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AN INNOVATIVE METHOD FOR DETERMINATION OF URANIUM ISOTOPES IN SOILS BY ALPHA-SPECTROMETRY COUPLED WITH MICROTHENE-TOPO COLUMN

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Determination of the low-level activity concentrations of uranium isotopes in soil samples are very important in many fields, including nuclear industry, environmental science, radioecology, geology and geochronology. As early as 2002, our laboratory has started to develop a method for determination of uranium isotopes by α-spectrometry in soil samples, which was based on fusion with Na₂CO₃ and Na₂O₂ at 600 ℃, leaching with HNO₃, silicate mineralization with HF, coprecipitation as hydroxides, Microthene-TOPO (tri-octyl-phosphine oxide) column extraction, elution with (NH₄)₂C₂O₄, source preparation by electrodeposition and measurement by α-spectrometry. An improved method have been published later in 2004.
Experience has shown that whether or not to remove silicates from the leaching solution is very important to the separation and determination of uranium isotopes. Because any silicon gel present in the leaching solution may block the column and make the uranium separation from other interfering α-emitting nuclides less effective, even failed. In fact, the α-particle energy of many natural radionuclides is nearby that of uranium isotopes. The most critical nuclide is ²¹⁰Po, whose energy (Eα: 5.30 MeV) almost coincides with that of ²³²U (Eα: 5.32 MeV) that is commonly used as an yield tracer. Therefore, ineffective separations surely interfere with accurate determination of uranium isotopes by α-spectrometry.
In the early procedures, the silicates were mineralized with HF. The treatment can remove some part of silicates as volatile SiF₄, and other part still remains in the leaching solution. Although the procedure works well, the treatment with HF is time-consuming and toxic not only for workers but also for environment. In order to further improve the method, a new procedure was developed, in which silica was coated with polyethylene glycol 2000 (PEG) in HNO₃ and the colloidal silica was allowed to settle down and finally was removed from the leaching solution through filtration. For method validation, reference materials supplied by the IAEA were analysed based on the new established method. The results showed that all the ²³⁸U, ²³⁴U and ²³⁵U concentrations obtained are in good agreement with the recommended or information values. Therefore, the new method can provide reliable results. The method has also been applied to analyse some different kinds of environmental soils, showing that (1) the yields are high and stable, (2) no ²¹⁰Po and thorium isotopes are observable in the uranium sources prepared with the recommended procedure, and (3) it is time-saving and has good suitability for soils.

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