Determination of 226Ra in natural water samples by liquid scintillation counting

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Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Introduction

Determination of 226Ra in drinking water, natural waters and other environmental samples is an important task due to its high radioactivity. 226Ra can be determined directly or via its progenies (e.g., 222Rn). According to the newest comprehensive papers (IAEA, 2010; Jia and Jia, 2012), activity concentration of 226Ra (mBq L-1) in medicinal thermal waters of Europe (e.g. Hungary) is 0.2-6 mBq L-1, while in drinking water it can reach 4-7 mBq L-1. 226Ra in water is easily measurable, typically relative uncertainty of results (in cases they were over MDA) was 6%, calculated using a coverage factor of 1.13.

Discussion 2: Method reliability

To check the reliability of the method, 2 water samples of a porphyry ore (Determination of activity concentration of 226Ra) and food and environmental samples; Institute of Nuclear Chemistry and Technology (WNTK), Warsaw, Poland 2014-16) were analyzed. The results show acceptable agreement with the reference values (see Table 1).

The well-known thermal medical waters of Spa Rudas were also analyzed, and results are reported in Table 2. The result of the sample “Hungary” was checked and confirmed by spectrometry. A 311 Aliquot was evaporated and the solution was sealed. According to the α-spectrum of the seal, activity concentration of 226Ra in the original sample was 46.7 ± 1.5 mBq L-1. Earlier results are also presented in Table 2, taking into account their high variability, the results reported in this paper are acceptable.

Table 2: Results of porphyry ore and food samples (2014-16)

Table 1: Comparison of 226Ra activity concentration in medicinal thermal waters of Hungary (MAJ) and Radon and radium content of thermal medical waters of Europe (Jia and Jia, 2012).

Table 3: Activity concentration of 226Ra in natural water samples of the black sea region in the Crimea.

Conclusions

A relatively fast, simple and reliable method has been developed for determination of 226Ra from natural water samples, using radiometric separation and LSC measurement. Activities of 226Ra (for determination of the chemical yield of the procedure) and 226Ra were determined from the same LSC measurement. The LSC spectrum of 226Ra and 133Ba consists of β counts from 226Ra tracer and α counts from 226Ra analyte in the same LSC measurement. The α-spectrum contains α counts from 133Ba tracer and α counts from 133Ba analyte in the same LSC measurement. The LSC source preparation and LSC measurement. Activities of 133Ba (for determination of the chemical yield of the procedure) and 226Ra were determined from the same LSC measurement.

Results

Of 38 analyzed water samples (bottled mineral waters, medicinal thermal waters and natural surface waters) can be seen in Tables 1 and 3. Our experiments have shown that the average chemical recovery was 60(15), and we could not find correlation between recovery and sample composition (saline earth content).

According to 2.3.1, the background between channels 00-100 of the LSC spectrum and pumping 100 min detection time, typically 10 mBq of minimal detectable activity (MDA) was achieved. Therefore, analyzing a sample of 0.5-1 L, the first indication of detection in the Council Directive 2012/24/EU (Council of Europe 92) for drinking water is nearly achievable. Typical relative uncertainty of results (in cases they were over MDA) was 6%, calculated using a coverage factor of 1.13.

Discussion 3: Method validity

To validate the reliability of the method, 2 water samples of a porphyry ore (Determination of activity concentration of 226Ra) and food and environmental samples; Institute of Nuclear Chemistry and Technology (WNTK), Warsaw, Poland 2014-16) were analyzed. The results show acceptable agreement with the reference values (see Table 1).

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Results of analysis of some popular bottled mineral waters (selected randomly) are reported in Table 3. Differences between older and newer values can be explained by changes in exploitation or processing technology (e.g. changing of the spring).

References


