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

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Abstract
A relatively fast, simple and reliable method has been developed for determination of 226Ra from natural water samples, using radiochemical separation and liquid scintillation counting (LSC). The method is based on the usage of 228Ra as tracer, on sorption on MnO2, back-extraction of Mn(II), and precipitation of BaSO4, converting Ba(II) into BaSO4, stabilised and then measured by LSC. The 226Ra tracer and the 228Ra analyte were determined parallel using the same LSC measurement. Analyzing model solutions and real samples, 85±15% average recovery and 10 mBq of limit of detection were observed. (Detection time was 200 min). This method was successfully used for analysis of bottled mineral waters, medicinal thermal waters and natural waters.

Keywords: Bio-DLLC, LSC, MnO2, Natural water

Introduction
Determination of Radon in drinking waters, natural waters and other environmental samples is an important task due to its high radioactivity. The Radon can be determined directly or via its progeny (e.g. 226Ra). According to the newest comprehensive papers (Kasztovszky et al., 2021), a spectrometry, scintillation counting and the liquid scintillation counting methods are mostly used as measurement techniques for determination of Radon. However, in another recent comprehensive paper (Tent et al., 2020) only spectrometry, spectrometry and its emittance technique are referenced, while LSC is only mentioned as a technique for determination of Radon.

Method

To check the reliability of the method, 2 water samples of a proficiency test (Determination of activity concentration of 3H, 226Ra, 241Am, 239Pu in food and environmental samples; Institute of Nuclear Chemistry and Technology (KRT), Warsaw, Poland 2014-14) were analyzed. The results show acceptable agreement with the reference values (see Table 1). The well-known medicinal thermal waters of Spa Rusz were also analyzed, and results are reported in Table 2. The result of sample “Hungarian” was checked and confirmed by spectrometry. A 3.1 mCi of evaporated and the sample was washed. According to the sensitivity of the spectrometry, activity concentration of the original sample was 447±7 Bq l⁻¹. Earlier results are also presented in Table 2, taking into account their high variability, the results reported in this paper are acceptable.

Discussion of LSC measurements

To optimize the pulse decay discriminator setting of the LSC analyzer, 228Ra standard was used as pure α-emitter (as the α-emitter). 226Ra decay by electron capture but by K, λγ, Auger electrons and conversion electrons. (This is a well-known procedure, see for example Kirby and Kasztovszky (2021) 226Ra sulfate precipitate was dissolved and the decay was confirmed. This was repeated until the pH of the supernatant reached 7 (typically 3 times). The BaCO3 precipitation was dissolved in 1.0 M HNO3, 1 drop HNO3(aq) was added to make colorless. The solution was transferred to a 20 ml plastic test tube, 6 µl of triton X-100 surfactant was added and LSC measurement was performed using a TriCar 2000Tr (Packard, USA) equipment.

The uncertainty is given using a coverage factor of 1 (k = 1).