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Analysis of the Background Gamma Radiation in the College of Science at Malaz

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High background gamma radiations have been observed in different laboratories and rooms of the College of Science at Malaz. They have been measured at some selected laboratories using a high-resolution gamma spectrometer. Gamma ray lines of different background spectra, as well as the corresponding radioactive isotopes leading to these lines, have been identified. Different radioactive isotopes such as ^{40}K, ^{226}Ra, and ^{228}Ac with their daughters have been detected in this area.

During the last few years, different nuclear techniques have been developed to study some environmental problems. These techniques are applied to the study of atmospheric (air and water) pollution. The two most important techniques to be successfully applied are x-ray fluorescence and neutron activation analysis. These techniques are mainly used with high-resolution x- and gamma-ray spectrometry, which are based, respectively, on silicon detectors and lithium drifted and hyperpure germanium detectors. Nelson *et al.* (1974) have reported the different nuclear methods and techniques applied for environmental trace element analysis.

Measurement of the background radiations and analysis of its components are of great importance in environmental studies as well as in other spectroscopic studies for distinguishing the activity of samples under investigation. In environmental studies the level of activity is often so low that only a few counts per second may be detected. Knowledge of the background spectrum in a certain area is important for identifying the radioisotopic contents and determining the activity levels in this area.

Experimental Method and Results

The used gamma ray spectrometer has been reported by Farouk and Alsoraya (submitted for publication).

Optimum energy resolution and linearity of the gamma spectrometer were achieved by choosing the optimum integrating and differentiating time constants and other settings of the research amplifier, which provides nearly a pure Gaussian shape of the peaks. The energy resolution of the spectrometer was better than 1.8 keV (FWHM) at the 1332 keV gamma ray line of ^{60}Co. The energy values of the photopeaks of the gamma ray lines were calculated by using standard ^{182}Ta, ^{226}Ra, and ^{241}Am sources, whose gamma ray energies are well known. The accuracy of energy determination was better than 0.25 keV. The peak areas of the detected gamma ray lines were determined by direct summation of the channel contents after the subtraction of the Compton background, which was considered to be a linear function of the channel number.

The background spectra were measured in three different laboratories, situated in three separated buildings. Each measurement was carried out for a period of 24 h in order to improve the statistics. The level of the background radiation was almost the same in all three laboratories.

To ensure that the background radiations are not related to any radioactive contamination of the Ge(Li) detector, an additional measurement was carried out with the detector shielded by about 6-cm-thick lead blocks. The attenuation of the background spectra due to this shielding was satisfactory. Moreover, an additional test using 2-×-2-in. NaI(Tl) crystal was carried out. Measuring the background spectrum with and without lead shielding ensures that the background radiations are not related to any detector's contaminations. All three laboratories were free of any radioactive sources.

Identification of radioactive isotopes corresponding to the gamma ray lines in the background spectra was performed by comparing the obtained photopeak energy values with those in the *Table of Isotopes* (Lederer 1978). To further test for the existence of the detected radioactive isotopes as the main source of the background radiations, the relative intensities of different gamma ray lines for each isotope in the background spectra were compared with the corresponding relative intensities tabulated by Lederer (1978). The comparison was carried out after normalisation of the peak areas using the relative efficiency curve of the used Ge(Li) detector, described by Farouk and Alsoraya (submitted for publication). The agreement between measured reference relative intensities was found to be within 25%. The discrepancies in the relative intensities may be related to the fact that the relative efficiency curve of the Ge(Li) detector was measured for a point source.

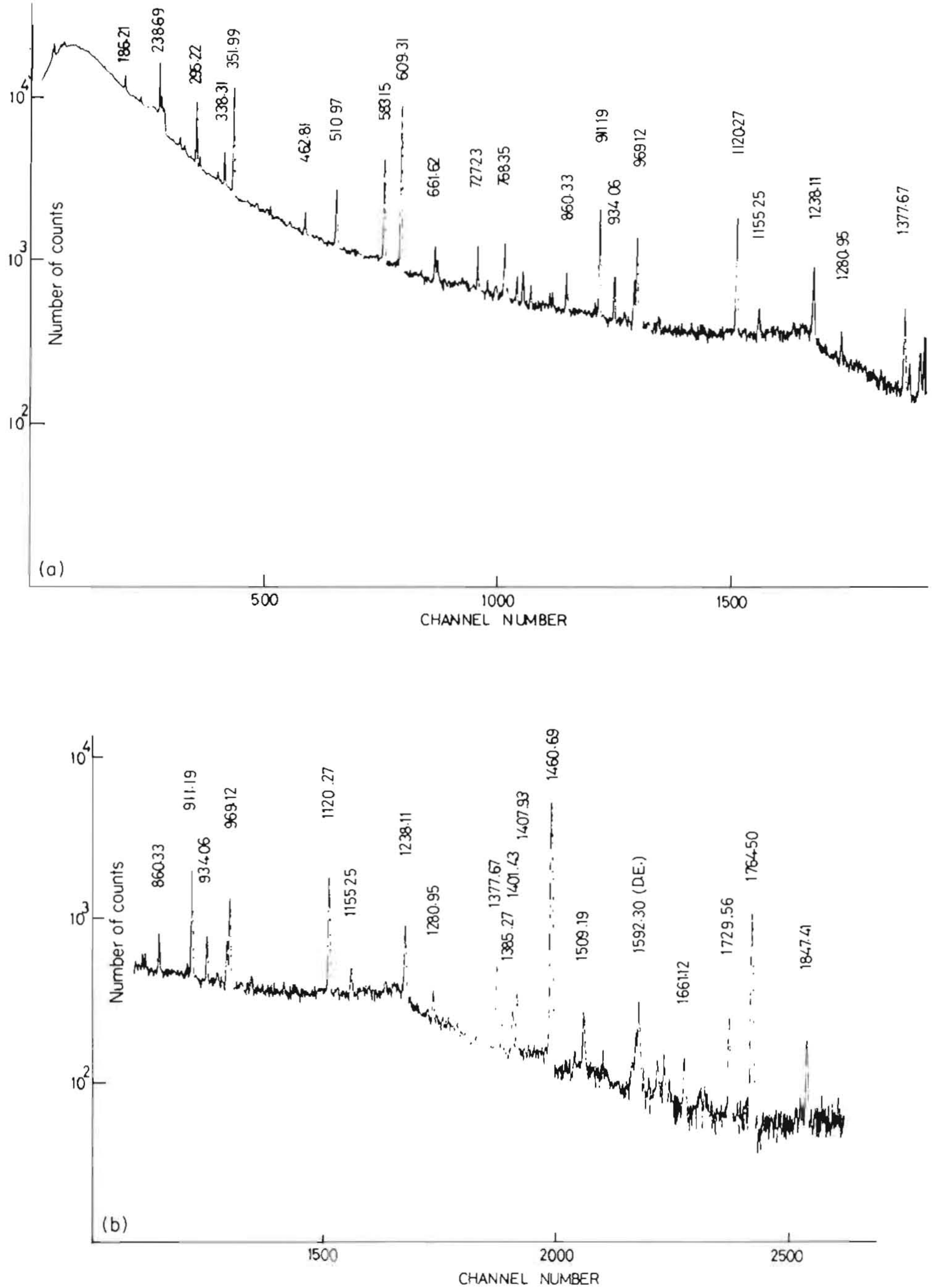

Fig. 1. Energy spectrum of the background radiation.

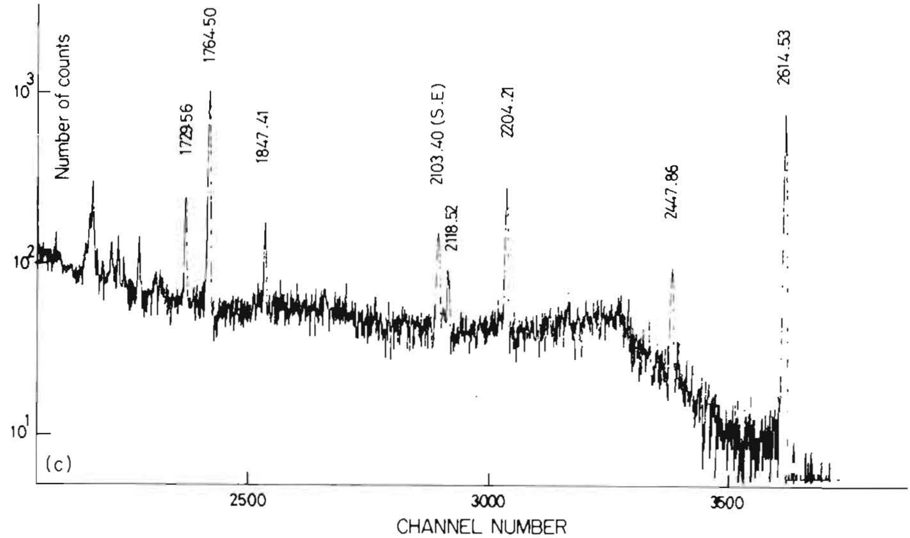

Fig. 1(c)

Discrepancies exceeding 25% between point and extended sources were reported in the ANSI/IEEE (1978).

One of the measured background spectrum is shown in Fig. 1, along with the photopeak energy values corresponding to different gamma ray lines. The results of our measurements are summarised in Table 1, which lists the calculated photopeak energy values of the background spectra together with the reference energies. Relative intensities of different photopeaks are also given, as are the gamma ray emitters and their parent radioactive isotopes.

The experimental results, summarised in Table 1, suggest that there is some radioactive contamination existing in different laboratories. This contamination, which is approximately constant for the whole area of the College of Science, consists of two main radioactive series ^{226}Ra and ^{228}Th with their equilibrium daughters. The activity of the background contamination was calculated and found to be equivalent to a ^{60}Co source of 0.06 μCi situated 20 cm far away from the detector. Although this level of contamination is not dangerous, it is necessary to mention its existence.

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Table 1. **Background gamma radiations and their relative intensities.**

E (keV)		Relative Intensity	Gamma Emitter	Parent Isotope
Present	Reference			
0186.21	0186.21	00768 ± 052	Rn-222	Ra-226
0238.68	0238.63	03600 ± 143	Bi-212	Pb-212
0241.98	0241.98	01559 ± 078	Bi-214	Pb-214
0247.05		01187 ± 060		
0270.08	0270.23	00941 ± 048	Th-228	Ac-228 or Pa-228
0295.22	0295.22	03274 ± 163	Bi-214	Pb-214
0338.31	0338.32	00983 ± 050	Th-228	Ac-228 or Pa-228
0351.99	0351.99	06072 ± 300	Bi-214	Pb-214
0462.81	0463.30	00591 ± 030	Th-228	Ac-228 or Pa-228
0510.97	0510.72	02049 ± 102	Pb-208	Tl-208
0583.15	0583.14	03687 ± 185	Pb-208	Tl-208
0609.31	0609.31	10000 ± 000	Po-214	Bi-214
0661.62	0661.67	00918 ± 046	Ba-137	Cs-137
0665.40	0665.45	00459 ± 030	Po-214	Bi-214
0727.23	0727.27	00878 ± 044	Po-212	Bi-212
0768.35	0768.35	01301 ± 065	Po-214	Bi-214
0860.33	0860.37	00737 ± 040	Pb-208	Tl-208
0911.19	0911.23	03599 ± 180	Th-228	Ac-228 or Pa-228
0934.06	0934.06	00756 ± 040	Po-214	Bi-214
0964.65	0964.60	00847 ± 044	Th-228	Ac-228 or Pa-228
0969.12	0969.11	02309 ± 115	Th-228	Ac-228 or Pa-228
1120.28	1120.28	04514 ± 210	Po-214	Bi-214
1155.25	1155.19	00449 ± 029	Po-214	Bi-214
1238.11	1238.11	02020 ± 101	Po-214	Bi-214
1280.95	1280.96	00424 ± 027	Po-214	Bi-214
1377.67	1377.67	01298 ± 065	Po-214	Bi-214
1385.27	1385.31	00230 ± 021	Po-214	Bi-214
1401.43	1401.50	00315 ± 026	Po-214	Bi-214
1407.93	1407.98	00755 ± 046	Po-214	Bi-214
1460.69	1460.75	24348 ± 480	Ar-40	K-40
1509.19	1509.23	00594 ± 033	Po-214	Bi-214
1588.13	1588.30	00610 ± 038	Th-228	Ac-228 or Pa-228
1592.30		01325 ± 074	(D.E. of 2614 keV)	
1661.12	1661.28	00334 ± 029	Po-214	Bi-214
1729.56	1729.60	00459 ± 049	Po-214	Bi-214
1764.50	1764.50	04607 ± 168	Po-214	Bi-214
1847.41	1847.42	00550 ± 038	Po-214	Bi-214
2103.40		01068 ± 067	(S.E. of 2614 keV)	
2118.52	2118.55	00395 ± 031	Po-214	Bi-214
2204.21	2204.21	02149 ± 107	Po-214	Bi-214
2447.86	2447.86	00769 ± 043	Po-214	Bi-214
2614.53	2614.47	08881 ± 311	Pb-208	Tl-208

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قياس الخلفية الاشعاعية بكلية العلوم بالملز

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قسم الفيزياء ـ كليـــة العلوم ـ جامعـة الملك سعود ـ الـرياض ـ المملكـة العربية السعودية

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