RAPID DETERMINATION OF ACTINIDES AND RADIOSTRONTIUM IN ENVIRONMENTAL SAMPLES IN RESPONSE TO EMERGENCIES USING LIQUID CHROMATOGRAPHY COUPLED TO ICP-MS

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Nuclear accidents occurred in latest years highlighted the difficulty to achieve, in a short time, the quantification of alpha and beta emitters. Indeed, most of the existing methods, though displaying excellent performances, can be very long, taking up to several weeks for some radioisotopes, such as ^{90}Sr.

The objective of this study is the rapid determination of $^{234, 235, 236, 238}$U, $^{230, 232}$Th, $^{239, 240}$Pu, ^{237}Np, ^{241}Am and ^{90}Sr, in environmental samples, using an extraction chromatography (EXC) automated and coupled on-line to an inductively coupled plasma mass spectrometer (ICP-MS). Due to its low abundance sensitivity, ^{90}Sr fractions can be collected after the purification step and measured with an adapted gas proportional counter method. The EXC chromatography provides good efficiencies with reduced solvent volume and analysis time. The ICP-MS measurement allows having an increase of analytical throughput compared to radiometric and other mass spectrometric approaches. The coupling on line of the EXC chromatography to the ICP-MS permits to increase the sensitivity since chromatograms are obtained instead of mass spectrum.

The main constraint of the coupling on-line of the automated EXC chromatography to the ICP-MS is the compatibility between the elution fractions and the recommended measurement media. Indeed, to be compatible with the introduction medium of ICP-MS, each elution solution should have a concentration below 10 wt% for acids (to minimize corrosion) and below 0.2 wt% for salts (to prevent salt deposition on the cones). These limits are unavoidable especially in crisis situation characterized by a large number of samples.

The separation protocol was defined and successfully applied, off-line, to environmental water samples (tap, river and sea waters). These performances are characterized by yields $\geq$ 70% for all radionuclides and standard deviations $\leq$ 10%. The method was also applied to solid environmental samples (soil) after a digestion and co-precipitation steps.

The newly developed separation method was then automated and coupled on-line to ICP-MS. The performances were optimized using a design of experiments and the results processed with Minitab. The optimized automated extraction chromatography coupled on-line to an ICP-MS allows the separation and the measurement of the referred radionuclides in less than 20 minutes as well as a sensitivity gain higher than 20 times compared to an off-line measurement.