ULTRA-TRACE ANALYSIS OF ANTHROPOGENIC LONG-LIVED RADIONUCLIDES IN THE ENVIRONMENT WITH ACCELERATOR MASS SPECTROMETRY

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Long-lived actinides, e.g., ^{236}U, ^{237}Np, ^{239,240}Pu, ^{241}Am can be measured largely background-free by Accelerator Mass Spectrometry (AMS) due to the absence of stable isobars. The minimum sample size is basically defined by the detection efficiency including chemical sample preparation. The overall detection efficiency for actinides was successfully increased at the Vienna Environmental Research Accelerator (VERA) laboratory by around one order of magnitude to $5 \cdot 10^{-4}$ by several improvements of the setup and the measurement procedure [1]. This either significantly simplifies sample preparation eliminating the need for chemical separation of actinides from each other [2] or it allows the analysis of all the major long-lived actinides listed before from a single sample at ultra-low levels (below 10^{-3} ppq for ^{241}Am) after chemical separation. The latter approach was used to search for a marker to identify the basis of the proposed new geological age of "the Anthropocene" in urban sediments from the Vienna underground (Karlsplatz). This exemplary project will be presented in more detail in this talk covering also other on-going projects related to actinide detection at the VERA laboratory. This includes the production of an isotopic spike for the quantitative analysis of environmental ^{237}Np and the characterization of the ^{233}U/^{236}U ratio from different emission sources which has the potential to become a novel sensitive fingerprint for nuclear weapons fallout from the 1950s.

The analysis of long-lived fission products such as ^{99}Tc ($t_{1/2} = 2.1 \cdot 10^5$ yrs) or ^{135}Cs ($t_{1/2} = 2 \cdot 10^6$ yrs) in the general environment requires the suppression of background from stable isobars, i.e., ^{99}Ru and ^{135}Ba. Both radionuclides are considered promising oceanographic tracers. The worldwide unique technique of Ion-Laser Interaction Mass Spectrometry (ILIAMS), recently implemented at VERA achieved a Ru and Ba suppression of 5 orders of magnitude when overlapping a green (532 nm) continuous-wave laser with the ion beam before injection into the accelerator [3]. I will discuss the status of development focusing on ^{99}Tc analysis for which a suitable normalisation method is needed to overcome the lack of a stable Tc isotope. As for the normalisation of ^{237}Np, the most reliable normalisation can be expected from measurements relative to a second artificial isotope produced by irradiation at accelerator facilities providing higher beam energies than VERA.

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824096 (Radiate), from the Austrian Science Fund (FWF): P 31614-N28 and I 4803-N.

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