Determination of Natural Isotope and Radionuclide of Out Door High Dose Rate in Garmik Area-kurdistan Region NE-Iraq.

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Abstract

Radioactive materials, containing high-count rate, are found in some areas in the world which have worldwide use as construction and facing material. The radiation doses, in the Garmik area, are about 268.6 nGy h^{-1}, which are density population by residents of ten of villages and two towns.

The outdoor terrestrial gamma-ray background in some region of Garmik area was studied in order to determine the absorbed gamma dose rates of the soils and rocks. Gamma ray spectra have been recorded using the advance nuclear measurement system (digital spectroscopy analyzer DSA with NaI (TI) detector). This method is very suitable for measuring outdoor gamma radiation dose because the gamma count and human -radiation exposure will not be lost by the method by which the whole radiation exposure has been determined. A new equation has been formulated for this method. The total dose rates inside Sulaimani city was (42.873) nGy h^{-1} considered as a normal local outdoor dose rate (background).

The average values of outdoor dose rates of the studied samples, in Tatan, Hangazhal and Garmik areas have been found to be (226.1005, 257.477,322.541) nGy h^{-1} respectively. These values are nearly 6 times grater than the normal local outdoor dose rate of the background of Northeastern Iraq. The dose rate of each radioactive elements or isotopes have been determined for each spectrum of each mentioned area which are equal to 8.4554, 67.0995, 66.9057, 50.6143 nGy h^{-1} for Sulaimani city, Tatan, Hangazhal and Garmik respectively. The total rate of radionuclide is about ٢٢،٧٦% of total outdoor dose rate.

Introduction

Garmik area is located in the extreme northeast of Iraq and about 60km to the northeast of Sulaimani city near the border with Iran Fig.1. The area situated between the latitude 35^{o}43`28.63``) N and longitude (45$^{o}$57`00.85``) E and with the elevation of 4092 feet from mean sea level (msl). The area covers about 200km^{2}, which consists low grade of metamorphic rocks (phyllite) which are derived from metamorphism of pelletic sedimentary rocks (shale) as shown in Fig 2.

In literatures, the natural background radiation defined as cosmic, radon gas and terrestrial radiation. They mentioned that the external radiation exposure attributed mainly to cosmic rays and terrestrial radionuclide that are occurring at trace levels in all rocks and soils (UNSCEAR, 2000). Average outdoor absorbed dose rate of the world value, in the air, is 44 nGy h^{-1} (Daryoush, 2003). The specific levels of the terrestrial background radiation are related to the types of rocks from which the soils originated. Therefore, the natural environmental radiation mainly depends on geological and geographical conditions. Higher radiation levels are associated with igneous rocks, such as granite, and lower levels with sedimentary rocks. There are exceptions, however, as some shale and phosphate rocks have relatively high content of radionuclide (Michalis, 2003).

Cosmic radiations vary according to height from ground regularly in all location on the world, but the terrestrial radiation vary from small area to another which depend on rock layer components. Therefore, different count rates and dose rates have been recorded in the studied area, which shows anomalies (high dose rate) in Garmik area comparing with Sulaimani city (area of the background) in which normal local outdoor dose is measured.

The gamma radiation dose rate of the mentioned area must be oriented as a national interest and duty of the Regional Government of Kurdistan and Iraq for which the Iraqi Authority has established National Establishment for Radiation Protection. Moreover of late, the local governorates (i.e. Kurdistan Region) now trying to establish local office for this purpose. Several works have done TUFAIL (2000) used a NaI(TI) detector with gamma ray spectrometer employing the spectrum stripping technique for determining the values of whole body equivalent dose and got 27-108 nGy/h range in Pakistan marble Shagjjamba (2006) used portable scintillation spectrometry with 3×3 NaI (Tl) detectors for measuring the external outdoor radiation level and terrestrial gamma dose rate for urban environments in Mongolia and found equal to 86.9 ± 15.0 nGy/h Seiichi (2003) used pocket gamma ray dosimeters and a handy neutron rem counter for measuring terrestrial gamma ray dose rate which was nearly equal 0.45 mSv/y Dragović (2006) studied the gamma dose rates due to naturally occurring terrestrial radionuclides (Ra^{226}, Th^{232} and K^{40}). Their calculations were based on radioactivity in collected soil samples from 21 different regions of Serbia and Montenegro, the measured gamma dose rates, was ranged from (7.40 to 29.7) nGy/h for Ra^{226}, from (12.9 to 46.5) nGy/h for Th^{232} and from (12.5 to 37.1) nGy/h for K^{40}. They mentioned that, the total absorbed gamma dose rate due to these radionuclides varied from (34.5 to 97.6) nGy/h with mean of 66.8 nGy/h

Uosif (2007) selected sedimentary samples from different locations on the east and west banks of the Nile River in Upper Egypt, he found that the samples were contained Ra, Th and Kin concentrations up to(52±7.3), (76.2±6.2) and (351.9±17.6) Bq/kg, respectively Al-Ghorabie (2005) employed CaSO4:Dy (TLD-900) thermo-luminescent dosimeters for the detection of terrestrial gamma radiation at three different mountainous locations in the three locations: Al-Taif city, Al-Hada village and Ash-Shafa village, in the western region of the Saudi Arabia, he cited that, the average gamma radiation dose rates were 468, 541, and 781 µGy/y for At-Taif city, Al-Hada village and Ash-Shafa village, respectively. Merdanoğlu (2006) used HPGe detector for determining external hazard index and terrestrial absorbed dose rate for Th^{232} and U^{238} in the area of Kestanbol (Canakkale), Turkey, they recorded the dose of 1.4 nGy/h and 219 nGy/h, respectively for the two mentioned radionuclide, Patricia (2007) studied external natural radiation, cosmic and terrestrial components, by using NaI scintillation counters while driving along the roads in Costa Rica for the period July 2003–July 2005. The average air-absorbed dose for the terrestrial component was 29.52±14.46 nGy/h.

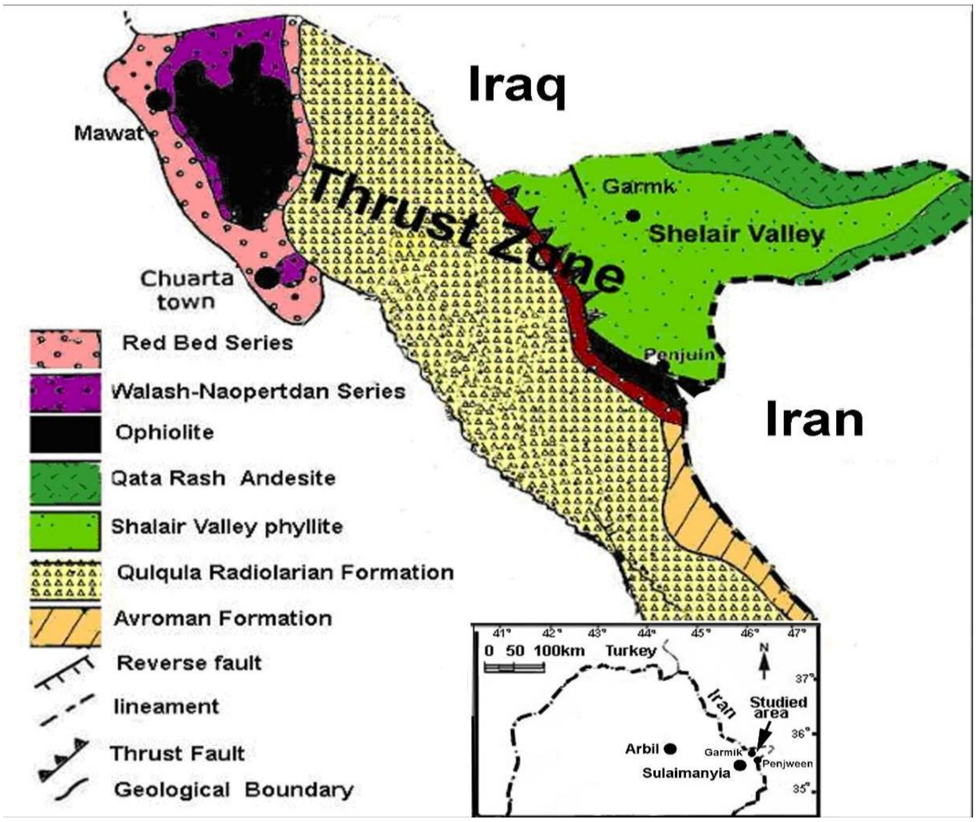

Fig.1: Geological and location map of the Shalair valley (northeast Iraq) has the high count rate from phyllite rock.

Fig.2: Two photos of the weathered (left) and fresh outcrop phyllite metamorphic rock with high count rate at Shalair valley (northeast Iraq)

Experimental Procedure

Gamma-ray detection system:

High-efficiency spectroscopic system has been used for the measurement of the energy spectrum of the emitted gamma rays in the energy range between 10 *keV* and 2000 *keV*. The system consists of a scintillation (NaI(Tl)) detector (with crystal size 2inch × 2inch) Experimental arrangement for spectra collection includes detector and signal processing electronics, which is consisted of digital spectroscopy analyzer-DSA with characteristics of multi functions spectroscopy amplifier, single channel analyzer-SCA, multi channel analyzer and personal computer with Genie2000 soft ware program as shown in Fig.3. The employed DSA-1000 is a full featured 16K channel integrated Multi-channel Analyzer based on advanced digital signal process in techniques (DSP). When it is paired with the suitable computer, the DSA-1000 becomes a complete spectroscopy workstation, capable of high quality acquisition and analysis (Canberra, 2001; Genie, 2004).

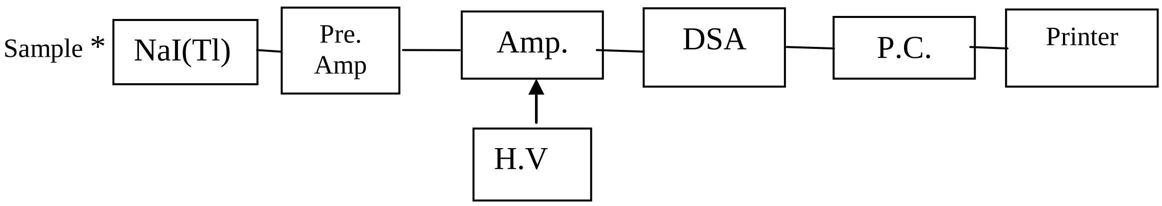

Fig.3: Shows the schematic diagram of the setup.

Spectra collection of ground (soil and Rock):

The preparation was started by putting the standard source (Cs-137) of activity 18.6 mBq under the detector, which is shielded by cylinder of Pb with 50mm thickness. The detector is modulated to the DSA, which in turn modulated to computer via Genie (2000) software program and then the high voltage were adjusted to 900V by activating a MCA-adjust in new window in the gamma spectrum software. After collecting spectrum for two hours the energy calibration of the source has been done through window in gamma spectrum software.

Data collection:

The radiation in the mentioned areas were detected by portable detector (BGO), more than 200 count /sec. were accumulated. Also the gamma detection system were operated by putting the detector window on the ground which consists of soil and phyllite for the three areas (Hangazhal , Garmik and Tatan) spectra is recorded for two hours in each areas of high anomaly and in the area of background in the Sulaimani city directly as shown in Figs(4,5,6 & 7).

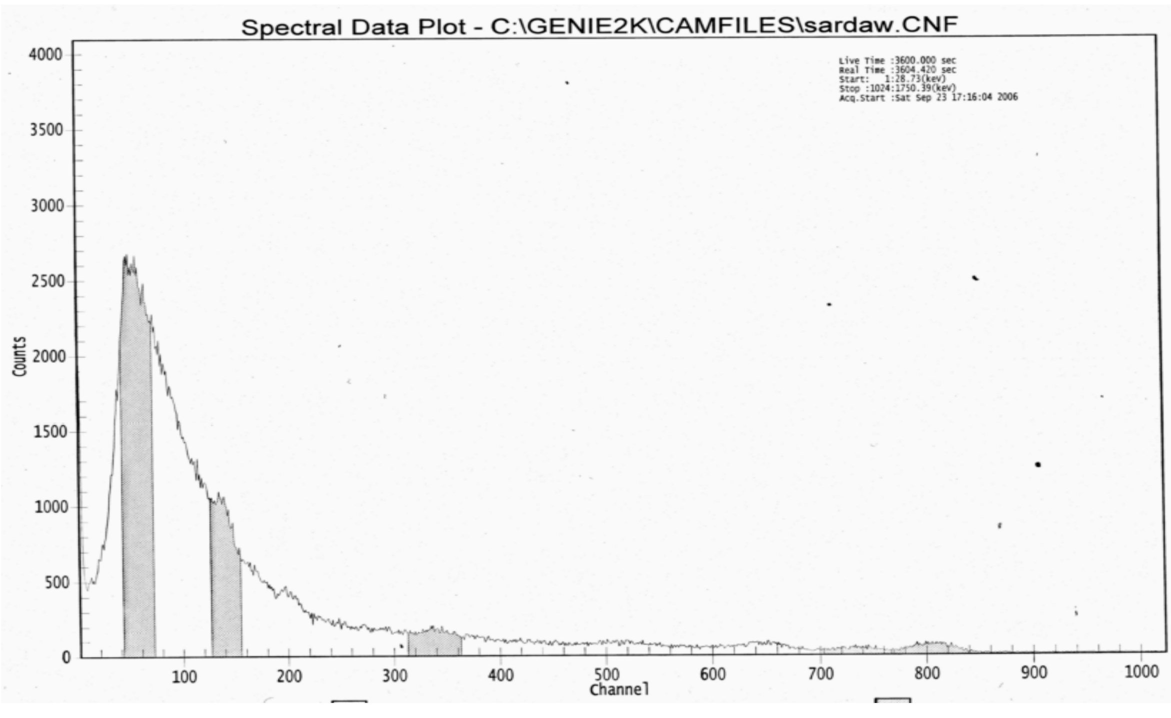

Fig .4: Background natural radiation from rock and soil of Sulaimani city- Sardarawa.

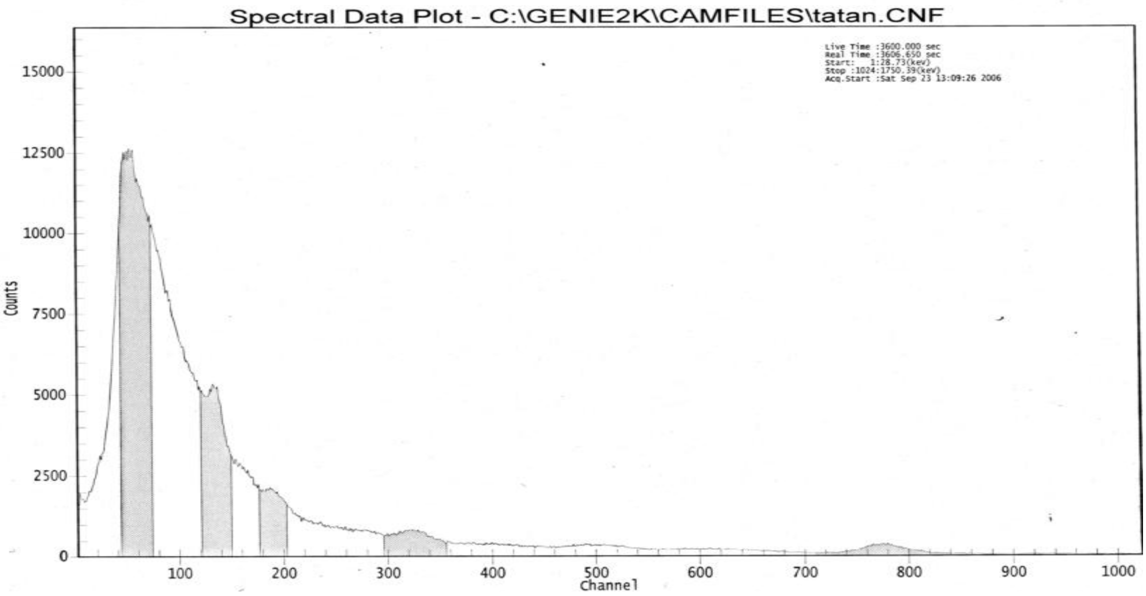

Fig.5: Background of natural radiation from rock and soil of Tatan village.

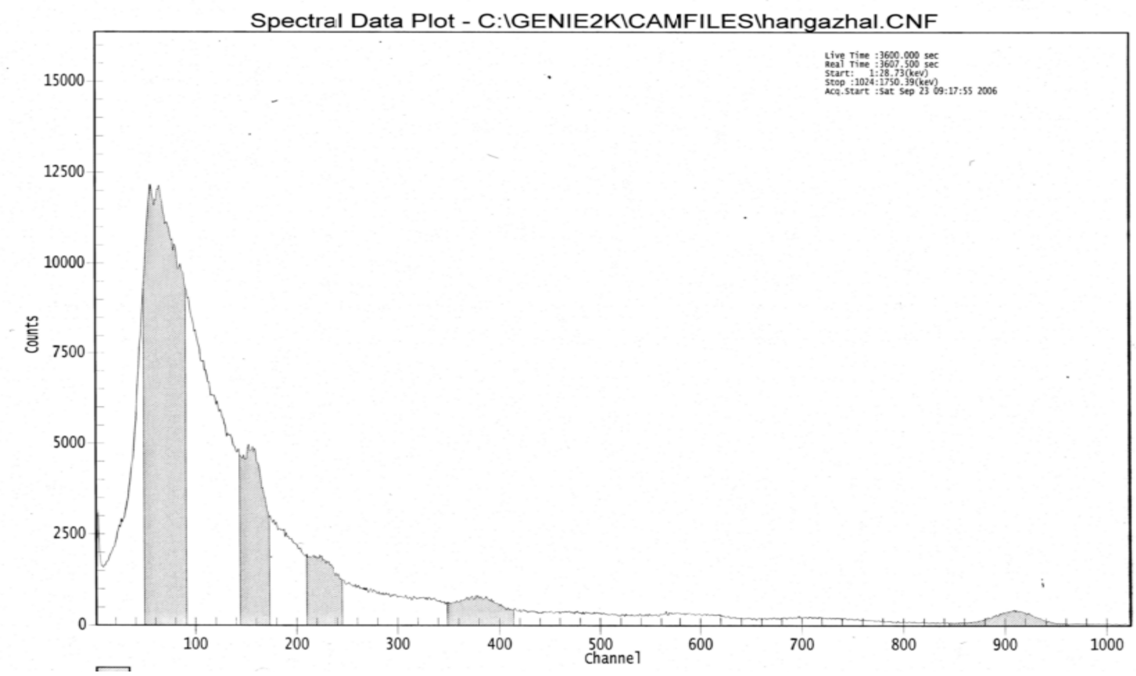

Fig.6: Background of natural radiation from rock and soil of Hangazhal village.

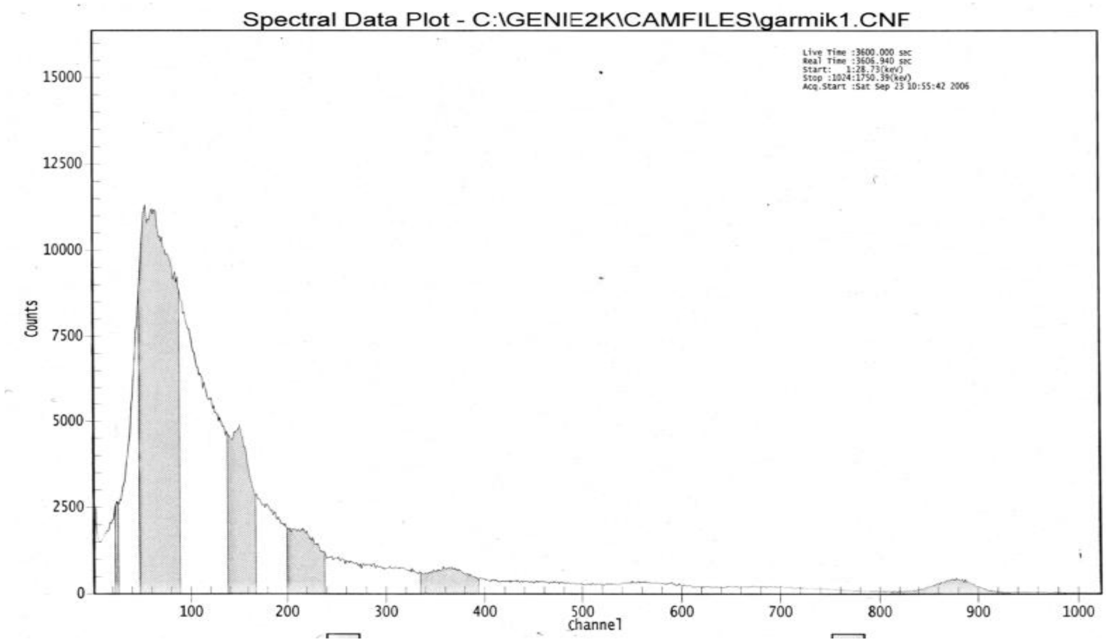

Fig.7: Natural Background radiation from rock and soil of Garmik town.

Direct detection theory:

The aim of this work is to determine gamma radiation exposure on human directly, thus this process need new suitable formula, which directly measures gamma spectrum and whole energy of exposure radiation. Several factor and parameter have been used for reducing energy loss also. In order to get an exposure radiation equation of the area, the following equations have been modified by adding several factors and then formulating new equation as shown below.

The new formula does not contain mass of radioactive material because this was the only possible direct measurement to achieve in the areas. The distance was neglected as equation (1) because the detector was located on the soil of areas.

Exposure rate $= 6 \times C \times E \times N$ …(1)(James,2000)

Where: C= source activity in Curie (Ci), E=gamma energy in MeV, N=No. of gamma photons per disintegration (photon yield). Hereafter, the new formula contains factors like (efficiency, geometry factor and mass of human). In this work, the exposure could not be considered from a point source because many factors to be added if so, to equation (1) ;

Exposure rate $(X) = A_{up} \times E_p$ …(2)

A_{up} = Area under peak,

E_P = peak energy/sec

Where C in the equation is replaced by the area under peak of the spectrum in the equation (1) it means that the radiation comes from all around, the energy of each peak in the outdoor spectrum was used instead of unique energy of the source and factor N, can be neglected because NaI(TI) detector recorded gamma and x-ray only. The multiplied integer 6 was removed from the equation because there are many sources in different distances; therefore the inverse square law is not applied for the point source equation. This means that equation (2) does not contain distance factor. Equation (2) then multiplied by total time (T_{total}) to obtain the total energy during one year. It will be directly proportional to the exposure rate. Therefore measuring exposure radiation per one hour doesn't need to add $T_{total.}$ Then new equation we obtained.

$$\text{Exposure rate }(X) = A_{up} \times E_p \times T_{total} \qquad \dots (3)$$

Another two factors must be added which are;

G-factor must be added to the equation in order to decrease the energy loss due to the difference between the area of the scintillation counter and the human body. Since G-factor can be defined as the ratio between the area of the human body (≈ rectangular area) and the area of the scintillation counter.

$$G = \frac{A_{Human}}{A_{Detector}} \qquad \dots (4)$$

Where A_{Human}= average human body area (6080 cm^2 =0.608 m^2). $A_{Detector}$= detector area which is found by the area of the circle with radius: r=2.54Cm , $G \approx 300$

$$\text{Exposure rate }(X) = A_{up} \times E_p \times T_{total} \times G \qquad \dots (5)$$

By adding the efficiency factor to the relation (5) one gets;

$$\text{Exposure rate}(X) = \frac{A_{up} \times E_p \times T_{total} \times G}{\xi_{eff}} \qquad \dots (6)$$

Another factor to be considered which added to the equation is the accumulation time (2 hours) of detecting counts by the scintillation detector.

$$\text{Exposure rate}(X) = \frac{A_{up} \times E_p \times T_{total} \times G}{2 * \xi_{eff}} \qquad \dots (7)$$

The above equation represents total energy of the spectrum in order to convert it to dose rate which it must be divided by the human body mass. The average weight of the human assumed to be (70Kgs).

The absorbed dose (D) =exposure rate of radiation(X)/ Mass (m).

$$\text{Absorbed dose}(D) = \frac{A_{up} \times E_p \times T_{total} \times G}{2 \times \xi_{eff} \times W_{average}} \qquad \dots (8)$$

The summation must be added to obtain the absorbed dose of each area of the peaks which containing the spectrum.

$$Absorbed\ dose(D)_{position} = \sum_{i}^{n} \frac{A_{(i)up} \times E_{(i)p} \times T_{total} \times G}{2 \times \xi_{(i)eff} \times W_{average}} \quad \ldots (9)$$

To obtain the equivalent dose (D_E) in rem, absorbed dose (D) is multiply by quality factor (Q=0.7) and the final equation became as shown below.

$$Equivalent\ dose(D_E)_{position} = \sum_{i}^{n} \frac{A_{(i)up} \times E_{(i)p} \times T_{total} \times G}{2 \times \xi_{(i)eff} \times W_{average}} \times Q \quad \ldots (10)$$

Dose radiation detection by equation (10) had exactly the same to the measuring dose rate by wallac-instrument (universal survey meter RD-8).

Method of calculation of dose rate:

Each measured γ-ray spectrum has been analyzed by a dedicated software program (Gamma analyzer – Genie 2000), which performs a simultaneous fit to all the significant photopeaks appearing in the spectrum and obtaining best spectrum optimization. Menu-driven standard reports are available as a summary which includes peak number, centroid channel, energy, net area counts, background counts, FWHM, radionuclide identification and half life time as selected by using scroll of each peaks in the spectrum. Moreover, the summery include the average activity in *Bq*, error ratio, peak fitting for each detected radionuclide. The report can be printed for each spectra of a certain region as shown in tables (1, 2, 3, & 4). Using hard wares: Digital Spectroscopy Analyzer –DSA and software program Genie 2000 the best spectrum optimization were obtained.

One of the characteristic of gamma analyzer software is smart analyzing work. The NaI(Tl) detector (as example in this study which has rare resolution energy between(6-8) Kev) are used with DSA and Genie 2000 software cause to reduce the resolution energy to 2 Kev as shown in Table 4.Therefore, the isotopes or radionuclide of spectrum could be distinguished easily as shown in Tables (9, 10, 11, & 12). Radionuclide specification could be determined by using a method of comparison between software program nuclear data sheet (NDS) and peak energy of spectrums .The difference between software energy peak of radionuclide and spectrum peak energy is reduced to 1.6 KeV as shown in Tables (9,10,11,& 12).

Generally total exposure dose rate of all peaks with background of each spectra of these three areas have been calculated by using equation (9)as shown in tables (5,6,7 & 8). In the other side, the activity and exposure dose of each peak in the spectrum of isotope or radionuclide have been calculated by using equation (10) as shown in tables (9,10,11,&12).

Table 1: Peak energy versus radionuclide count rate by using soft standard analysis report to collect data spectra of Sulaimani city-Sardarawa.

PK	ID	Area under peak	Area under peak	Peak back-ground	FWHM	Channel	Left	PW	Counts/Sec
1		55.16	4673	30559	16.92	49.24	42	31	1.3E+000
2		69.83	1831	25182	7.18	57.68	42	31	5.1E-001
3	Xe^{133}	81.19	2623	38757	15.00	64.21	42	31	7.3E-001
4	Ac^{228}	208.20	1032	18049	19.45	137.24	127	29	2.9E-001
5		213.54	1281	22277	19.85	140.31	127	29	3.6E-001
6	Pa^{234}	227.43	658	11751	20.93	148.30	127	29	1.8E-001
7	Br^{82}	555.66	1558	7066	38.84	337.03	313	51	4.3E-001
8		590.23	568	1908	23.92	356.92	313	51	1.6E-001
9		1245.41	517	1975	57.86	733.63	703	65	1.4E-001
10		1339.96	172	971	54.97	788.00	767	94	4.8E-002
11		1360.62	1200	1284	49.85	799.88	767	94	3.3E-001
12		1406.04	808	987	56.30	826.00	767	94	2.2E-001

Table 2: Peak energy versus radionuclide count rate by using soft standard analysis report to collect data spectra of Tatan Village.

PK	ID	Peak energy /KeV	Area under peak	Peak B.ground	FWHM	Channel	Left	PW	Cts/Sec
1	Th^{227}	49.78	7351	48162	6.56	46.15	43	32	2.0E+000
2	Th^{232}	58.52	27860	165752	18.93	51.17	43	32	7.7E+000
3	Pb^{212}	76.63	21886	268339	23.89	61.58	43	32	6.1E+000
4		94.10	1266	70837	4.30	71.63	43	32	3.5E-001
5	U^{235}	206.94	17689	120742	22.27	136.51	121	30	4.9E+000
6	Rh^{105}	306.02	3590	49996	19.81	193.48	177	27	1.0E+000
7		512.47	1613	20350	27.55	312.20	296	61	4.5E-001
8	Rb^{83}	530.28	1609	28457	27.92	322.44	296	61	4.5E-001
9	Cs^{138}	545.17	3516	28338	35.09	331.00	296	61	9.8E-001
10		571.78	1302	10949	29.23	346.30	296	61	3.6E-001
11		1297.35	6436	7784	65.16	763.50	711	130	1.8E+000
12		1322.57	6622	6572	54.61	778.00	711	130	1.8E+000
13		1357.35	3986	5480	55.32	798.00	711	130	1.1E+000
14		1417.71	739	905	45.72	832.71	711	130	2.1E-001

Table 3: Peak energy versus radionuclide count rate by using soft standard analysis report to collect data spectra of Hangazhal village.

PK	ID	Peak energy /KeV	Area under peak	Peak B.ground	FWHM	Channel	Left	PW	Cts/Sec
1	Cs^{136}	66.40	27199	125395	15.03	55.71	49	43	7.6E+000
2	Xe^{133}	82.65	27045	234601	15.01	65.05	49	43	7.5E+000
3		97.37	14502	208939	13.50	73.51	49	43	4.0E+000
4		110.09	7699	164439	10.39	80.82	49	43	2.1E+000
5		122.26	3424	82596	10.95	87.83	49	43	9.5E-001
6	Nb^{95M}	235.61	4218	74496	23.10	153.00	144	30	1.2E+000
7	Eu^{152}	246.15	12413	107979	21.24	159.06	144	30	3.4E+000
8		261.93	1631	38199	21.90	168.14	144	30	4.5E-001
9	Zr^{97}	355.37	1908	39776	17.40	221.86	210	36	5.3E-001
10		373.11	4385	40494	27.90	232.06	210	36	1.2E+000
11		612.82	1509	23525	29.14	369.89	349	66	4.2E-001
12	I^{134}	623.43	3355	29612	37.52	376.00	349	66	9.3E-001
13		663.43	2784	14411	38.70	399.00	349	66	7.7E-001
14		1551.33	16104	6819	75.72	909.54	845	118	4.5E+000

Table 4: Peak energy versus radionuclide count rate by using soft standard analysis report to collect data spectra of Garmik town.

PK	ID	Area under peak	Area under peak	Peak back ground	FWHM	Channel	Left	PW	Cts/Sec
1		11.66	309	10148	3.72	24.43	23	4	8.6E-002
2		63.34	21747	92331	13.38	53.95	48	42	6.0E+000
3		78.29	23367	220299	15.11	62.54	48	42	6.5E+000
4	Ba^{133}	93.54	15279	230630	15.48	71.31	48	42	4.2E+000
5		107.18	7461	189206	12.73	79.15	48	42	2.1E+000
6		118.12	1160	77836	13.32	85.44	48	42	3.2E-001
7		225.60	6564	76619	18.22	147.24	138	31	1.8E+000
8	Pa^{234}	244.30	11683	69847	23.52	158.00	138	31	3.2E+000
9		345.43	4311	48900	22.87	216.15	200	39	1.2E+000
10	Kr^{89}	369.52	2103	22452	28.91	230.00	200	39	5.8E-001
11		580.08	718	13646	13.78	351.07	335	60	2.0E-001
12		608.99	4614	28434	46.80	367.70	335	60	1.3E+000
13	Bi^{214}	1431.86	10552	3917	50.93	840.84	812	120	2.9E+000
14		1475.50	4995	4343	41.82	865.94	812	120	1.4E+000
15		1477.35	19677	5949	57.71	867.00	812	120	5.5E+000

Table 5: Total radiation exposure outdoor dose rate from soil and rock of Sulaimani city – Sardarawa.

Peak Energy/ KeV	Area under peak	Peak B.ground Area	efficiency	Dose nGy / hr	Dose mrad / yr
55.16	4673	30559	1	0.6663	0.5841
69.83	1831	25182	1	0.6474	0.5669
81.19	2623	38757	1	1.1518	1.001
208.2	1032	18049	1	1.3621	1.1939
213.54	1281	22277	0.95	1.8155	1.5915
227.43	658	11751	88	1.1	0.9639
555.66	1558	7066	0	4.8415	4.2441
590.23	568	1908	0.28	1.7895	1.5686
1245.41	517	1975	0.14	7.6	6.6626
1339.96	172	971	0.12	4.3759	3.8359
1360.62	1200	1284	0.12	9.6565	8.4649
1406.04	208	987	0.11	7.8665	6.8958
Total				42.873	37.5732

Table 6: Total radiation exposure outdoor dose rate from soil and rock of Tatan village.

Peak Energy/KeV	Area under peak	Peak B.ground Area	efficiency	Dose nGy / hr	Dose mrad / yr
49.78	7351	48162	1	0.9474	0.8305
58.52	27860	165752	1	2.9135	2.554
76.63	21886	268337	1	7.6251	6.685
94.1	1266	70837	1	2.3262	2.0392
206.94	17689	12074.2	1	9.8218	8.6098
306.02	3590	49996	0.6	9.3705	8.2142
512.47	1613	20350	0.34	11.35	9.9494
530.28	1609	28475	0.33	16.5745	14.5292
545.17	3516	28338	0.3	19.8467	17.3976
571.78	1302	10949	0.295	8.1413	7.1366
1297.35	6436	7784	0.13	48.6549	42.651
1322.57	6622	6572	0.13	46.0219	40.3428
1357.35	3986	5080	0.125	35.2421	30.8932
1417.71	739	905	0.11	7.2646	6.3681
Total				226.1005	198.2006

Table 7: Total radiation exposure outdoor dose rate from soil and rock of Hangazhal village.

Peak Energy/ KeV	Area under peak	Peak Back ground Area	efficiency	Dose nGy / hr	Dose mrad / yr
66.4	27199	125395	1	3.4739	3.0452
82.65	27045	234601	1	7.4143	6.5
97.37	14502	208939	1	7.4594	6.5388
110.09	7699	164439	1	6.4974	5.6956
122.26	3424	82596	1	3.6057	3.1608
235.61	4218	74496	0.87	7.3087	6.4068
246.15	12413	107979	0.78	13.0261	11.4187
261.93	1613	38199	0.73	4.7	4.2952
355.37	1908	39776	0.53	9.5827	8.4
373.11	4385	40494	0.47	12.215	10.7077
612.82	1509	23525	0.275	19.1268	16.7666
625.43	3355	29612	0.27	26.1	22.878
663.43	2784	14411	0.26	15.0431	13.1868
1551.33	16104	6819	0.1	121.9239	106.8785
Total				257.477	225.8787

Table 8: Total radiation exposure outdoor dose rate from soil and rock of Garmik town.

Peak Energy/KeV	Area under peak	Peak Back ground Area	efficiency	Dose nGy / hr	Dose mrad/ yr
11.66	309	10148	1	0.0418	0.0366
63.54	21747	92331	1	2.4774	2.172
78.29	23367	220299	1	6.5405	5.7335
93.54	15279	230630	1	7.8865	6.9133
107.18	7461	189206	1	7.227	6.3352
118.12	1160	77836	1	3.1992	2.8044
225.6	6564	76619	0.88	7.3115	6.4092
244.3	11683	69847	0.78	8.755	7.6746
345.43	4311	48900	0.54	11.6703	10.2302
369.52	2103	22452	0.47	6.619	5.8022
580	718	13646	0.28	10.2014	8.9425
608.99	4614	28434	0.275	25.092	21.9957
1431.86	10552	3917	0.11	64.5743	56.6058
1475.5	4995	4343	0.11	42.9451	37.6456
1477.35	19677	5949	0.11	118	103.4394
Total				322.541	282.7402

Table 9: radiation exposure outdoor dose rate of natural radionuclide from soil and rock of Sulaimani city -Sardarwa .

Radio nuclide	Spectra peak energy/KeV	NDS peak energy/KeV	Area under peak	Peak B.ground Area	Activity /Bq	Dose nGy/ hr	Half life
Xe^{133}	81.19	81	2623	38757	0.73	1.1518	5.24d
Ac^{228}	208.2	209.3	1032	18049	0.29	1.3621	$1.405*10^{10}$yr
Pa^{234}	227.43	226.9	658	11751	0.18	1.1	$4.468*10^{9}$yr
Br^{82}	555.6	554.3	1558	7066	0.43	4.8415	211.8m
TOTAL						8.4554	

Table 10 : radiation exposure outdoor dose rate of natural radionuclide from soil and rock of Garmik town.

Radio nuclid	Peak enrgy /KeV	NDS peak enrgy/KeV	Area U. peak	Peak B.ground Area	Activity /Bq	Dose	Half life
Ba^{133}	78.3	79.6	23367	220299	6.5	6.5405	10.5y
Pa^{234}	225.6	226.9	6564	76619	1.8	7.3115	$4.468*10^{9}$y
Kr^{89}	345.4	345	4311	48900	1.2	11.6703	3.16m
Bi^{214}	609	609.3	4614	28434	1.3	25.092	1600.01y
TOTAL						50.6143	

Table 11: radiation exposure outdoor dose rate of natural radionuclide from soil and rock of Tatan village.

Radio nuclide	Peak energy /KeV	NDS peak energy /KeV	Area Under peak	Peak B.Ground Area	Activity /Bq	Dose nGy/ hr	Half life
Th^{227}	49.8	50.2	7351	48162	2.0	0.9474	$7.038*10^{8}$y
Th^{232}	58.5	59	27860	165752	7.7	2.9135	$1.405*10^{10}$y
Pb^{212}	76.6	77.1	21886	268339	6.1	7.6251	$1.405*10^{10}$y
U^{235}	207	205.3	17689	120742	4.9	9.8218	$7.038*10^{8}$y
Rh^{105}	306	306.1	3590	49996	1.0	9.3705	2121.6m
Rb^{83}	530.3	529.6	1609	28475	0.45	16.5745	86.2d
Cs^{138}	545.2	546.9	351	28338	0.98	19.8467	32.2M
TOTAL						67.0995	

Table 12: radiation exposure outdoor dose rate of natural radionuclide from soil and rock of hangazhal village.

Radio Nuclide	Peak energy /KeV	NDS peak energy /KeV	Area Under peak	Peak B.ground Area	Activity /Bq	Dose nGy/ hr	Half life
Cs^{136}	66.4	66.9	27199	125395	7.6	3.4739	13.16d
Xe^{133}	82.65	81	27045	234601	7.5	7.4143	5.245d
Nb^{95M}	235.6	235.7	4218	74496	1.2	7.3087	5196m
Eu^{152}	246.1	244.7	12413	107979	3.4	13.0261	13.6y
Zr^{97}	355.4	355.4	1908	39776	0.53	9.5827	16.9h
I^{134}	623.4	621.8	3355	29612	0.93	26.1	52.6m
TOTAL						66.9057	

Discussion

The method which employed, in this work, is different radically from all previous works because the total outdoor gamma absorption dose has a large difference with total outdoor radionuclide absorption dose. The total outdoor absorbed dose in each area has different value which ranges from (226.1 to 322.5) nGy/hr as shown in Tables (5, 6, 7 & 8). This value is about six time more than local standard absorbed dose of Sulaimani city-Sardarawa (42.8) $nGy{\cdot}h^{-1}$. The local standard absorbed dose was close to the world standard outdoor dose which is about 44 $nGy{\cdot}h^{-1}$ (Daryoush, 2003). The total equivalent out door dose is ranged from 37.57 to 282.74 m rem /yr which are estimated from Tables (5,6,7 & 8) by using equation (10).This value was six times more than the world average of outdoor(terrestrial and cosmic) natural radiation (from 60 to160) m rem /yr (Michalis,2003) specially in Tatan, Hangazhal, Garmik(198.2,225.87, 282.74) m rem / yr.

The average fractional total radionuclide dose (FTRD) was about (22.76 %) of total outdoor absorbed dose (TOAD). The contribution of FTRD in Sulaimani city –Sardarawa was about 19.72% of the TOAD in the studied locations as shown in Tables (5,9) while that of Hangazhal- village was about 26 % of total outdoor absorbed dose in this location as shown in Tables (7, 12). The contribution of FTRD in Garmik –town was about 15.7 % of total outdoor absorbed dose in this location as shown in Table (8, 10). It is about 29.7 % of the TOAD in Tatan-village as shown in Tables (6, 11).

This work differs from previous ones by determining radionuclide or natural isotopes which are not exist in natural radioactive series. Their dose values is apart of the total dose value either in radionuclide dose or outdoor dose. Therefore more than half of the absorbed dose has been lost if compared with previous works as indicate bellow. The absorbed doses of

Xe^{133} and Br^{82} are about 73% of total radionuclide dose (TRD) in Sulaimani city –sardarawa. Each dose contributes in about 14 % and 59 % of TRD respectively as shown in Table 9. The absorbed dose of Ba^{133} and K^{89} are about 36 % of TRD in Garmik town, each of them contribute in about 13 % and 23 % of TRD respectively as shown in Table 10. The value for Rh^{105} , $Rb^{183}$and Cs^{138} are about 68.25 of TRD in Tatan-village and each of them contribute in about 14 % , 24.7 % and 29.6% respectively as shown in Table 11. However, Hangazhal-village didn't contained a natural radionuclide series elements. But it is containing other natural radionuclide like Cs^{136}, Xe^{133} , Nb^{95M} , Eu^{152} , Zr^{97} and I^{134} which are contributing in about 5.2 % , 11.0 % , 10.9 % ,19.6%, 14.3 ,and 39 % respectively as shown in Table 12.

Further more, the natural radioactive series are calculated which is a contribute in total outdoor absorbed dose (TOAD); The U^{238} and Th^{232} are found in Sulaimani city –Sardarawa with dose rate ١,٣٦ $nGy{\cdot}h^{-1}$ and 1.1 $nGy{\cdot}h^{-1}$ which are equal to 16.1 % and 13 % of TRD in Sulaimani city–Sardarawa respectively as shown in Table 13. The $U^{235}$and Th^{232} are found in Tatan village with dose rate ١٠,٧٧$nGy{\cdot}h^{-1}$, ١٠,٥٤ $nGy{\cdot}h^{-1}$ which were equal to 16 % and 15.7 % of TRD in Tatan village respectively as shown in Table 13 .The U^{238} has been found in Garmik town with dose rate ٣٢,٤ $nGy{\cdot}h^{-1}$equal to 64%of TRD in Garmik town as shown in Table 13.

Table 13: Th^{232}, U^{238}, U^{235}dose ratio from soil and rock of all studied area.

Th^{232}			U^{238}		U^{235}	
Area	Dose	Its ratio of radionuclei	Dose	Its ratio of radionuclei	Dose	Its ratio of radionuclei
	nGy/hr	dose	nGy/hr	dose	nGy/hr	dose
Sulaimani city-Sardarawa	1.36	16.1%	1.1	13%	---------	-------------
Tatan village	10.54	15.7%	--------	-----------	10.77	16%
Garmik village	-------	----------	32.4	64%	---------	-------------

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تحديد الجرعة الأشعاعية للنظائر الطبيعية و نواة مشعة خارج الباب ذو العد العالي لمنطقة كرمك شمال شرقي اقليم كردستان – العراق.

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الخلاصة

توجد المواد المشعة ذو العد العالي في بعض مناطق بلدان العالم ، هذه المواد توجد بنسب ملحوظة في الصخور التي يستخدم كمواد اساسية في البناء.الجرعة الاشعاعية في منطقة كرمك تقدر بحوالي nGy/h ٢٦٨,٦ .تمّت دراسة خلفية اشعاعية كاما خارج الباب لبعض مناطق كرمك للحصول على جرعة كاما الممتصة من تربة وصخور جبال المنطقة .
لقد سجل الطيف الكامي لبعض المواقع في منطقة كرمك بواسطة المنظومة المتقدمة لقياس الأشعة النووية والتي تتكون من المحلل المطيافي الرقمي DSA مع الكاشف الوميضي NaI(Tl) . هذه الطريقة تتناسب جيدا مع جرعة كاما خاج الباب لأنه يسجل اكثر العد الكامي وهذا يفيد لتحديد كمية اشعاع كاما التي يتعرض لها لأنسان .تمّ استخدام صيغة جديدة لحساب الجرعة الاشعاعية. تقدر الجرعة الأشعاعية لمنطقة مدينة السليمانية ب nGy/h ٤٢,٨٧٣ و التي نعتبرها كالجرعة الأشعاعية الأعتيادية المحلية .
تم الحصول على الجرعة النسبية الاجمالية لمدينة السليمانية التي تقدر بـnGy/h ٤٢,٨٧٣ والتي اعتبرت كالجرعة خارج الباب الاعتيادية المحلية . و قيمة معدل الجرعة الاشعاعية الخلفية خارج الباب للنماذج في المواقع تاتان ،هنكزال ،كرمك حوالي nGy/h (٢٢٦,١٠٠٥،٢٥٧,٤٧٧،٣٢٢,٥٤١) بشكل متتالي.هذه القيم تقريبا أكثر من قيم الجرعة الاشعاعية الخلفية خارج الباب لمنطقة الجرعة الاعتيادية المحلية لمدينة السليمانية بست مرات.
ولقد تم الحصول على نسبة الجرعة الاشعاعية الخلفية لنواة مشعة داخل السلاسل الاشعاعية الطبيعية بحوالي nGy/h (٥٠,٦١٤٣، ٦٦,٩٠٥٧، ٦٧,٠٩٩٥، ٨,٤٥٥٤) لمدينة السليمانية ،تاتان ،هنكزال و كرمك بشكل متتالي . وايضا لقد تم استنتاج النسبة المئوية للجرعة الاشعاعية الخلفية للنواة المشعة التي تعود داخل السلاسل الالشعاعية الطبيعية (٢٢,٧٦%) من الجرعة الاشعاعية الكلية في تلك المناطق .