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A direct-AMS multi-isotope survey of uranium ore concentrates

Uranium ore concentrate (UOC) is an important nuclear material of interest for Canada. A large-scale analytical program is being led by the Directorate of Security and Safeguards (DSS) of the Canadian Nuclear Safety Commission (CNSC) to establish a reference dataset of UOCs that have passed through and/or that are currently under Canadian regulatory control. Isotopic ratios are among the signatures being captured under the reference dataset. Accelerator Mass Spectrometry (AMS) has been used for the measurement of 236U/238U and an assessment of 187Os/188Os in the trace levels of Os in UOC samples. Furthermore, since UOCs are typically concentrated in uranium to ⪆70% by weight, a direct-AMS assay method is possible in which the samples can be measured without time-consuming chemical digestion and processing. Using this direct-AMS approach, several related ratios (231Pa/238U, 230Th/238U, 226Ra/238U) were also assessed within the data acquisition sequence used for measuring the 236U/238U ratios, and 185Re, 187Re and 187Os, 188Os, 191Ir and 193Ir in the sequence for the 187Os/188Os ratios. Ratios of these isotope measurements are used to calculate the 187Os/188Os ratio and elemental ratios of Re:Os:Ir in the UOC samples. These results can be displayed in a "bar-code"pattern to simplify UOC source identification. Unexpectedly large 236U/238U ratios (approx. 10-7) were found in several UOC samples. The 187Os/188Os ratio was also shown, for the first time, to be a viable supplementary signature for the discrimination of UOCs. This direct-AMS method may have the potential to become an effective tool for nuclear forensics provenance assessment applications for UOCs.

This paper will provide an overview of the UOC AMS survey method and results, and will discuss technical considerations related to the need for a wider range of reference materials, further refinement of the sputter target preparation, as well as the Cs+ sputter ion source itself.

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