Contribution ID: **141** Contribution code: **ATA-4** Type: **Oral Presentation**

Minor actinides radionuclides to reveal sources of anthropogenic radioactivity to the Baltic Sea

Wednesday, 23 October 2024 09:20 (20 minutes)

The most studied actinide radionuclides to unravel contamination sources in general environmental samples have been 238Pu, 239Pu, 240Pu and 241Am. In the last few years, thanks to the development of ultra-sensitive Mass Spectrometry techniques like AMS, this list has been expanded to other less studied and minor actinides nuclides providing key information on the source terms. 236U and 237Np AMS techniques have been fully established [1,2]. The lack of an appropriate isotopic tracer for 237Np studies has been overcome using 242Pu as a non-isotopic tracer [2,3]. AMS techniques have been pushed to the limit to assess the analysis of the most minor actinides radionuclides such as 233U, 241Pu, 242Pu and 244Pu [4,5]. Overall, it has been constated that the combined study of the 233U/236U, 241Pu/239Pu, 242Pu/239Pu and 244Pu/239Pu atom ratios is a promising tool to unravel multiple contamination sources in complex scenarios.

The Baltic Sea marine environment has been historically exposed to multiple local and regional actinides sources: i) atmospheric debris from the Chernobyl accident (1986), ii) liquid releases from Sellafield and La Hague nuclear reprocessing facilities transported through the North Sea, iii) authorized radioactive discharges from nuclear facilities in the Baltic Sea region, and iv) possible leakages from dumping sites within this marine region [6]. These sources coexist with the baseline levels imposed by the atmospheric nuclear tests (945-1980) or global fallout. Although the Baltic Sea has been one of the most studied areas regarding the distribution of anthropogenic radionuclides, long-lived actinides have been scarcely investigated and there are still many open questions about their source terms and distribution.

This work focuses on the study of a sediment core from the Tvären Bay, directly impacted by the liquid releases from the Studsvik Nuclear facility (east coast of Sweden), since 1959 up to now. This core preserves a sediment record since the 1950s, being a key natural reservoir to study the scarcely documented historical releases from Studsvik. In a previous study, the analysis of the full Pu isotopic vector (238Pu, 239Pu, 240Pu, 241Pu, 242Pu and 244Pu) on the 1 MV AMS system at the Centro Nacional de Aceleradores (CNA, Seville, Spain) allowed us to assess the Pu sources in this area and to reconstruct the liquid release history for Pu [7]. The results show the presence of highly enriched 239Pu, probably originating from the Swedish nuclear program in the 1960s-1970s and the handling of high burn-up nuclear fuel in later years. Moreover, new results on 237Np, 233U and 236U have been obtained. The 233U/236U atomic ratio has been studied to unravel the 236U inputs, revealing an intense release of 236U in the 1970s. In contrast, a minor contribution is observed in the case of 237Np. This work is now being expanded to study 241Am and 243Am.

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Student Submission

No

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Session Classification: Actinide Techniques and Applications

Track Classification: Actinide Techniques and Applications