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Analysis of radionuclides at ultra low levels: synergy of low and high-energy mass spectrometry with gamma-spectrometry

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Content

Recent developments in low-energy (mainly associated with ICPMS – Inductively Coupled Plasma Mass Spectrometry) and high-energy mass spectrometry (represented by AMS – Accelerator Mass Spectrometry) have made them dominant techniques for analysis of long-lived radioisotopes (e.g. 10Be, 14C, 36Cl, 41Ca, 53Mn, 99Tc, 129I, 135Cs, uranium and plutonium isotopes) in various types of samples from meteorites to deep ocean seawater. In the radiometrics sector the most important development has been associated with underground operation of large volume Ge detectors, which have been dominating in analysis of short and medium-lived radionuclides emitting gamma-rays (e.g. 7Be, 54Mn, 60Co, 134Cs, 137Cs, 210Pb). This has been mainly because of better sensitivity (a higher detector efficiency and a lower background), which helped to decrease a sample size at least by about a factor of ten, and improve thus the detection limits down to μBq/kg, by about three orders of magnitude when compared with previous installations. Specific attention has been given to Monte Carlo simulations of background characteristics of Ge detectors, which if carried out in advance of the construction of a low-level spectrometry system, they could predict its characteristics and parameters. New developments in ultra low-level radionuclide analysis have had great impact on nuclear science and applications in environmental, life and space sciences. Many of the applications were not possible to carry out before either because of a lack of suitable samples (as too large samples were required for radionuclide analyses), or because of limited analytical sensitivities of existing instruments. Specific features of radiometric and mass spectrometry techniques for analysis of radionuclides in the environment at ultra low levels will be compared, and applications of radionuclides as tracers of environmental processes recently carried out by the University of Bratislava in collaboration with other laboratories will be presented.

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