Every atom counts: High-precision U-isotope analysis on nanogram quantities of U from geoenvironmental materials

L. BANKS*[1,2], M.S.A. HORSTWOOD[1], S.R. TAPSTER[1], S.R. CHENERY[1], D.J. SMITH[2], T.L. BARRY[2]

[1]British Geological Survey, Keyworth, Nottingham, UK
[2]University of Leicester, University Road, Leicester, UK
(*correspondence: lba@bgs.ac.uk)

In the geosciences, there is an increasing need to measure smaller amounts of material faster, and more precisely. Conventional solution sample introduction for ICP-MS can lead to significant inefficiencies in measurements, both in terms of wasted time and sample. There is also a relatively large amount of potentially hazardous waste produced per sample. These issues arise from low signal to noise ratios (SNR) and the lack of complete sample aspiration. Overcoming these limitations can be achieved by *low volume sampling.* This method utilises small volumes of total solution to preconcentrate the analyte of interest [1], therefore increasing the SNR. This lower volume approach increases the throughput of samples by three times. The smaller amount of solution, coupled with the aspiration of the whole sample, leads to significantly reduced sample wastage. The washout achieved using this method is effective to >99%, after a sample containing 2 ng U, taking only 6 minutes.

The measurement precision achieved using 2 ng natural U is <0.01% 2RSE by the low volume method (utilising the Teledyne-CETAC MVX 7100 µl Workstation), compared to the conventional method which achieves >0.02% 2RSE. This novel technique facilitates 2.5 times better precision than the conventional method on 2 ng natural U, or matches the precision of the conventional method but on ~6 times less material. The robustness of the data is further improved by employment of an IRMM3636 double spike, leading to an order of magnitude improvement in inter-session reproducibility and eliminating intra-session overdispersion compared to standard sample bracketing alone.

This improved precision on smaller amounts of material facilitates studies requiring increased spatial resolution, and enables analysis of materials with concentrations of analyte previously too low to measure. We demonstrate the application of this technique to crystal fragments of natural U-bearing minerals, and conclude that this technique can be applied to routine environmental analysis.

[1] Bauer and Horstwood (2018), *Chem. Geol* 476, 85-99