

Highlights of Analytical Chemistry in Switzerland

Division of Analytical Chemistry

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Polonium – on the Trace of a Powerful Alpha Nuclide in the Environment

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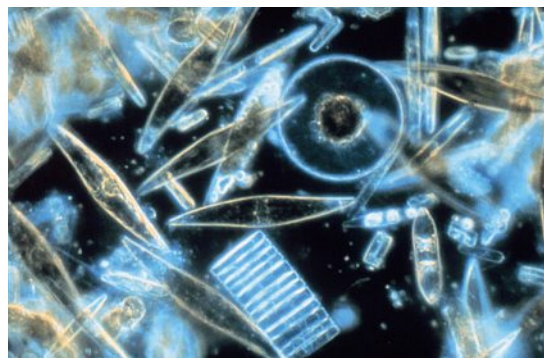
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Polonium-210 (²¹⁰Po) belongs to the natural decay series of uranium-238. It is produced at the end of the decay series as a daughter nuclide of the β -emitter lead-210 (²¹⁰Pb). ²¹⁰Po decays with a half-life of 140 days. Therefore chemical modifications and transport processes are possible. The main source of ²¹⁰Po is the natural fallout of the decay of radon-222 in the atmosphere. The ingestion of dust particles causes 8–10% of the natural internal radiation dose of man. ²¹⁰Po can accumulate especially in seafood.

Polonium is a very toxic metal. Irène Joliot-Curie died in 1957 of leukemia probably caused by the inhalation of polonium dust from a broken vial in 1946. A well-known case is the death of the ex-Soviet agent Alexander Litvinenko. He died in London weeks after drinking poisoned tea.

²¹⁰Po is a strong alpha emitter with an energy of 5'400 keV and has only one weak gamma ray emission at 803 keV (0.005% emission probability). Therefore the analytical method of choice is alpha spectrometry. The first two steps in every alpha spectrometry are the destruction of the matrix and the selective enrichment of the analyte. Above temperatures of 250 °C polonium is lost by evaporation. Therefore the methods of choice are wet ashing or microwave digestion. The final sample solution is set to a reducing milieu by the addition of hydroxylamine hydrochloride. The polonium is deposited onto a silver disc, which is then analyzed with alpha spectrometry.



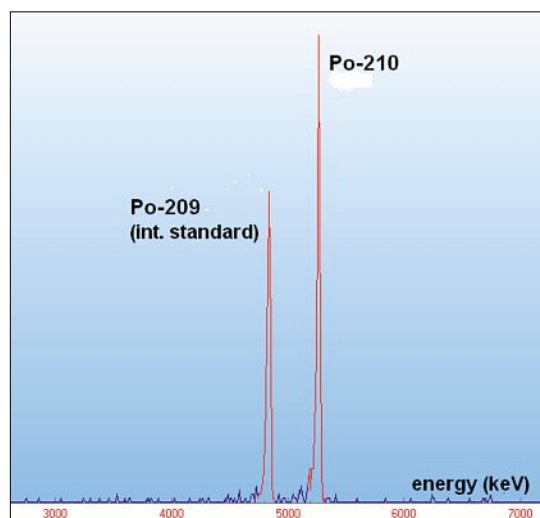
Diatoms (@ public domain).

Sediments containing the residues of diatoms are known as siliceous earths, also called diatomaceous earths or mountain flours. They find a wide spread use in industry, in cosmetics and in supplementary diet (healing earths). Our investigations of healing earths with gamma ray detection showed remarkable amounts of nuclides of the radioactive series of ²³⁸U and ²³²Th. In one sample we measured 400 Bq/kg of ²¹⁰Pb, the precursor of ²¹⁰Po. Our focus then switched to ²¹⁰Po. Its activity was 42 Bq/kg, so the two nuclides were not in equilibrium. Probably most of the ²¹⁰Po was lost during a heating step during the production process. **The yearly intake of two kg of this healing earth would result in a dose of 500 μ Sv, half of the annual permitted dose for non-professionals in Switzerland. ²¹⁰Po activity only causes 10 μ Sv.**

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Reference

M. Yamamoto, T. Abe, J. Kuwabara, K. Komura, K. Ueno, *et al.*, *J. Radioanal. Nuc. Chem.* **1994**, 178, 81.



Alpha spectrum of a healing earth extract. For quantification control ²⁰⁹Po was added (70 mBq). ²⁰⁹Po has an alpha energy of 4'800 keV. The sample was counted for 24 h in an alpha vacuum chamber (silicon barrier detector).



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