High-precision tungsten isotope compositions of uranium ore concentrates

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The application of high-precision stable isotope ratio measurements of non-traditional elements to nuclear forensic science is still in its infancy. It is likely that the isotope systems of elements such as tungsten (W), which forms a stable volatile hexafluoride, will be significantly perturbed by processes occurring within the nuclear fuel cycle. Isotope fractionation occurring during uranium enrichment and additional isotope effects generator via reactor operations are expected to large. Development of W isotope ratios in to useful nuclear forensic signatures require constraints on the range of W isotope compositions entering the nuclear fuel cycle via uranium ore concentrate (UOC). Natural W isotopic variability is expected between different parent ore bodies which are mined for UOC production. Additionally, various purification methods are used during UOC production that may induce additional W isotope fractionation including chemical leaching, solvent extraction, ion exchange and precipitation.

Here we present high-precision W isotope compositions for ~30 UOCs using double-spike MC-ICPMS. Preliminary data indicates W isotope compositions (reported as $\delta^{184/182}$W relative to NIST SRM-3163) range between -0.50 and +0.35‰ in UOCs. This range is similar to the range observed in natural samples reported to date[1,2,3] except for one sample that is isotopically lighter than SRM-3163. This result suggests that production of UOC does not induce significant W isotope fractionation beyond naturally occurring processes and that anomalous W isotope compositions of nuclear materials from further along in the nuclear fuel cycle will reflect processes such as enrichment and reactor operations. LLNL-ABST- 770546

[1]Krabbe, Kruijer, & Keine, (2017), Chem. Geol. 450, 135-144. [2]Kurzweil et al. (2018), Chem. Geol. 476, 407-417. [3]Kurzweil et al. (2019), Geochim. Cosmochim. Acta 251, 176-191.