Uranium isotopic and concentration measurements in picomole quantities on multi-collector inductively coupled plasma mass spectrometry

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Abstract

Techniques used for accurate determination of natural uranium isotopic ratios and concentration with 0.1‰-1‰ precision in 1,000-1 picomole quantities have been developed on a multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS), Thermo Electron NEPTUNE. A ^{233}U-^{236}U double spike method was employed to correct mass bias and determine uranium concentration. Protocols with Faraday cups and one newly-developed MasCom secondary electron multiplier (SEM) were used to determine the intensities of ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, and spectral background from ^{235}U and ^{238}U ion beams. A sample size of 200-600 ng U and of 1-4 ng U is needed to offer the reproducibility (2 RSD) of 0.1-0.5‰ using a Faraday cup-protocol and of 1-2‰ using only one SEM, respectively. Repeated measurements of international standards, NBL-112A and HU-1, and laboratory-made coral and speleothem standards give averaged $\delta^{234}U$ and concentration values within error of values on other ICP-MS and TIMS techniques. The techniques can be applied to the exploration of the frontiers in diverse fields of Earth Sciences, such as U-series chronology, paleoclimatology, oceanography and geochemistry.