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Establishment of radiochemical protocol for determination of uranium isotopes (^{234}U, ^{235}U and ^{238}U) in sea water by alpha particle spectrometry

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Alpha spectrometry is a technique that provides accurate information for the determination of trace-level natural and artificial radio nuclides in a variety of samples. It has the advantage of being extremely sensitive and specific for studying actinide and uranium (U). The micro co-precipitation (with NdF_3) method and electro deposition method are two chemical protocols developed for the analysis of U isotopes in water-based samples by alpha-particle spectrometry. U in sea water was chemically separated by co-precipitating with $Fe(OH)_3$ and further purified by passing through a micro column of UTEVA ion exchange resin. To prepare the alpha sources micro co-precipitation with NdF_3 was used as the first method and as the second method, electro deposition was used. The alpha spectroscopy measurements were carried out using a Passivated Implanted Planar Silicon (PIPS) detector.

The sources prepared by the electro deposition method yielded better spectra than those prepared by the micro co-precipitation method. Chemical recovery of U was measured using ^{232}U as a tracer. For the electro deposition method the measured chemical recovery was 65% whereas for the micro co-precipitation method it was only 51%. The average radioactivity values for ^{238}U, ^{235}U and ^{234}U isotopes by the electro deposition method were 23.5 ± 9.4 mBq kg^{-1}, 1.2 ± 0.5 mBq kg^{-1}and 19.1 ± 5.6 mBq kg^{-1} respectively and ^{238}U and ^{234}U were 9.1 ± 1.4 mBq kg^{-1}, 6.9 ± 1.1 mBq kg^{-1} respectively for the micro co-precipitation method. The ^{235}U peak was not well resolved. Minimum detectable activity (MDA) measured by the electro deposition method and co-precipitation method were 0.5 mBq kg^{-1} for ^{235}U and 0.8 mBq kg^{-1} for both ^{238}U and ^{234}U. In this study, the ^{234}U/^{238}U activity ratio was in the range of 0.43 to 1.11, with 0.8 average. The value of the radioactivity concentrations of U obtained in this work was 26 mBq kg^{-1} and the world average U concentration in sea water is 40 mBq kg^{-1} of ^{238} U.

In conclusion, it can be stated that the electro deposition method is more successful as a chemical protocol for analysis of U isotopes in sea water samples by alpha-particle spectrometry.

Keywords: Alpha spectrometry, co precipitation, electro deposition, uranium isotopes

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