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Complex spectra analysis of peaks interference through gamma-ray spectrometry of U-235, Ra-226 and Th-234

Natural radioactivity is unevenly distributed in the terrestrial environment, depending on the rocky nature of the soil. It can be dangerous for human life at a certain concentration of radionuclides. Unfortunately, these radionuclides are imperceptible to the human senses and detectors are used to “observe” them. In Burkina Faso, there are localities where the radioactivity is relatively higher than elsewhere. In these High Background Radioactivity Areas (HBRAs), studies have to be performed to determine the exact level of radioactivity in order to deduce the possible risks for the residents as well as those of neighboring localities where soil could be transported. There could have some nuclear security issues according to the nature of the transported materials which can involved illicit trafficking at borders. So appropriate detection measures are requires for detecting and identifying crucial threats in order to make difference between materials from real threat such as HEU and which one from innocent circumstance like NORM. RPM, identiFinder, inSpector 1000, PRD and Radeye are some efficient and appropriate devices for the use on field to detect radioactivity. For that nuclear security issue, it is very important to have accurate result of activity measurement which can be used to evaluate the radiological hazards. For this reason, the specific activity of U-238, U-235, Ra-226, Th-232 and K-40 have to be determined. Unfortunately, there is a lack of precision in the quantification of these nuclides. This is due to the complexity of the involved peaks. Indeed, the deconvolution process is faced to the peak interference phenomena of the spectra analysis. In fact, the direct detection of Ra-226 by gamma-ray spectrometry method is done by using its ionizing radiation emission energy of 186.211 kev. For the U-235 the most probable emission of energies are 185,720 keV and 143,767 keV. These radionuclides have their peaks so close that their respective peaks resolutions do not make it possible to distinguish them. Thus, the quantification of U-235 is increased by that of Ra-226 and vice versa. One solution used to overcome this issue is based on the secular equilibrium of the U-238 series. Since the proportions are well known between the isotopes of uranium, and the concentration of Ra-226 is equal to that of U-238, it is possible to find an acceptable estimation of the activities of Ra-226 and U-235. However, in a given sample, one cannot really ensure that the proportions have remained intact between the isotopes of uranium. The complexity remains in the quantification of these radionuclides and that of Th-234. This last one is used to determine the activity of the U-238 and unfortunately, it has two peaks of 92.38 keV and 92.80 keV energy extremely close to each other, also facing the interference phenomena which remains a real challenge. Fortunately, innovative calculation techniques, new algorithms and tools could provide a solution. In this study, methods and results for gamma spectra analysis using commercial and open-access tools will be compared and discussed. It is brought on this paper, a solution for solving the interference phenomena problem based on these tools. These new methods will be used to analyze the spectrum of a sample from a HBRA. The activity of U-235, Ra-226 and Th-234 will be calculated with acceptable accuracy.

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