Novel method for measuring ultra-trace levels of U and Th in Au, Pt, Ir, and W matrices using QQQ-ICP-MS and an O_2 reaction gas

KHADOUJA HAROUAKA[1], ERIC W. HOPPE[2], ISAAC J. ARNQUIST[3]

[1]PNNL, Richland WA, khadouja.harouaka@pnnl.gov
[2]PNNL, Richland WA, eric.hoppe@pnnl.gov
[3]PNNL, Richland WA, isaac.arnquist@pnnl.gov

The advent of commercial elemental MS/MS instrumentation has given rise to multiple opportunities for method development aimed at analytes in challenging matrices that either reduce or eliminate the need of extensive sample pre-processing. Here, ultra-trace concentrations (ppq level) of natural ^{232}Th and ^{238}U and non-natural tracer isotopes ^{229}Th and ^{233}U were measured in a solution of 10 ppm each of Au, Pt, Ir, and W in 2% HNO_3 using a QQQ-ICP-MS. Polyatomic interferences across a *m/z* range of 227-239 were characterized: the major interferants with with $^{229}Th^+$ is $^{194}Pt^{35}Cl^+$, with $^{232}Th^+$ are $^{184}W^{16}O_3^+$, $^{183}W^{16}O_3H^+$, $^{192}Pt^{40}Ar^+$, $^{196}Pt^{36}Ar^+$, $^{195}Pt^{37}Cl^+$, and $^{197}Au^{35}Cl^+$, with $^{233}U^+$ are $^{193}Ir^{40}Ar^+$, $^{197}Au^{36}Ar^+$, $^{184}W^{16}O_3H^+$, and with $^{238}U^+$ is $^{198}Pt^{40}Ar^+$. Upon reaction with O_2 gas, the highest sensitivity analyte species formed were ThO^+ and UO_2^+. Scanning the selected *m/z* range of 227-270 amu showed that higher oxide polyatomic species either did not form or did not create significant background on the target analyte masses. All measured concentrations in standard solutions matched the target values within the 98% confidence interval. The Th measurements were 80% accurate or better at the 10 ppq level and above, and the U measurements were 90% accurate or better at the 10 ppq level and above. While measurements at the 1 ppq level were consistent with target values within 1 standard deviation, the standard deviations of all three replicates were greater than 20% of the measured concentration value. Method detection limits in the matrix solutions were 2.74 fg Th and 12.9 fg U, which are comparable to detection limits of 1.2 fg Th and U previously measured in pristine 2% HNO_3 blank solutions. This method is but one example of how state of the art quadrupole mass spectrometry and collision reaction cell technology can be leveraged to develop novel analytical capability.