Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.25144

50 years of Uranium isotopic Reference Materials at JRC-Geel

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The history of uranium isotopic reference materials certified at JRC-Geel and provided to customers during the last 50 years is reviewed [1], by presenting the methods for preparation and certification as well as the most relevant applications for several examples of certified reference materials (CRMs). These include the IRMM−019−029 series of UF_6 (uranium hexafluoride) materials and several series of uranium nitrate solutions, namely the IRMM−072, IRMM−073, IRMM−074, IRMM−075, IRMM−183−187, IRMM−2019−2030 and IRMM−3000 series as well as the IRMM−3636a,b Double Spikes.

The IRMM-3000 series of HEU materials is ideal for investigating or verifying the linearity of the ^{235}U enrichment scale between 20 % and 90 % for various types of isotope mass spectrometers, such as TIMS/MTE, TIMS/DS and MC-ICPMS, with various detection systems and measurement methods. This is illustrated in the attached Figure, by using all available verification measurements performed for the IRMM−3000 series solutions (blue filled squares), performed by JRC-Geel (TIMS/MTE and TIMS/DS), the IAEA (TIMS/MTE and MC-ICPMS) and ORNL (TIMS/MTE and MC-ICPMS). As a conclusion regarding the application of the IRMM-3000 series for a variety of modern mass spectrometers and methods, the verification of $^{235}U/^{238}U$ ratios for the enrichment scale from 20 % to 90 % can be confirmed at a level of better than 0.025% for both uncertainties and accuracy.

The certified isotope ratios for the above mentioned isotope reference materials from JRC-Geel are traceable to the SI via the gravimetrical preparation, either directly through gravimetrical mixing of highly enriched base materials, or indirectly by using the existing gravimetrically prepared reference materials for calibration of the mass spectrometers used for the certification measurements. Due to developments of isotope mass spectrometers and standardized analytical methods during the past decades, the performance of certification measurements in terms of precision, accuracy and uncertainties has improved significantly. This has led to a comprehensive set of state−of−the−art uranium isotopic reference materials offered by JRC-Geel, which is available for nuclear safety and security purposes but also much appreciated in the scientific community.

References: [1] S Richter et al, “50 Years of uranium isotopic reference materials at JRC−Geel”, JRNC, 2024, 333,:825–840