An improved procedure for the determination of $^{210}$Po in sediments by $\alpha$-spectrometry

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Abstract: The procedure used in our work is described in detail by Edgington and Robbins in 1975. We developed herein an improved version of this procedure that can be used for the determination of Po-210 in sediment samples. The optimisation consists in a substantial reduction of digestion time. Thus, the whole procedure can be performed within about 3-4 hours followed by overnight counting of the alpha sources. The repeatability was estimated by analysing 7 duplicates of IAEA 385 Irish Sea Sediment. The procedure has been tested and applied on lake sediments from Iacob Lake, Danube Delta, suggesting a substantial time gain and providing accurate and reliable results for the Po-210 activity concentrations. Alpha and gamma spectrometry has been employed for the radiometric measurements of Pb-210, Ra-226 and Cs-137. Preliminary results showed a clear correlation between the sedimentation rates and the natural flooding events or human interventions related to the hydro-technical works.

Methodology

Alpha spectrometry

Pb-210 massic activity (Bq kg$^{-1}$) was determined through its grand-daughter Po-210 by means of alpha-spectrometry. After applying the radiochemical procedure, the samples were measured using an ORTEC SOLOIST alpha spectrometer with PIPS detector.

Gamma spectrometry

The Cs-137 and Ra-226 activities (Bq kg$^{-1}$) were measured by non-destructive direct gamma spectrometry (after Rn-222 and Ra-226 reached equilibrium). The measurements were performed using an HPGe ORTEC n-type detector with beryllium window. Decay corrections were applied with the sampling date.

Sampling site

Danube delta developed in the north-western part of the Black Sea where the river flows into the sea. Sediment cores were collected from lacustrine units until 1 m depth using gravity corers. They were further subsampled in layers of 1 to 3 cm for alpha and gamma spectrometry investigations.

Results and discussions

We developed here an improved procedure involving the use of more concentrated HCl solution. This allows improvements such as:

- the use of a significantly smaller amount of acid compared to the classical procedure
- the substantial reduction of a total sample digestion time.

Thus, the whole procedure can be performed within about 3-4 hours followed by overnight counting of the alpha sources.

The repeatability of the new procedure was investigated by analysing 7 duplicates of IAEA 385 Irish Sea Sediment.

Constant rate of supply (CRS) model

The method was applied on lacustrine sediments from Danube Delta. The constant rate of supply (CRS) model was used, considering the flux of Pb-210 to the sediment constant. Cs-137 has been used as time marker of the two major radioactive depositions in the region, originated from Chernobyl accident and nuclear test in the atmosphere. The two Cs-137 peaks corresponding to the Chernobyl accident (1986) and to the maximum nuclear test fallout (1963) were found in each sediment column.

Conclusions

- Improvements have been made for one of the most used procedure of Po-210 determination by alpha spectrometry, which has been tested in our laboratory. The method is adequate for small environmental samples by alpha spectrometry and the results are obtained within one day.
- The Pb-210 dating method was applied successfully for lake sediments from Danube Delta. The obtained sedimentation rates reflect the variation of the sediment budget caused by flooding or by human activity. The Pb-210 derived ages in each sediment column and Cs-137 data are in good agreement.

References:


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