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The accurate determination of isotope ratios by MC-ICP-MS for the production of isotopic certified reference materials at NRC

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Isotopic analysis plays a fundamental role across a wide range of scientific disciplines, including geoscience, environmental science, and the medical and life sciences [1]. Isotopic Certified Reference Materials (iCRMs) are essential for validating analytical methods, correcting instrumental mass bias, and serving as “delta-zero” references. Despite significant efforts by National Metrology Institutes to produce high-quality iCRMs, challenges remain in establishing accurate and internationally consistent reference values.

A notable example is zinc [2]. Isotope ratio measurements reported by Chang et al. (2001) differed from earlier coulometric determinations by 8-sigma. Similarly, mass spectrometric measurements of the IRMM-3702 Zn isotopic CRM, based on mixtures using only three of zinc’s five stable isotopes for mass bias correction (Ponzevera et al., 2006), led to a major revision of zinc’s standard atomic weight, rendering it inconsistent with the previous value. This case underscores a broader issue affecting many elements: the need for independent, reliable measurements and high-quality iCRMs to support research that depends on accurate and precise isotope ratio data.

Multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) is among the most advanced techniques for isotope ratio measurements, offering exceptional sensitivity and precision. However, achieving high accuracy requires robust correction of instrumental mass bias, which remains a significant challenge. In addition to the well-recognized mass-dependent fractionation (MDF), mass-independent fractionation (MIF) has been observed in MC-ICP-MS for many elements [1]. This complicates the selection of appropriate mass bias correction models, as applying MDF-based models to isotopes exhibiting MIF can introduce systematic bias.

To address these challenges, National Research Council Canada (NRC) has, over the past two decades, developed state-of-the-art methodologies for certifying isotopic CRMs using MC-ICP-MS. This presentation will highlight recent advances in the application of the full gravimetric isotope mixture model and optimized regression approaches for mass bias correction, as well as NRC’s innovative strategies for producing SI-traceable isotopic reference materials.

[1] L. Yang; S. Tong; L. Zhou; Z. Hu; Z. Mester; J. Meija *Journal of Analytical Atomic Spectrometry*, **2018**, *33*, 1849-1861.

[2] J. Meija, J. He, B. Methven, Z. Mester and L. Yang; *Geostandards and Geoanalytical Research*, **2024**, 48, 795-805.