass bias correction laws suitable for MC-ICP-MS measurement

S.J.G. GALER[1] AND W. ABOUCHAMI[2]

[1] Max-Planck-Institut für Chemie, Postfach 3060, 55020 Mainz, Germany (sjg@mpch-mainz.mpg.de)
[2] Max-Planck-Institut für Chemie, Postfach 3060, 55020 Mainz, Germany (afa@mpch-mainz.mpg.de)

Mass bias is typically 1-2% per mass unit during measurement of moderately heavy elements by MC-ICP-MS, with heavy isotopes being favoured over light isotopes. Such fractionations are about an order of magnitude larger than those of TIMS measurements and, unlike TIMS, ratios remain offset from true values throughout the measurement cycle. This means that unless the correction for mass bias is done accurately, the precision of measurement may appear good, but its accuracy may be poor. Unfortunately, the physics of the ICP-MS plasma and interface region are too complex to arrive at any reasonable, general fractionation law from first principles. For this reason, the “laws” used have been transliterated from those used for TIMS.

A more promising approach is to ignor the physics entirely and to consider the behaviour of the ICP-MS system at the “asymptotic limits”. Only a fractionation law that can reproduce a large (infinite) fractionation per mass unit for small masses, tending to zero for extemely large masses, can reasonably describe the behaviour of the instrument. Furthermore, the machine sensitivity as a function of mass, expressed in V/ppm, is simply the integral of the mass bias law required. If such a “law” can be found, which is reasonble for both high and low masses, it is likely that it will also be adequate in the mass range of a single element. It can be shown that most of the commonly-used laws do not meet these requirements.

Here, we show that mathematical functions with the required form for the mass bias and machine sensitivity (as a function of atomic mass) do exist. The ability of these functions to accurately correct mass bias will be presented and compared with the laws commonly used.

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Thorium isotopic composition of synthetic standards measured by the Finnigan NEPTUNE and Finnigan TRITON

L. BALL[1], K. SIMS[2], J.B. SCHWIETERS[3] AND D. TUTTAS[3]

[1] Dept of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution, Woods Hole MA, 02543 (LBall@WHOI.edu)
[2] Dept of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole MA, 02543.
[3] Thermo Electron (Bremen) GmbH, Barkhausenstr. 2, 28197 Bremen, Germany

There is a large range of ^{232}Th/^{230}Th in volcanic rocks (^{232}Th/^{230}Th ~ 140,000 - 300,000), reflecting time-integrated variations in the Th/U of their mantle source. There are now several “in house” and “commer-cially available” Th isotopic standards that cover this range in ^{232}Th/^{230}Th. At the level of precision (ca. 1-2%, 2σ) of most thermal ionization mass spectrometric methods (TIMS) there is, in general, good consensus on the Th isotopic composition of these standards. Recent developments in plasma ionization mass spectrometry (PIMMS) have significantly enhanced Th sensitivity (by a factor 10-100), and improved the precision of Th isotopic measurements by at least a factor of 2. The level of precision obtainable with PIMMS is now smaller than our knowledge of the absolute value of these standards. This discrepancy makes it difficult to assess whether the accuracy of PIMMS Th isotopic measurements are comparable to the improved precision and reproducibility.

To assess the accuracy of Th isotopic measurements at a level comparable to the improved precision of PIMMS techniques requires better characterization of the Th isotopic standards. Here we report replicate measurements of several “in house” (UCSC, WUN, ThU) and two commercially available Th isotopic standards (IRMM-35; IRMM-36) using both PIMMS (Finnigan NEPTUNE) and TIMS (Finnigan TRITON). These new analyses are then compared with literature data for these same standards from other laboratories.