Study of the Natural Radioactivity of Selected Samples of the Oil of Al-Nada District in Najaf

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Abstract

This study reported activity concentration of 238 U, 232 Th, 40 K in 50 soil samples AL-Nada district - Najaf Governorate - Iraq Measurement using gamma ray spectrometer NaI (TI) (3x3). The activity concentrations of natural radionuclides are found to range from (31.319±0.741) Bq.Kg-1 to (1.1583 ± 0.0821) Bq.Kg-1with average (11.851±0.281) Bq.Kg-1 of uranium ^{238}U. From (1.117±0.048) Bq.Kg-1 to (23.948±0.649) Bq.Kg-1 with an average of (6.283±0.148) Bq.Kg-1 for thorium ^{232}Th,.from(13.592±0.282) Bq.Kg-1 to (705.834±6.179) Bq.Kg-1 and average (265.494±1.445) Bq.Kg-1 potassium^{40}K , equivalent radium from (12.489 ± 0.328) Bq.Kg-1 to (84.199 ± 1.911) Bq.Kg-1 and average (40.078±0.564) Bq.Kg-1 , internal hazard index from (0.039) Bq.Kg-1to(0.256) Bq.Kg-1 and average(0.139) Bq.Kg-1,external hazard index ranged from(0.033) Bq.Kg-1 to (0.227) Bq.Kg-1 and average(0.108) Bq.Kg-1 values either of absorbed dose in air from (5.728±0.150) nGy/h to (42.667±0.901) nGy/h and average(19.914±0.264) nGy/h , internal annual effective dose from (0.028±0.0005) mSv/y to (0.209±0.0044) mSv/y and average (0.097±0.0013) mSv/y, external annual effective dose from (0.0070±0.0001) mSv/y to (0.0523±0.001) mSv/y and average (0.0244±0.0003) mSv/y The results were found to be comparable or lower than similar global reporting data. According to this, research soil The area can be considered to have a normal level of natural background radiation

Keywords: S oil, Natural Radioactivity, concentrations, NaI (TI)

1. Introduction

Human Environment is Radioactive human begins with Exposure to Radiation from sources such as the universe Rays. Natural Radionuclides the water in, air, soil and plants and artificial radioactivity of sediment in nuclear test Medical application. Gamma radiation from natural Radionuclides and cosmic rays constitute external exposure and those from inhalation, ingestion food and drinking water constitute internal exposure Humanity. [1] Estimated 80% dose contribution natural Radionuclides in the Environment the remaining 20% come from cosmic rays and Nuclear process natural Radionuclides Disturbing the terrestrial Environment is mainly Potassium (40K) and Uranium (238U) thorium (232Th) and radioactive gas Radon these naturally occurring radioisotopes are produced by decay Radon directly from the ground the decay of natural radium is the main source radium Radiation exposure [2]. Natural Radioactivity is very extensive spread in the global Environment and mainly depends on Geological and geographical Conditions .and appears in Different Levels of Soil in all regions of the world [3]. It is necessary to explain the methods used in this study including gamma-spectroscopy to determine the concentration of radioisotopes in the soil of radioisotopes in the soil, as they establish the radioactive pathways of humans, plants and animals, and are indicators of environmental accumulation [4]. The scintillator detector is based on scintillation or luminescence. The crystals of organic and inorganic materials contain activator atoms that fluoresce after absorbing radiation and are then referred to as phosphors. For inorganic phosphors, scintillation phosphors include strontium activated in NaI (TI) [5]. The iodine atom of NaI (TI) provides high gamma ray absorption coefficients and inherent efficiency, and the probability of complete absorption at low energy is very high. Compared with semiconductor detectors (HPGe), this type of detector has the best energy Resolution Detector [7, 6]. The detector used in work is the active area NaI (TI) scintillation detector (3x3).

2. Experimental Technical Calculation

In this study, variety of soil samples 50 in AL-Nada District-Najaf Governorate -Iraq in deep 5 cm from the surface of ground. The study area was divided into Najaf and Al- Which represents the Al-Nada neighborhood without the camp area, 35 samples collected from different places. The second section, which represents the camp area, which collected 15 samples randomly, then were taken in a clean plastic container, after drying the samples using an Oven at temperature 50 C , to obtain a net weight, and milling process using a sieve with 1 mm diameter to obtain an equal size .Then were kept moisture-free before radioactivity measurement in an oven for (30) minute to reach a constant weight and avoid any humidity adsorption Samples were be ready to the measure U238, Th232 and K40 concentration using this technique. The location of the studied area using Global positioning system (GPS) **Figure 1.** Iraq map showing Najaf Governorate

Figure 1. Iraq map.

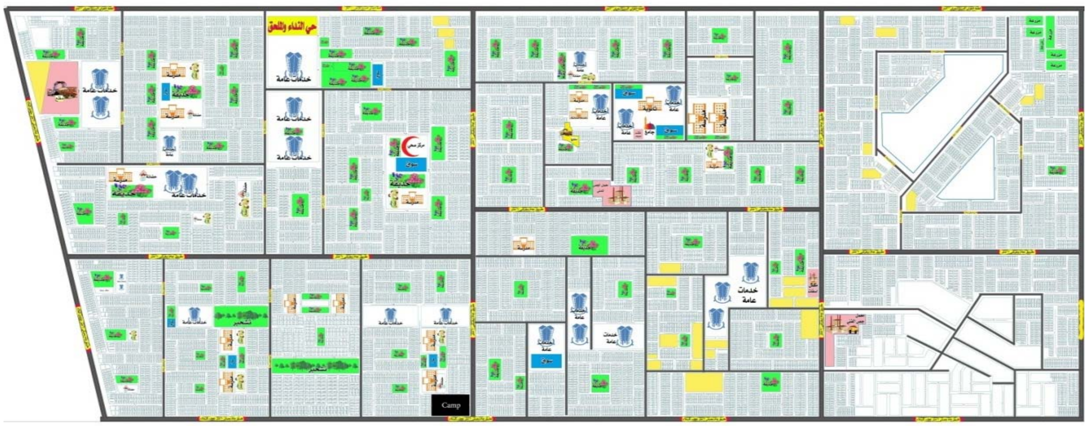

Figure 2. Shows the Al-Nada distract map.

3. Experimental Technology

To measure the gamma activity concentration of naturally occurring radionuclides in soil samples, namely 238U, 232Th and 40K. The gamma ray spectrum of the scintillation detector [8] NaI (TI) from ORTEC has an effective area of "3 x 3" inches (Fig. 1), an energy resolution of 7.9%, and an efficiency of 4.6% at 662 keV. Energy calibration and efficiency calibration of the gamma spectrometer were performed using nuclear reactors (60Co, 137Cs, 22Na and 54Mn). In the physics department, there are seven gamma ray emitters ranging from 511 KeV to 2500 KeV. The minimum detection limits (LLD) for 238U, 232Th and 40K are 3.17 Bq.kg-1, 1.2 Bq.kg-1 and 11.54 Bq.kg-1, respectively. The standard source is placed on the detector, the geometric matching is exactly matched to the geometric sample form, and the distance between the sample and the detector is the same. In some cases, there may be a source of radiation in the counting chamber, rather than the source of the measurement (referred to as the radioactive background). Therefore, shielding must be used to reduce the radioactive background. The shield used in this study consists of two layers, the first layer is stainless steel with a width of (30 mm) and the second layer is lead [9,10]

Table 1. Concentration of Uranium, Potassium, Thorium and his geological information on soil samples location.

Bq/kg Specific Activity			Location Latitude(°E) Longitude(°N)	samples
^{40}K	^{232}Th	^{238}U		
415.462±1.580	5.039±0.101	9.339±0.227	E 044 ·18.164 N32·03.238	1
LD	8.161±0.129	6.219±0.185	E 044 ·18.617 N 32·03.434	2
105.385±0.796	6.888±0.118	10.025±0.235	E 044 ·18.294N32 ·02.921	3
330.575±1.409	5.584±0.106	9.047±0.223	E 044 ·18.332 N32 ·03.364	4
231.845±1.165	7.457±0.121	19.982±0.327	E 044 ·18.517 N32 ·04.230	5
150.773±0.945	4.380±0.939	16.097±0.296	E 044 ·17.727 N 32 ·04.076	6
315.661±1.364	8.239±0.128	10.230±0.235	E 044 ·18.816 N32 ·04. 090	7
115.97±0.833	4.241±0.092	8.601±0.217	E 044 ·17.430 N32 ·03.213	8
272.748±1.274	7.816±0.125	13.999±0.276	E 044 ·18.055 N 32 ·04.014	9
297.646±1.336	6.509±0.115	22.157±0.349	E 044 ·18.411 N 32 ·04.009	10
250.888±1.240	1.117±0.048	9.736±0.234	E 044 ·17.666 N32 ·03.034	11
274.001±1.324	2.802±0.078	12.453±0.270	E 044 ·18.826 N 32 ·04.712	12
307.026±1.444	2.396±0.074	LD	E 044 ·17.792 N 32 ·03.053	13
268.189±1.303	4.287±0.096	1.158±0.082	E 044 ·18.842 N 32.05.929	14
274.831±1.341	3.256±0.085	9.126±0.234	E 044 ·17.842N32 ·05.181	15
244.231±1.240	3.979±0.092	8.353±0.219	E 044 ·18.191 N 32.05.491	16
380.269±.1.568	1.708±0.061	4.785±0.168	E 044 ·18.539 N 32 ·05.745	17
352.066±1.434	4.182±0.092	7.274±0.200	E 044 ·18.978N32 ·03.583	18
395.524±1.543	4.674±0.097	9.425±0.228	E 044 ·18.167 N 32 ·03.727	19
381.799±1.514	1.997±0.997	8.535±0.217	E 044 ·18.122N32 ·04.825	20
395.881±1.562	1.780±0.061	8.355±0.217	E 044 ·18.289N32 ·04.901	21
287.497±1.360	1.450±0.056	21.323±0.355	E 044 ·18.386 N 32 ·04.274	22
281.886±1.308	8.080±0.129	4.688±0.161	E 044 ·18.318N32 ·04.040	23
158.413±0.991	LD	12.575±0.267	E 044 ·17.874 N 32 ·04.177	24
221.693±1.195	3.546±0.088	15.363±0.301	E 044 ·18.178 N 32 ·04.227	25
368.738±1.494	2.678±0.074	15.551±0.294	E 044 ·18.415 N 32 ·04.387	26
249.305±1.320	6.615±0.125	19.156±0.350	E 044 ·18.764 N 32 ·04.371	27
234.832±1.187	2.960±0.077	4.0676±0.149	E 044 ·18.576 N 32 ·04.072	28
303.618±1.460	7.791±0.136	10.206±0.256	E 044 ·19.134 N 32 ·05.590	29
369.703±1.599	5.677±0.1155	9.563±0.246	E 044 ·18.924N 32 ·03.754	30
204.644±1.201	5.500±0.116	3.301±0.147	E 0444 ·19.051N 32 ·03.691	31
280.366±1.411	7.966±0.138	3.659±0.154	E 044 ·18.901 N 32 ·03.886	32
166.349±1.416	10.086±0.149	24.207±0.380	E 044 ·19.154N32 ·04.026	33

190.616±1.152	6.754±0.126	19.338±0.351	E 044 ·18.677 N 32 ·03.975	34
195.395±1.093	4.987±0.101	2.086±0.108	E 044 ·19.817N 32 ·04.670	35
327.893±1.603	8.750±0.151	7.127±0.226	E 044 ·18.155N 32 ·04.255	36
392.18±1.640	6.543±0.123	9.168±0.240	E 044 ·19.149 N 32 ·04.255	37
363.014±1.551	7.131±0.126	9.625±0.242	E 044 ·19.144 N 32 ·04.254	38
323.503±1.464	4.477±0.100	3.336±0.142	E 044 ·18.18 N 32 ·04.029	39
114.524±0.827	3.171±0.080	29.332±0.401	E 044 ·18.916 N 32 ·04.035	40
286.045±3.851	23.948±0.649	7.430±0.594	E 044 ·18.912 N32 ·04.044	41
266.496±3.825	13.231±0.496	10.896±0.741	E 044 ·18.911 N 32 ·04.046	42
142.469±0.889	1.705±0.058	LD	E 044 ·18.870N32 ·04.055	43
705.834±6.179	13.399±0.495	10.633±0.726	E 044 ·18.905N32 ·04.660	44
115.923±0.868	9.099±0.141	4.538±0.164	E 044 ·18.912N32 ·04.069	45
13.592±0.282	3.148±0.079	6.939±0.193	E 044 ·18.913N32 ·04.069	46
223.463±1.150	5.906±0.108	23.623±0.358	E 044 ·18.915N32 ·04.180	47
269.409±1.411	5.047±0.112	15.225±0.321	E 044 ·18.920N 32 ·04..085	48
245.788±1.274	4.960±0.105	31.319±0.741	E 044 ·18.921N32 ·04.089	49
202.917±1.142	6.280±0.117	29.694±0.418	E 044 ·18.921 N 32 ·04.026	50
265.494±1.445	6.283±0.148	11.851±0.281	average	
705.834±6.179	23.948±0.649	31.319±0.741	Maximum	
0.28213.592 ±	1.117±0.048	1.1583±0.0821	Minimum	
420	45	33	World Wide average [3]	

Table 2. Internal and external Hazard Index, and radium equivalent in soil samples.

radium equivalent Ra_{eq} $Bq.Kg^{-1}$	external Hazard Index $H_{ex} \leq 1$	Internal Hazard Index $H_{in} \leq 1$	samples
48.537±0.493	0.131	0.156	1
18.511±0.386	0.050	0.066	2
27.989±0.466	0.075	0.102	3
42.487±0.484	0.114	0.139	4
48.498±0.591	0.131	0.185	5
33.970±0.503	0.091	0.135	6
46.318±0.524	0.125	0.152	7
23.596±0.414	0.063	0.087	8
46.178±0.554	0.124	0.162	9
54.384±0.617	0.146	0.206	10

30.653±0.398	0.082	0.109	11
37.558±0.484	0.101	0.135	12
27.524±0.270	0.074	0.075	13
27.940±0.319	0.075	0.078	14
34.944±0.45Z	0.094	0.119	15
32.850±0.447	0.088	0.111	16
36.509±0.377	0.098	0.111	17
40.364±0.444	0.109	0.128	18
46.564±0.487	0.125	0.151	19
40.790±0.424	0.110	0.133	20
41.385±0.425	0.111	0.134	21
45.533±0.540	0.123	0.180	22
37.948±0.447	0.102	0.115	23
25.708±0.397	0.069	0.103	24
37.504±0.519	0.101	0.142	25
47.773±0.515	0.129	0.171	26
47.812±0.631	0.129	0.180	27
26.383±0.352	0.071	0.082	28
44.726±0.563	0.120	0.148	29
46.149±0.534	0.124	0.150	30
26.924±0.407	0.072	0.081	31
36.640±0.461	0.098	0.108	32
51.439±0.674	0.139	0.204	33
43.673±0.621	0.118	0.170	34
24.263±0.338	0.065	0.071	35
44.888±0.568	0.121	0.140	36
48.723±0.543	0.131	0.156	37
47.776±0.542	0.129	0.155	38
34.649±0.398	0.093	0.102	39
42.685±0.579	0.115	0.194	40
63.703±1.819	0.172	0.192	41
50.334±1.746	0.135	0.165	42
13.918±0.204	0.037	0.039	43
84.199±1.911	0.227	0.256	44
26.477±0.434	0.071	0.083	45
12.489±0.328	0.033	0.052	46
49.275±0.602	0.133	0.197	47
43.186±0.591	0.116	0.157	48

57.338±0.684	0.154	0.239	49
54.2990.6744	0.146	0.226	50
40.078±0.564	0.108	0.139	average
84.199±1.911	0.227	0.256	Maximum
12.489±0. 328	0.033	0.039	Minimum
370	≤ 1	≤ 1	World Wide average [3]

Table 3. Annual Effective internal and external dose and absorbed dose in air in soil samples.

Annual dose Indoor **mSv/y**	Annual dose Outdoor **mSv/y**	Absorbed Dose Air in AD **nGy/h**	Samples
0.121±0.011	0.0304±0.0003	24.769±0.233	1
0.040±0.0009	0.0102±0.0002	8.277±0.174	2
0.065±0.0011	0.0163±0.0003	13.303±0.215	3
0.105±0.0011	0.0263±0.0003	21.432±0.228	4
0.115±0.0014	0.0289±0.0003	23.530±0.275	5
0.080±0.0012	0.0202±0.0003	16.444±0.234	6
0.112±0.0012	0.0282±0.0003	23.006±0.245	7
0.056±0.0009	0.0140±0.0002	11.443±0.192	8
0.111±0.0013	0.0278±0.0003	22.695±0.258	9
0.130±0.0014	0.0327±0.0004	26.690±0.288	10
0.076±0.0009	0.0192±0.0002	15.654±0.189	11
0. 092±0.0011	0.0232±0.0003	18.919±0.228	12
0.071±0.0006	0.0178±0.0002	14.501±0.131	13
0.070±0.0007	0.0176±0.0002	14.381±0.151	14
0.086±0.0011	0.0217±0.0003	17.698±0.217	15
0.081±0.0010	0.0203±0.0003	16.515±0.210	16
0.093±0.0009	0.0235±0.0002	19.129±0.181	17
0.101±0.0010	0.0253±0.0003	20.639±0.210	18
0.116±0.0011	0.0291±0.0003	23.750±0.230	19
0.103±0.0010	0.0259±0.0002	21.104±0.203	20
0.105±0.0010	0.0263±0.0002	21.474±0.203	21
0.111±0.0013	0.0279±0.0003	22.740±0.255	22
0.092±0.0010	0.0232±0.0003	18.938±0.209	23
0.062±0.0009	0.0157±0.0002	12.822±0.188	24
0.091±0.0012	0.0227±0.0003	18.544±0.243	25

0.118±0.0012	0.0297±0.0003	24.224±0.244	26
0.114±0.0014	0.0286±0.0004	23.354±0.295	27
0.066±0.0008	0.0166±0.0002	13.510±0.166	28
0.109±0.0013	0.0272±0.0003	22.214±0.264	29
0.114±0.0012	0.0286±0.0003	23.360±0.252	30
0.066±0.0009	0.0165±0.0002	13.474±0.191	31
0.089±0.0011	0.0225±0.0003	18.329±0.216	32
0.119±0.0015	0.0299±0.0004	24.384±0.312	33
0.103±0.0014	0.0258±0.0004	21.077±0.289	34
0.059±0.0008	0.0150±0.0002	12.208±0.158	35
0.109±0.0013	0.0275±0.0003	22.400±0.266	36
0.120±0.0013	0.0302±0.0003	24.653±0.256	37
0.117±0.0013	0.0295±0.0003	24.013±0.255	38
0.087±0.0009	0.0218±0.0002	17.812±0.189	39
0.099±0.0013	0.0249±0.0003	20.296±0.269	40
0.148±0.0041	0.0371±0.0010	30.233±0.838	41
0.119±0.0040	0.0299±0.0010	24.362±0.810	42
0.035±0.0005	0.0089±0.0001	7.234±0.097	43
0.209±0.0044	0.0523±0.0011	42.667±0.901	44
0.061±0.0010	0.0154±0.0002	12.581±0.200	45
0.028±0.0007	0.0070±0.0002	5.728±0.150	46
0.117±0.0014	0.0293±0.0003	23.900±0.281	47
0.105±0.0014	0.0262±0.0003	21.402±0.277	48
0.136±0.0016	0.0341±0.0004	27.799±0.320	49
0.127±0.0015	0.0320±0.0004	26.080±0.313	50
0.097±0.0013	0.0244±0.0003	19.914±0.264	average
0.209±0.0044	0.0523±0.0011	42.667±0.901	Maximum
0.028±0.0005	0.0070±0.0001	5.728±0.150	Minimum
1	1	55	[3] World Wide average

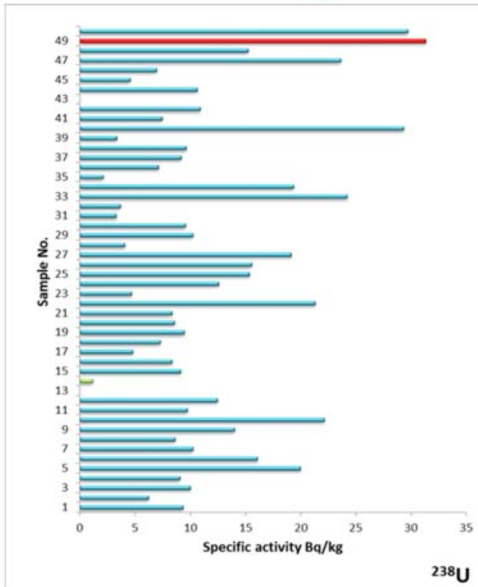

Figure 2. The specific effectiveness of uranium in selected soil samples.

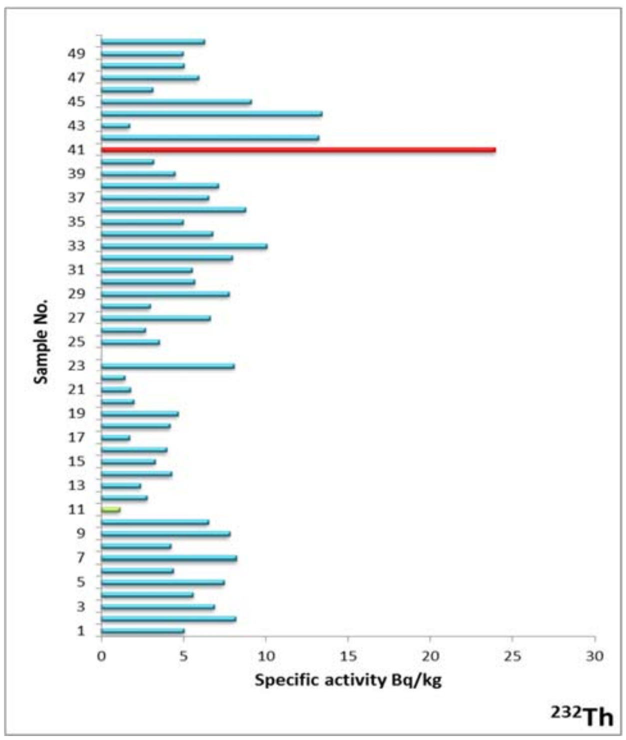

Figure 3. The specific effectiveness of Thorium in selected soil samples.

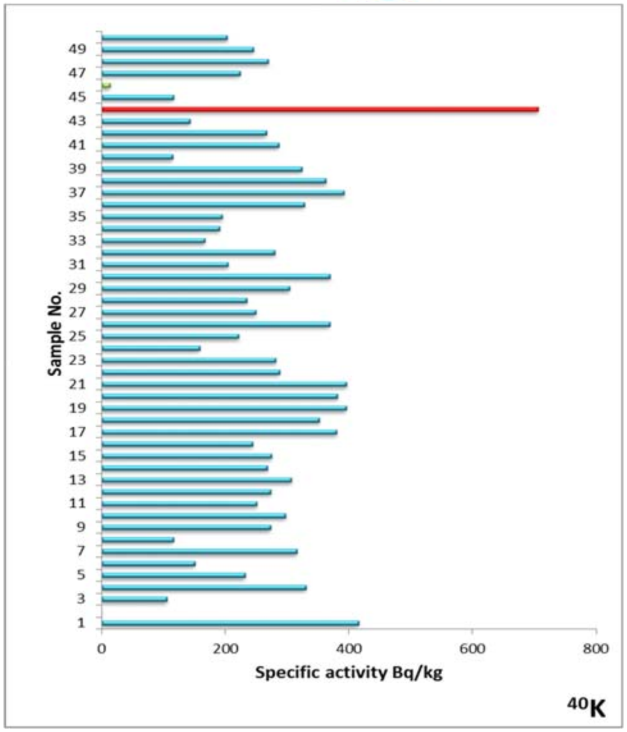

Figure 4. The specific effectiveness of Potassium in selected soil samples.

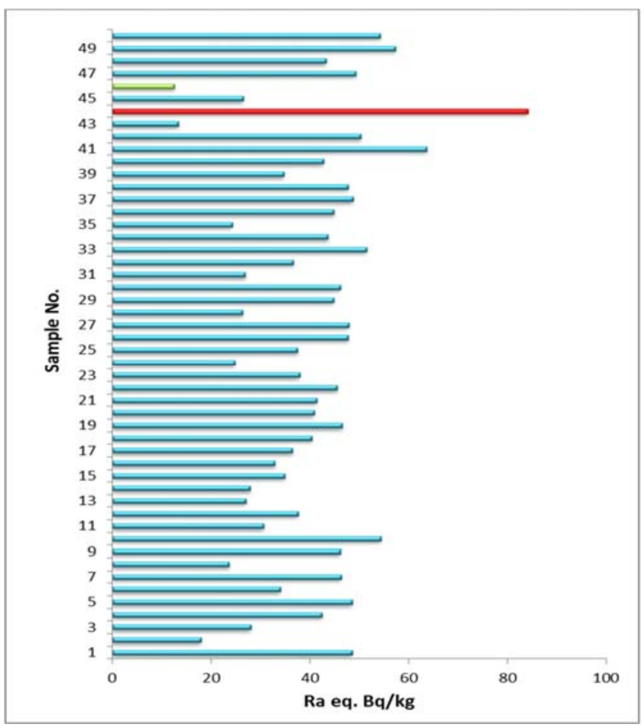

Figure 5. The equivalent radium in selected soil samples.

3. Results and Discussion

In the present study, the NaI(TI) scintillation detector was used to determine the level of natural radioactivity soil samples collected AL-Nada District-Najaf Government –Iraq After calculation of the specific effectiveness of radionuclides 238U,232Th,40K, radium equivalent internal Hazard Index and external Hazard Index, internal and external annual dose absorbed dose in air. The results of 50 samples of al-Nada district soil in Najaf, Iraq as shown in **Tables (1-3)** the results were compared with the universally value [3] It was noted that:

- The value of Uranium-238 (31.319$\pm$0.741) Bq/kg was in sample 49 which is within the camp area and the Minimum value is (1.158$\pm$0.0821) Bq/kg in sample 14 located within an empty area with no buildings and gardens and the rate of these values is (11.851$\pm$ 0.281) Bq/kg
- For the thorium-238, the Maximum value is (23.948 ± 0.649) Bq / kg in sample 41 taken from the camp area and the Minimum (1.117 ± 0.048) Bq / kg is sample 11taken from a public (6.283$\pm$ 0.148) Bq/kg
- Potassium-40, the Maximum value for specific efficacy is (705.834 ± 6.179) Bq / kg in sample 44, which was taken from the camp area and the Minimum value was (13.5926 ± 0.282) Bq / kg Taken from the camp area and the average values were (265.494±1.445)Bq / kg
- For internal Hazard Index H_{in}, the Maximum value is (0.256) Bq / kg, which is model 44 and Minimum is (0.039) Bq / kg, which is model 46 and the average of these values is (0.139) Bq / kg
- For the external Hazard Index H_ex, the Maximum value of was (0.227) Bq / kg, which is the number 44 and the lowest is (0.033) Bq / kg, which is model 46. The average value of (.108)
- For indoor dose, the Maximum (0.209 ± 0.0044) mSv/y was the number 44 and the lowest value is (0.028 ± 0.0005) mSv/y, which is the 46th location within the camp area and the mean value is (0.097±0.0013) mSv/y The Maximum absorption value was (42.667 ± 0.901) mSv/y, which represented the average values were (0.0244±0.0003) mSv/y The Maximum absorption value was (42.667 ± 0.901) mSv/y, which represented the 44th site that represented the camp.The Minimum value was (5.728 ± 0.150) mSv/y, which represents site 46, which represents the camp The (19.914 ± 0.264) mSv /y.

4. Conclusion

The active concentrations of 238U and 40K and 232Th are lower than the world average. The value of the known radiation hazard index in the study area is also calculated below the recommended value. The results show that the average dose rate does not exceed the world's average recommended value and does not pose a serious health hazard. The data provided can be used for comparisons in future surveys and can be used to develop radiographs for the area. The results can also be used as reference data for monitoring possible future radioactive contamination

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