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Fast procedure for self-absorption correction for low γ energy radionuclide Pb-210 determination in solid environmental samples

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Low-energy X and γ radiations (for example of 210Pb: E γ = 46.5 keV) are effectively self-absorbed even in thin environmental samples, including air filters with captured dust or contaminated soil, as well as in bottom sediment matrixes with limited quantities of the samples. In this paper, a simple method for the direct analysis of 210Pb (T 1/2 = 22.3 years) by gamma-ray spectrometry in environmental samples with self-absorption correction is described. The method is based on the comparison of two γ peak activities coming from other natural radionuclides, usually present in environmental samples. The analysis the dependence of the self-absorption correction factor for the 210Pb activity on the activity ratios of 911 and 209 keV peaks and 609 and 295 keV peaks coming from nuclides of 238U or 232Th rows, present in typical environmental samples was done.
Instrumental gamma spectrometry with HPGe detectors is usually applied for environmental radioactivity monitoring. The preferred method for the correcting of this effect is to use spiked or natural matrix reference materials.
Commercially available radioactive standards allow us to establish the dependence of the detection efficiency versus the energy of c-photons in the wide energy range from 40 to 2,000 keV, for the fixed geometry (for example: cylindrical or Marinelli beaker and known chemical composition of the sample. However, several very important primordial and anthropogenic radionuclides occurring in the environmental samples emit low-energy photons in the range up to 200 keV, particularly: 210Pb—46.5 keV, 241Am—59 keV, 234Th (238U)—63.3 and 92.6 keV, 228Th—84.8 keV,235U—140, 163 and 186 keV and 226Ra—186 keV. For these radionuclides one should take into account the occurrence of the self-absorption of soft c radiation in the measured samples, which strongly depends on the density, resultant atomic number—Z and geometry of the samples.
Therefore, instrumental gamma ray spectrometry may require additional corrections for self-absorption of gamma rays, as environmental samples often differ in densities and composition from each other, and the offered calibration standard reference materials may have slightly different chemical compositions. Generally, two basic approaches have been applied for solving the problem of self-attenuation in volume samples: experimental and mathematical—using Monte Carlo simulations. Finally, a few computer programs have been developed for calculating the corrected detection efficiency for samples with a normalized shape with a known chemical composition (e.g. LabSOCS).
In all solid environmental samples together with the very important 210Pb radionuclide there are other natural radionuclides. Some of them emmit at least one of the pair of photons with different energies. Simultaneous determination of the ratios of their c-line activities can be a valuable method for searching for small chemical changes in the examined matrixes. We have proved this for at least following radionuclides: 228Ac emitting with sufficient efficiency photons with energies 209 and 911 keV, or a pair of 214Pb–214Bi with gamma-ray energies of 252 and 609 keV can be used for simultaneous self-absorption correction in the determination of the another soft-gamma

emitter—210Pb.

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