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

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Introduction

Determination of 226Ra in drinking waters, natural waters and other environmental samples is an important task due to its high radio-toxicity. 226Ra can be transferred into a 20 mL plastic LSC vial, 16 mL of the sample was added to make complex with Pb2+. 19 mg Ba(NO3)2 and 5 mL 40% (saturated) Na2SO4 solution were added. The sample was adjusted to 4-7 using 1 M HNO3 or 1 M NaOH. After that 4 Bq 133Ba tracer and 1.25 g MnO2 Resin® were added. (As 226Ra does not decay.) The sample was stirred for at least 1 hour and the resin was allowed to settle (preferably for a night). The supernatant was discarded. The precipitate was suspended in 2 mL saturated K2CO3 solution and it was evaporated with 362 mL distilled water to dryness to convert BaSO4 to BaCO3. (This is a well-known procedure, see for example Kirby and Sealy 1953). The precipitate was re-suspended in 1:1 acetic acid and precipitate was dissolved. The solution was transferred to a 20 mL plastic LSC vial, 6 mL 0.1 M HCl was added to reduce the spillover of 133Ba counts into the 226Ra peak. The peaks in the α-spectrum correspond (from left to right) to 226Ra (4784 keV), 222Rn (5490 keV), 218Po (2576 keV), 214Pb, 214Bi and 210Pb. (As 226Ra has a 15.6 d half-life, this is a well-known procedure, see for example Kirby and Sealy 1953).

To optimize the pulse decay discriminator setting of the LSC analyzer, 226Ra standard was used as pure α-emitter (as a α-emitter, 226Ra has a 15.6 d half-life). 226Ra decay by electron capture but by α-rays, γ-rays, Auger electrons and conversion electrons. The 226Ra-activity of sample at separation, α and β-background of the same composition as real samples.

To study the relative influence of α-emitters progenies of 226Ra (214Pb and 214Bi) as well as of spillover of 133Ba counts into the 226Ra peak, the peaks in the α-spectrum correspond (from left to right) to 226Ra (4784 keV), 222Rn (5490 keV), 218Po (2576 keV), 214Pb, 214Bi and 210Pb. 226Ra has a 15.6 d half-life, this is a well-known procedure, see for example Kirby and Sealy 1953.

Results

The results of 38 analyzed water samples (bottled mineral waters, medical thermal waters and natural surface waters) can be seen in Table 1 and 2. Our experiments have shown that the average chemical activity was 66±10% and we could not find correlation between recovery and sample composition (aldehyde world content).

Conclusion

A relatively fast, simple and reliable method has been developed for determination of 226Ra from natural water samples, using radiochemical separation 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 analysis of some popular bottled mineral waters (selected randomly) are reported in Table 3. Consequently, older results were also presented in Table 2, taking into account their high variability, the results reported in this paper are acceptable.

Analysis of some popular bottled mineral waters (selected randomly) are reported in Table 3. The uncertainty is given using a coverage factor of 1 (k=1).