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Short Research Article

The first Romanian underground laboratory with ultralow radiation background†

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Introduction

In recent years, several dedicated underground facilities have been built all over the world to measure with an extremely high sensitivity some unique and rare modes of decay and also products of the nuclear reactions induced by neutrinos. These caves, tunnels and mines provide excellent shielding from cosmic rays and some of them are located in rocks (or salt) with a very low level of natural radioactivity. Thus they are the best available places for low-background alpha, beta, gamma and SF-measurements. The galleries dug in salt ores are the most suitable places for housing underground laboratories due to the fact that during their formation, sodium chloride crystallizes before potassium and uranium salts. For this reason, these areas are practically free of natural radioactivity. In fact, extremely low-level beta counting is used in evaluating results of some chemical as well as neutrino experiments. In this way, some radionuclides such as T, ^{14}C, ^{210}Pb, ^{210}Po, ^{7}Be may be measured with high resolution without special extra-shielding systems. Our underground laboratory is placed in a gallery in a salt mine in Slanic-Prahova town. The laboratory is situated 208 m under the external lift entrance and the thickness of rocks above it is about 270–300 m.

The following facilities are included:

- Gamma spectrometry for ultra low activities;
- whole body counter;
- dosimetry at ultra low levels.

Before carrying out the experiments it was necessary to have a complete characterization of the low radiation background site.

Results and discussion

The preliminary investigations were carried out in the Unirea salt mine and the following work has been performed:

- High resolution gamma spectrometry with an ORTEC portable system equipped with a GeHP detector of 33% relative efficiency.
- Dosimetric measurements using an Eberline FH40G with a proportional counter.

Before the measurement with these instruments, it was necessary to raise the calibration curves. For the calibration we had to study if the counting rate is constant vs time (the slope of the curves from Figures 1 and 2 are constant).

The data obtained using an Eberline FH40G-10 as a rate meter contains both counts due to electronic noise and to natural radiation background. The electronic noise represents about 10 nSv/h. The dose rates into the galleries due to natural background, corrected for the electronic noise are between 1.6–9.8 nSv/h. This value correlated with the results of the spectrometric measurements assures a low enough background for

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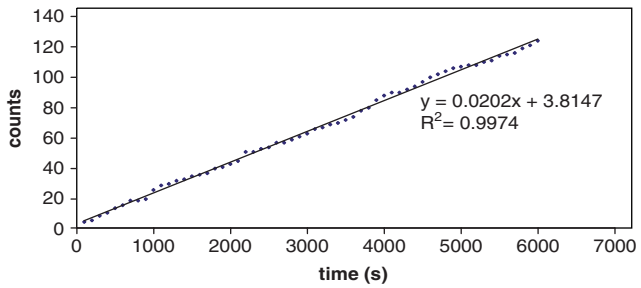

Figure 1 Counts vs time, sanatoriu area—Slanic Unirea salt mine; measurement performed with a doseratemeter Eberline FH 40-10.

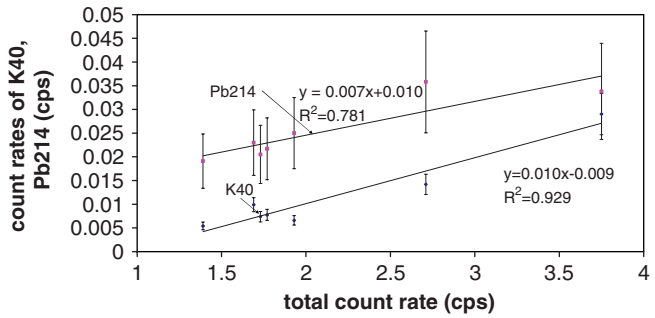

Figure 2 Correlations between count rates of K40 and Pb214 vs count rate on spectra collected in Slanic Unirea salt mine.

high sensitive measurements of ultra low level radioactivities.

The total count rates from 40 keV to 3 MeV of collected spectra in the gallery, 1.4–2.8 cps, are about 100 times lower compared with a spectrum collected in the same conditions in open field of ~175 cps. There are good correlations between ^{214}Pb, ^{40}K vs total count rates on spectra.

Conclusions

From the point of view of characteristic radiation background, the Unirea mine has the lowest count rates comparing to other Romanian salt mines. The measured data show that the radiation background in the gallery is up to 120 times less than in the open field. In spectra collected in the gallery, only traces of ^{40}K and Radon daughters were observed. The presence of ^{40}K gamma ray in spectra is due to the wood used inside the mine and to the people present. For further reduction of the background it will be necessary to construct a shielding made from electrolytic copper around the detector.

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