Assessment of the Natural Radioactivity and its Radiological Hazards in Stream Sediments at Gulf of Al Aqaba, Sinai, Egypt.

M.E. Ibrahim [1],N. Walley El-Dine[2], A. EL-Shershaby[2], S.M. EL-Bahi [2] and N. Ali [2]

[1]Nuclear Material Authority, Egypt.
[2] Faculty of women for Arts, Science and Education, Ain Shams University, Cairo, Egypt.

Abstract

Specific activities and distribution of natural radionuclides gamma emitting from^{238}U, ^{232}Th and ^{40}K in stream sediment samples were calculated. The samples were collected from different locations from western port of Gulf of Al- Aqaba have been carried out using the high-purity germanium (HPGe) detector. The activity concentrations of most samples are higher than the permissible level for ^{238}U, ^{232}Th and ^{40}K. The radium equivalent (Ra_{eq}), the external hazard index (H_{ex}) and effective dose rate were estimated for the radiation hazard of the natural radioactivity. The calculated values are higher than the recommended limit. The harmful radiation effects are posing to the public and tourists going to the area under investigation.

Also the specific activities of the samples were calculated using radiometric analysis with NaI(TI) detector, the obtained results from the two techniques confirmed each other. Consequently, this area is not safe for use as different activities.

Keywords: Stream Sediment/ Natural Radioactivity/ (HPGe) Detector / NaI (TI)Scintillation Detector.

1. Introduction

The assessment of gamma radiation dose from natural sources is of particular importance, the natural radiation is the largest contributor to the external dose of the world population. These doses vary depending upon the concentrations of the natural radionuclides, ^{238}U, ^{232}Th, their daughter products and ^{40}Kpresent in the soil and rocks, which in turn depend upon the local geology of each region in the world (Ahmed, 1985) (El-Shishtawy, 1989).

Most of the dose rate of natural radioactivity is due to the effect of primordial radionuclides, although the values take into account the contributions from cosmic radiation and cosmogenic radionuclides.

In fact, only about 15% of the total effective dose equivalent derives from exposure to cosmic radiation, and about 0.6% is attributable to cosmogenic radionuclides. The

Corresponding author. E-mail: nadia_walley5@hotmail.com

members of the radioactive decay chains of ^{232}Th (14%), ^{235}U and ^{238}U (55.8 %), along with ^{40}K (13.8%) are responsible for the main contributions to the dose from natural radiation, while a 0.3%is due to the effect of ^{87}Rb (Higazy. et al, 1992).

In the recent years, studies on high natural background radiation areas in the world have been of prime importance for risk estimation due to long – term low – level whole body radiation exposure to the public. With the increased public concern over radiation safety, the studies on natural background radiation areas provide a good scope for evaluating biological effects caused by low – level radiation exposure on a long – term basis (Abass, 2008)

The main target of the present work focuses on the environmental assessment of radioactive potential in the stream sediments (Saleh, 2006) (El- Wahab et al, 2011). Determination and evaluation of the radionuclides concentration are of great importance for assessment of external and internal radiation dose received by man.

2. Materials and Methods

2.1 Sampling location

The study area is part of south eastern Sinai, Egypt, western coastal zone of Gulf of Aquba. The area of study is drained by Wadi Lethel, Wadi Zewarai (trending NW-SE), Wadi Tarter and Wadi Um Adawi (trending E-W).They are bounded by Gabal El Gofa and Gabal Zewarai representing the basement rocks in the study area Fig. (1). At the southeastern port of the mapped area (Sharm El- sheik city).

Miocene sedimentary rocks (carbonate rocks) cover the downstream of the main wadis in close contact of the Gulf of Al-Aqaba are common. Although some geological and geochemical studies have been carried out on the basement rocks (Ahmed, 1985) (Saleh, 2006).

Fig. (1): Photogeologic map showing the Location of the stream samples.

2.2 Sample and Sampling Preparation

Thirty-three stream sediment samples were collected from different locations from western port of Gulf Al-Aqaba as shown in fig. (1). Each sample was weighted then placed in polyethylene bottle of 150 cm^3. The bottles were completely sealed for more than month to allow radioactive equilibrium to be reached between ^{238}U and^{232}Th and their corresponding daughters to be measured by gamma spectroscopy. This step was necessary to ensure that radon gas is confined within the volume and the daughters will also remain in the sample (Ahmed, 1985). The individual samples were placed on the detector manually during the work and each sample was analyzed for a time of 70000 seconds to obtain the gamma spectrum with good statistics. The gamma emitting radionuclides specifically recorded were ^{238}U, ^{232}Th, ^{226}Ra and ^{40}K.

2-3 Experimental Technique for Hyper Pure Germanium detector (HPGe)

Gamma spectrometry measurements were performed using a high purity coaxial germanium detector (HPGe), (ORTEC 572 A) of sensitive volume of 76.11 cm^3. The energy resolution of HPGe detector was 1.9 KeV at 1332.5 KeV gamma ray line of ^{60}Co. The quantitative analysis was achieved by using a maestro H- EG&G card which was interfaced with IBM Pc compatible to work as a multichannel analyzed (MCA). All The gamma measurements were taken after calibrating the MCA with: Co-60, Am-241 and Ra-226 point sources.

The efficiency curve of the HPGe detector in the energy range from 186KeV to 2450KeV was obtained through two stages. In the first stage the relative efficiency curve was obtained for two different stages. First, the relative efficiency curve of the detector was performed using a Ra-226 point source. In the second stage, the average relative curve of the detector was normalized to an absolute efficiency curve for certain geometrical configuration and normalization factor for these geometries (polyethylene bottles) have been determined. For this purpose standard solution of potassium chloride has been used (El-Tahawy. et al, 1992).

The γ- ray lines used to measure the activities of the studied isotopes are as follows (EML, 1990) (Beretka. and Mathew, 1985) (Merdano., and Altnsoy., 2006)

For the uranium- series, ^{214}Pb (351.9 KeV), ^{214}Bi (609.3, 768.4, 934.1, 1120.3, 1238.1 and 1764.8) KeV respectively and ^{226}Ra (186.2 KeV).

1) For thorium- series, ^{228}Ac (209.5, 338.5, 463.0, 911.1 and 968.9) KeV, ^{208}Ti (583.1, 860.1 and 2614.7) KeV and ^{212}Bi (727.2, 785.4 and 1620.6) KeV.
2) ^{40}K (1460.8) KeV for natural potassium.

The detector was surrounded by a lead cylindrical shield to eliminate the contribution of naturally occurring background radionuclides in the environment. However, an empty bottle with the same geometry was measured for subtracting the background to have more accurate results.

2.4 Radioactivity Counting

The counting time for each sample was nearly 70000 sec. The net area count after background corrections in each photo peak was used in the computation of activity concentration $C(Bq/Kg)$ for each of the radionuclides in the samples using the expression (UNSEAR, 2000)

$$C\ (Bq/Kg^{-1}) = \frac{C_a}{\varepsilon I M_s}$$

Where $C_a$the net count rate under each is photo peak due to each radionuclide, ε is the detector efficiency for the specific γ- ray, I is the reference intensity of the gamma line in a radionuclide and M_s is the mass of the sample (Kg). The lowest limits of detection (LLD_s) were obtained from the relation (Matoline., 1991)

$$LLD_s = \frac{4.66\ S_b}{\varepsilon \times I_\gamma}$$

Where S_b is the estimated standard error of the net background count rate in the spectrum of radionuclide. ε is the counting efficiency and I_γ is the abundance of gamma emissions per radioactive decay. The LLD_s values obtained were 0.20, 0.23 and 1.13 $Bq/Kg^{-1}$for, ^{238} U, ^{232}Th and^{40}K respectively.

3] Results and Discussion of Hyper Pure Germanium Detector (HPGe)

The concentrations and distribution of radionuclides in a stream sediment sample at west of Gulf Al-Aqaba, Sinai, have been determined using high-resolution gamma spectrometry to evaluate the environmental radioactivity.

The mean activity concentrations of ^{238}U, ^{226}Ra, ^{232}Th and ^{235}U were vary between (25.7 and 11511.6), (23.51 and 13546.57), (12.87 and 2633.30) and (2.03 and 647.63) Bq/Kg respectively, which represent the lowest and highest value in the studied samples respectively. While the concentration of ^{40}K is varying between (149.35 and 5516.98 Bg/Kg) which represent the lowest and highest value in the samples as shown in Table (1).

It clear that, the concentration of studied samples are higher than the permissible levels [50 (Bq/Kg)] for uranium except samples numbers (5 and 6). The concentration of most samples are higher than the permissible levels [50 (Bq/Kg)] for thorium except samples 5, and 6 whereas the concentration of most samples are higher than the permissible levels [500 (Bq/Kg)] (UNSEAR, 2000) for potassium except samples numbers 2, 3, 5,6,7,8, 9, 11, 13, 14, 15, and 29 respectively as shown in Fig.(1).

Table (1): The concentration of ^{238}U, ^{226}Ra, ^{232}Th, ^{40}K and ^{235}U in (Bq/kg), west of Gulf Al-Aqaba, Sinai, Egypt.

Sample	^{238}U	Ra-226	^{232}Th	^{40}K	^{235}U
1	10481.87	13546.57	2633.30	722.70	647.63
2	11511.56	13219.51	2406.26	356.32	599.52
3	8032.74	9289.97	1596.70	260.76	423.74
4	107.565	64.73	74.67	783.71	ULD
5	28.465	26.32	14.37	280.94	2.03
6	25.7	23.51	12.87	259.42	2.42
7	1419.635	1708.21	284.20	202.63	46.40
8	2223.61	2617.28	418.31	149.35	124.95
9	1786.55	2160.44	325.53	199.08	100.82
10	3000.51	3978.24	589.55	740.47	146.92
11	2653.655	2958.37	492.63	265.51	142.43
12	3754.34	4600.71	579.23	610.23	204.31
13	493.055	580.82	90.48	392.86	81.67
14	325.19	471.66	359.90	310.99	20.50
15	367.145	460.99	90.72	430.87	21.84
16	5725.585	7370.99	558.84	5516.98	347.20
17	2254.575	2630.98	256.53	1135.59	116.81
18	1509.165	1808.83	157.93	1783.62	74.92
19	873.015	1056.71	140.47	1864.45	69.10
20	662.69	867.42	104.59	1141.84	35.29
21	667.665	909.75	106.18	1673.20	43.65
22	1876.615	2385.04	498.65	2095.45	85.29
23	1079.76	1266.1	256.95	1010.26	51.17
24	1230.07	1508.06	241.77	1464.85	60.54
25	626.27	784.65	138.47	1926.79	54.76
26	607.7115	837.91	125.94	956.95	42.58
27	503.135	718.81	98.66	1026.61	26.21
28	543.155	576.91	477.91	879.66	78.20
29	359.445	450.82	331.07	276.36	19.66
30	552.84	656.39	397.99	538.93	46.46
31	628.59	880.34	288.67	2089.82	61.34
32	362.405	503.68	217.46	747.86	20.12
33	392.01	536.14	194.27	1182.92	24.67

The radionuclides concentration of ^{238}U series, ^{232}Th series in (ppm) and ^{40}K in wt % for the studied samples at west of Gulf Al-Aqaba, Sinai, Egypt, show that the concentration of ^{238}U, ^{232}Th and ^{40}K are varying between (2.08 and 933.17 ppm), (3.15 and 645.42 ppm) and (0.48 and 17.70%) respectively (Table 2). All samples are lower than Clark's value (3.5) which is representing the ratio between ^{232}Th and ^{238}U, (U – enrichment).

In this study, we calculate the radiological parameters such as indices: radium equivalent activity in (Bq/Kg), indoor absorbed gamma dose rate (nGy/h), external hazard index , effective dose rate and radioactivity level index for all stream sediment samples from west of Gulf Al-Aqaba, Sinai. These parameters are showing in (Table 3).

We concluded that all the values of radium equivalent of the samples at West of Gulf Al-Aqaba, Sinai are higher than the recommended maximum value 370 Bq/Kg (UNSEAR, 2000)· Except sample (4, 5, and 6) Also we note that the average values of dose rate for the samples are higher than the international average mean value 59 (UNSEAR, 2000) nGy/h except samples (5 and 6).

The calculated values of the external hazard index are found to be more than unity except sample (4, 5, and 6). The values of the effective dose rate are in the permissible level (1 m Sv/y) (ICRP,1991) except sample (1,2,3,8,9,10,11,12,16,17 and 22) as shown in Fig. (2) and the value of radioactivity level index (Iγ) is found to be more than unity except samples (5 and 6).

Table (2): Activity concentration of ^{238}U series, ^{232}Th series in (ppm), ^{40}K in (%) at west of Gulf Al- Aqaba, Sinai, Egypt.

Sample No.	^{238}U	^{232}Th	^{40}K%	^{232}Th / ^{238}U
1	849.7	645.42	2.32	0.76
2	933.17	391.35	0.84	0.42
3	651.16	589.77	1.14	0.91
4	8.72	18.30	2.51	2.1
5	2.31	3.52	0.90	1.53
6	2.08	3.15	0.83	1.51
7	115.08	69.66	0.65	0.61
8	180.25	102.53	0.48	0.57
9	144.82	79.79	0.64	0.55
10	243.23	144.50	2.38	0.59
11	215.12	120.74	0.85	0.56
12	304.34	141.97	1.96	0.47
13	39.97	22.15	1.27	0.55
14	26.36	88.21	1.00	3.35
15	29.76	22.23	1.38	0.77
16	464.14	136.97	17.70	0.3
17	182.76	62.88	3.64	0.34
18	122.34	38.71	5.72	0.32
19	70.77	34.43	5.98	0.49
20	53.72	25.63	3.66	0.48
21	54.12	26.02	5.37	0.48
22	152.13	122.21	6.72	0.80
23	87.53	62.98	3.24	0.72
24	99.71	59.26	4.70	0.59
25	50.77	33.94	6.18	0.67
26	49.26	30.87	3.07	0.63
27	40.79	24.18	3.29	0.59
28	44.03	117.14	2.82	2.66
29	29.14	81.15	0.89	2.79
30	44.82	97.55	1.72	2.18
31	50.96	70.75	6.70	1.39
32	29.38	53.30	2.40	1.81
33	31.78	47.61	3.80	1.4

Table (3): The values of radium equivalent in (Bq/kg), dose rate in (nGy/h), external hazard, effective dose rate (mSv/y) and radioactivity level index, at west of Gulf Al-Aqaba, Sinai, Egypt.

Sample	Ra_{eq}	H_{ex}	I_{γ}	D_R	E_{ff}
1	1736.84	46.93	117.6	6250.08	7.67
2	16687.9	45.09	112.9	6523.71	8.00
3	11593.3	31.33	78.38	4498.21	5.52
4	231.86	0.63	1.71	129.06	0.16
5	68.5	0.19	0.51	33.75	0.04
6	61.88	0.17	0.46	30.65	0.04
7	2130.22	5.76	14.42	803.04	0.99
8	3226.96	8.72	21.82	1232.83	1.51
9	2641.28	7.14	17.86	986.92	1.21
10	4878.31	13.18	33.05	1703.34	2.09
11	3683.28	9.95	24.93	1470.65	1.80
12	5475.99	14.8	37.03	2012.79	2.47
13	740.46	2	5.06	287.33	0.35
14	1010.26	2.73	6.967	390.48	0.48
15	623.89	1.69	4.284	235.36	0.29
16	8594.94	23.23	58.67	3052.01	3.74
17	3085.26	8.34	20.95	1181.36	1.45
18	2172.01	5.87	14.89	825.66	1.01
19	1401.15	3.79	9.73	545.94	0.67
20	1104.91	2.99	7.62	401.31	0.49
21	1190.42	3.22	8.28	427.33	0.52
22	3259.46	8.81	22.37	1221.53	1.50
23	1711.33	4.62	11.73	674.6	0.83
24	1966.59	5.31	13.5	748.28	0.92
25	1131.03	3.06	7.93	441.94	0.54
26	1091.69	2.95	7.52	384.01	0.47
27	938.94	2.54	6.49	324.3	0.40
28	1328.06	3.59	9.23	586.13	0.72
29	945.53	2.55	6.52	384.54	0.47
30	11267.0	3.42	8.74	522.71	0.64
31	1454.05	3.93	10.19	549.37	0.67
32	872.23	2.36	6.05	330.86	0.41
33	905.03	2.45	6.33	346.86	0.43

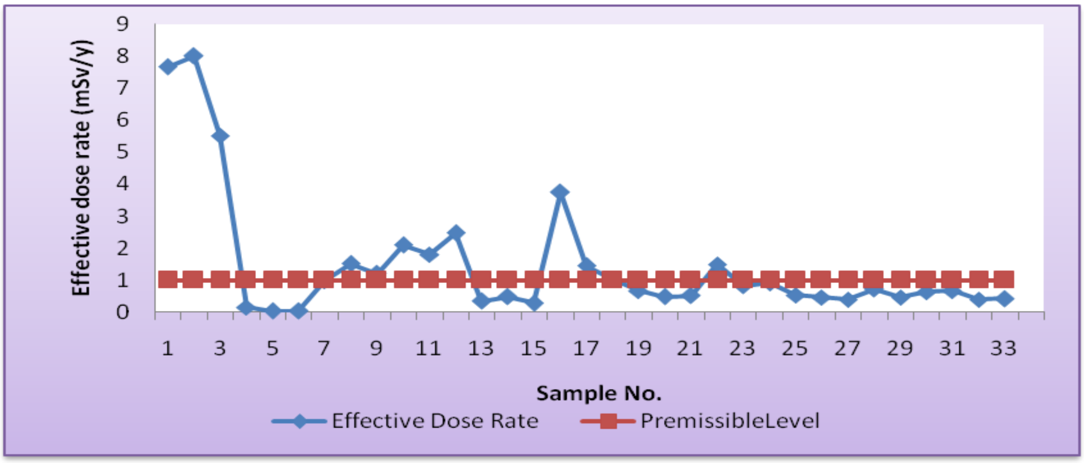

Fig. (2): Showing the values of effective Dose Rate, west of Gulf Al-Aqaba, Sinai, Egypt.

4.1] Experiment set up for the Radiometric Analysis with the NaI (TI) detector:-

The radiometric measurements achieved with the NaI (TI) – detector were used for quantitative determination of the radioactive elements; U, Th, Ra and K in the collected samples. This was mainly based on detection of the gamma-ray in four energy regions of interest (ROI's) representing Th-234, Pb-212, Pb-214 and K-40 daughters respectively. Each sample is crushed to about 1 mm mesh grain size and mixed well to avoid the non- homogenous distribution of minerals. Then a proper weight (300-350 gm) of the crushed sample is placed in plastic container, sealed well and left for at least 30 days to accumulate free radon and to attain radioactive equilibrium. The relation between the percentage of Rn -222 accumulation and time increases till reaching the steady state after about 30 days (Matoline., 1991).

The instrument is energy calibrated using two gammas ray emitting sources (Co-57 and Cs- 137) and then its sensitivity is calibrated using four artificial standard sources (NMA- U, IAEA- Ra, IAEA- Th and IAEA- K) (Cachran., 1992).

The concentrations of natural radioelement; potassium, uranium and thorium in the investigated area were used for calculating the specific activity, exposure rate and equivalent dose rate.

The conversion factor recommended by (IAEA, 1989) is given in (Table 4).

.

Table (4):- conversion of radioelement concentration to specific activity

1% K in rock	**= 313 (Bq/ Kg)**	**^{40}K**
1ppm U in rock	**=12.35 (Bq/ Kg)**	**^{238}Uor ^{226}Ra**
1ppm Th in rock	**= 4.06 (Bq/ Kg)**	**^{232}Th**

The total exposure **E** in (μR/h) and the dose rate in (nG/h) are given by (NEA, 1991) (UNSCEAR, 1993)

$$\mathbf{E=0.653\times eU+0.287\times eTh+1.505\times K\%}$$

$$D_{\alpha}\mathbf{=Exposure\ rate\ \times 8.69\ (nGy/h)}$$

Effective dose is a sum of multiplies of equivalent doses affect on human organs concerning weighting factors. Effective dose is expressed in msv and usually reported annually (per year: y = 8760 h)

$$E=\frac{Doserate(nGy/h)\times 8760\times 0.7}{1000000}\times 0.2$$

Where 0.7 X 10^{-6} is the conversion coefficient (Sv/Gy) for human organs (UNSEAR, 2000) .

4.2] Results and Discussion of NaI (TI) Spectroscopy

The results of radiometric analysis of 33 stream sediment samples at west of Gulf Al- Aqaba, Sinai, Egypt are given in Table (5), show eU, eTh and Ra with (ppm) also%.

The calculated specific activity for the K, U and Th measurements at west of Gulf Al- Aqaba, Sinai, Egypt in Table (5) where the lowest value of K- specific activity is ULD while the highest value is 2147.18 Bq/ Kg with the average 578.96, referring to the low content of potassium which can be neglected because its low effective energy as well as potassium have only one radioactive isotope "^{40}k" represent > 0.012% of the natural potassium.

On the other hand, the average value of U- specific activity is 1444.95 Bq/ Kg while the average value of Th- specific activity is 323.08 Bq/ Kg. The U and Th specific activities calculations higher than the permissible limits (50, 50, and 500) (UNSCEAR. 1993) except samples No. 4, 5, 6, and 27 for U specific activity. Samples No. 4, 5, 6, 13, 16, 19, and 25 for Th specific activity. Samples No. 1, 2, 3, 5, 6, 8, 9, 11, 12, 14, 17, 27, 29 and 30 for K specific activity. The comparison between the calculated specific activities of west of Gulf Al- Aqaba, Sinai, Egypt and the international permissible limits for U, Th and K respectively. The calculated exposure rate, dose rate and effective dose for the K, U and Th measurements in west of Gulf Al- Aqaba, Sinai, Egypt in Table (6).

The average calculated value of the effective dose rate in west of Gulf Al- Aqaba, Sinai (1.09 mSv/y)) is higher than the permissible limit "1 mSv/y" that recommended by the International Commission Radiological Protection (ICRP, 1991) as the maximum annual dose to the public members.

The comparison between the calculated effective dose rate and the International permissible limit is shown in (Fig. 3).

From these results we find that west of Gulf Al- Aqaba, Sinai, Egypt is considered not safe region from the environmental and radioactive pollution.

Table (5): The calculated specific activities for the K, U and Th measurements (in Bq/kg) at west of Gulf Al- Aqaba, Sinai, Egypt.

Sample No.	K(%)	eU (ppm)	eTh (PPm)	K- Specific Activity	U- Specific Activity	Th- Specific Activity
1	ULD	456	420	ULD	5187	1851.36
2	0.37	589	687	115.81	8484.45	2391.34
3	ULD	390	25	ULD	308.75	1583.4
4	3.17	ULD	ULD	992.21	ULD	ULD
5	0.75	4	ULD	234.75	ULD	16.24
6	0.32	3	1	100.16	12.35	12.18
7	2.03	38	245	635.39	3025.75	154.28
8	ULD	82	182	ULD	2247.7	332.92
9	ULD	53	141	ULD	1741.35	215.18
10	4.48	64	175	1402.24	2161.25	259.84
11	ULD	126	206	ULD	2544.1	511.56
12	ULD	83	313	ULD	3865.55	336.98
13	4.07	9	70	1273.91	864.5	36.54
14	0.92	18	39	287.96	481.65	73.08
15	1.62	15	38	507.06	469.3	60.9
16	3.4	ULD	184	1064.2	2272.4	ULD
17	1.52	42	148	475.76	1827.8	170.52
18	2.85	20	85	892.05	1049.75	81.2
19	1.89	ULD	118	591.57	1457.3	ULD
20	3.08	24	58	964.04	716.3	97.44
21	2.82	21	62	882.66	765.7	85.26
22	6.86	32	100	2147.18	1235	129.92
23	3.8	76	51	1189.4	629.85	308.56
24	2.63	34	81	823.19	1000.35	138.04
25	1.84	ULD	58	575.92	716.3	ULD
26	2.45	27	46	766.85	568.1	109.62
27	0.98	30	ULD	306.74	ULD	121.8
28	1.94	77	36	607.22	444.6	312.62
29	0.11	74	38	34.43	469.3	300.44
30	ULD	110	68	ULD	839.8	446.6
31	1.63	40	112	510.19	1383.2	162.4
32	1.87	46	34	585.31	419.9	186.76
33	3.64	43	40	1139.32	494	174.58
Average				578.96	1444.95	323.08

Table (6): Exposure rate, dose rate and effective dose for the K, U and Th measurements, in west of Gulf Al- Aqaba, Sinai, Egypt.

Sample No.	Exposure	Dose Rate	Effective
1	405.132	3520.597	4.32
2	618.2109	5372.252	6.59
3	128.255	1114.536	1.37
4	4.77085	41.45869	0.05
5	2.27675	19.78496	0.02
6	1.9956	17.34176	0.02
7	173.9462	1511.592	1.85
8	142.38	1237.282	1.52
9	107.284	932.298	1.14
10	139.3854	1211.259	1.49
11	170.68	1483.209	1.82
12	228.21	1983.145	2.43
13	54.41835	472.8955	0.58
14	32.0176	278.2329	0.34
15	31.5571	274.2312	0.34
16	125.269	1088.588	1.34
17	110.9856	964.4649	1.18
18	65.53425	569.4926	0.70
19	79.89845	694.3175	0.85
20	49.3974	429.2634	0.53
21	50.7571	441.0792	0.54
22	84.8083	736.9841	0.90
23	60.834	528.6475	0.65
24	66.60915	578.8335	0.71
25	40.6432	353.1894	0.43
26	41.47425	360.4112	0.44
27	10.0849	87.63778	0.11
28	48.5267	421.697	0.52
29	46.21755	401.6305	0.49
30	75.974	660.2141	0.81
31	87.06915	756.6309	0.93
32	38.21835	332.1175	0.41
33	43.9392	381.8316	0.47
Average	102.023	886.5802	1.09

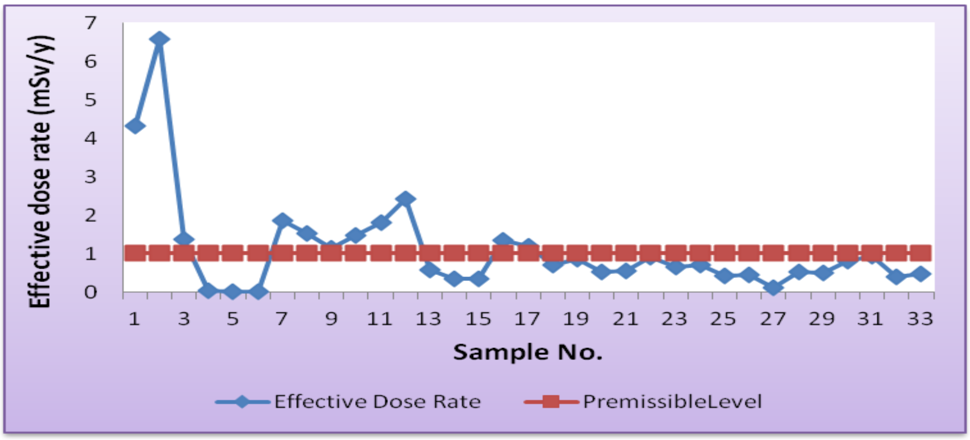

Fig. (3): The comparison between the calculated effective dose rate in mSv/y and the international permissible limit, west of Gulf Al- Aqaba, Sinai, Egypt.

Conclusion

Specific activities distribution of natural radionuclide of γ-ray activities produced by ^{238}U, ^{226}Ra, ^{232}Th and ^{40}K were determined in 33 stream sediments samples were collected from different locations from western port of Gulf of Al-Aqab. The activity concentrations in bulk samples for ^{238}U, ^{226}Ra, ^{232}Th and ^{235}U were vary between (25.7 and 11511.6), (23.51 and 13546.57), (12.87 and 2633.30) and (2.03 and 647.63) Bq/Kg respectively. While the concentration of ^{40}K is varying between (149.35 and 5516.98 Bg/Kg).

Also we note that the average values of dose rate for the samples are higher than the international average mean value 59 nGy/h. The calculated value of effective dose rate in the present study is higher than the permissible level (1mSvy^{-1}). On the basis of higher levels of natural radioactivity and gamma- absorbed dose rates in this area, stream sediments at Gulf of Al-Aqab, Sinai can be considered as a high natural background radiation area. The hazard index for the critical area seems to be extremely high and is not safe. Also radiometric measurements achieved with the NaI(TI) detector were used. The estimated effective dose rate is higher the permissible level. The results show that the gamma spectroscopic and the radiometric techniques confirm each other.

It is concluded that harmful radiation effects are pose to the public and tourists going to this area as a result of the activity of stream sediments.

Acknowledgements

The authors are grateful to the nuclear physics laboratory, faculty of women for arts, science and education, Ain Shams University, for the provision of laboratory facilities. Thanks are also extending to Nuclear Material Authority for their kind assistance in samples analysis.

References

Abass, A.A.,: Geology and radioelements distribution in the basement rocks of W. Um Adawi area, South Sinai, Egypt. Unpublished Ph.D thesis, faculty of sci. Ain Shames Univ.(2008).

Ahmed, A.M.: Geological studies of some granitic rocks around W. Um Adawi, Southeastern Sinai, Egypt. Unpublished Ph.D. thesis, Al Azhar Univ. Cairo,164.,(1985).

Beretka. J., Mathew. P. J., “Natural radioactivity of Australian building materials, industrial wastes and byproducts. Health Physics 48, pp: 87–95., (1985).

Cachran. J. K., "Applications to Earth., Marine and Environmental sciences"., M. Ivanovich., and R.S Harmon (Eds)., Clarendon press., Oxford., p. 334., (1992).

El-Shishtawy, Y.A.,:P gases of dykes intrusion in the granitic rocks of Southern Sinai, Egypt. Earth Science. Serial, Vol.3, 43-57.,(1989).

El-Tahawy. M. S., Farouk. M. A., Hammad. H. F., and Ibrahim. N. M., "Natural Potassium as A standard source for the Absoulte Efficiency Calib.of Ge Detector", Nucl.Sci.J.29, p. (361), (1992).

El- Wahab. M. A., Madkour. H. A., and El Saman. M. I., "Impact of anthropogenic activities and natural inputs on oceanographic characteristics of water and geochemistry of surface sediments in different sites along the Egyptian Red SeaCoast"., African Journal of Environmental Science and Technology No. 7., V. 5., pp: 494-511., July (2011).

EML., "Environmental Measurements Laboratory USA", Department of Energy, Nov. (1990).

Higazy, M., Abd El Tawab, M. and Ahmed, M.,: Geology of W. Um Adawi granitoids Southeastern Sinai, Egypt. Annals Geological Survey Egypt.Vol.XVIII, 39-43.,(1992).

IAEA., (International Atomic Energy Agency)., Contraction and use of calibration Facilities for radiometric field equipment. Technical Report Series No. 309., IAEA., Viennna., (1989).
ICRP, (International Commission on Radiological Protection)., Recommendations of ICRP Publication 60, Annals of the ICRP, Pergamon Press, Oxford., (1991).

Matoline. M., Laboratory of Gamma- ray spectroscopy, N.M.A., "Republic of Egypt"., Project E /4 /b030- 03., IAEA., (1991).

Merdano˘glu. M., and Altnsoy. N., "Radioactivity concentrations and dose assessment for soil samples from Kestanbol granite area".,Turkey. Radiation Protection Dosimetry 121 (No. 4)., Dosimetry 125 (1–4)., pp: 444–448., (2006).

NEA., (Nuclear Energy Agency)., " Exposure to radiation from radioactivity in building materials"., Report by NEA., Grop of Experts., OECD., Paris., (1991).

Saleh, M.M: Geological and radioactive studies on the granitoids rocks, North Ras Mohammed area, South Sinai, Egypt. Faculty of science Suez Univ., Unpublished Ph.D.(2006).

UNSCEAR. United Nations Scientific Committee on the Effects of Atomic Radiation (2000), Sources and effects of ionizing radiation. Report V. 1 to General Assembly, with Scientific Annexes (NY)., (2000).

UNSCEAR United Nations Scientific Committee on the Effects of Atomic Radiation. "Exposure from natural sources of radiation". Report to the General Assembly, 48rd Session. New York: United Nations (1993).

الملخص باللغة العربية

تقييم المخاطر الإشعاعية الناتجة عن النشاط الإشعاعى الطبيعى فى العينات الرسوبية فى خليج العقبة، سيناء، مصر"

محمد الأحمدى إبراهيم[1]، نادية ولي الدين[2]، امال الشرشابى[2]، ساميةمحمد البهي[2]،نيفين على

1- هيئة المواد النووية.
2- معمل الطبيعة النووية – كلية البنات للأداب و العلوم و التربية- جامعة عين شمس.

تم قياس تركيز أشعة جاما الطبيعية التى تنبعث من اليورانيوم- 238والثوريوم- 232 والبوتاسيوم-40لعينات رسوبية من خليج العقبة- سيناء بإستخدام كاشف الجيرمانيوم عالى النقاوة. وقد وجد أن معظم العينات أعلى من المسموح به عالمياً. تم حساب نشاط الراديوم المكافىء (Ra_{eq}) وأيضاً حساب معامل الإخطار الخارجى (H_{ex}) وكذلك معدل الجرعة الإشعاعية التى يتعرض لها الإنسان فى البيئة. وقد وجدت كل هذه العوامل أعلى من المسموح به عالمياً 0تم أيضا حساب تركيز العناصر بإستخدام كاشف الصوديوم وعمل مقارنة بين إستخدام كاشف الجيرمانيوم وأيضاً كاشف الصوديوم وقد وجد أن النتائج للطريقتين متطابقتين وبالتالى المنطقة تحت الدراسة ذات تأثير اشعاعى ضار للجمهور والسياح القادمين إلى هذه المنطقة.