Measurement of the natural radiation of soil samples from official offices in the city of Baghdad (Al-Karkh)

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الخلاصة

اربع وعشرون نموذج جمعت من جانب الكرخ في مدينة بغداد لقياس مستوى النشاط الإشعاعي لهذه النماذج بإستخدام مطياف أشعة كاما – كاشف الجرمانيوم عالي النقاوة (HPGe) واستخدمة برنامج (GINE-2000) للكشف عن النظائر المشعة وقيم الفعالية الخاصة بها وقد وجده بأن الفعالية المحددة للنضير (^{214}Bi) او (^{214}Pb) كانت مكافئة لمستوى الفعالية للـ(^{238}U) عند Bq/kg, (13.88±0.69) بينما معدل القيمة للـ(^{228}Ac) او (^{212}Pb) كان (15.73±0.86) Bq/kgوالذي يكافئ الخاصة بـ(^{232}Th) ومعدل قيمة الفعالية للـ(^{40}K) كان Bq/kg (317.58±14.11) وللـ (^{137}Cs) هو Bq/kg (1.83±0.27) وإن معدل قيمة الجرعة الممتصة في الهواء وتأثير الجرعة السنوية لجانب الكرخ كانت $nGy.\ h^{-1}$ (29.80±1.50)و$\mu sv.\ y^{-1}$ (36.54±1.84) على التوالي.

الكلمات المفتاحية

كاشف الجرمانيوم عالي النقاوة برنامج (GINE-2000)، مستوى فعالية (^{238}U)، مستوى فعالية (^{232}Th).

Abstract

Twenty – four soil samples were collected from the official offices at Al-Karkh side in the city of Baghdad to measure the effective radiation doses of these samples using a gamma – ray spectrometer, by high purity germanium detector (HPGe). The detection of radionuclide and the values of specific activity were calculated by using (GINE-2000) program. It was found that the rate of specific activity of the nuclide (^{214}Bi or ^{214}Pb) was equivalent to the specific activity of (^{238}U) at (13.88±0.69) Bq/kg, while its average value for (^{228}Ac or ^{212}Pb) was (15.73±0.86) Bq/kg which is equivalent to the specific activity of (^{232}Th). The average value of specific activity of (^{40}K) was (317.58±14.11) Bq/kg and for (^{137}Cs) was (1.83±0.27) Bq/kg. Then the average value of the absorbed dose in air and the annual effect dose for Al-Karkh side were (29.80±1.50) $nGy.\ h^{-1}$ and (36.54±1.84) $\mu sv.\ y^{-1}$ respectively.

Keyword

Radiation, Gamma-Ray Spectrometer, Absorbed Does and Annual effective dose rate.

1. Introduction

Studies related to determine the radioactivity levels and the radionuclides distributions in the environment are of great importance. Because, many of the species an the surface of the ground are exposed to radiation, both from a natural mainly or an artificial radioisotope. Natural radioisotopes come mainly from terrestrial origin, such as ^{238}U, ^{232}Th and ^{40}K. The most dangerous artificial sources of radiation is ^{137}Cs [1]. The determination of the concentration of these radioisotopes in the soil enables us to study the background count rate. This study chosen the Karkh side of Baghdad, which contains several important governmental offices. This district was bombarded heavily during the (1991 – 2003) wars. Since these offices were located in a heavily populated residential neighboring the purpose of this study becomes obvious, i. e, to conclude the impact of the measurement results on the general public in this side of the capital.

2. Sample preparation

Twenty – four soil samples were collected from carefully selected officers in Al- Karkh side, using a small shovel. The soil surface was scrapped, then a hole of 40cm was drilled. The hole depth was ranging between 10 to 15 cm. A sufficient amount of soil was taken in plastic bottles. The samples were indexed with special reference number. The samples were carefully prepared by removing any possible strange objects such as gravels and plant roots, after being dried for 3-4 days by sunlight exposure to remove the moisture. Thus the samples became homogeneous and impurity free and ready for counting.

A suitable quantity of the well dried samples was taken and placed in Marinelli beakers (~500 ml). After washing it very well with diluted hydrochloric acid, then with distilled water, so, it was prepared for measurements.

Fig.(1) showed the official map of Baghdad, and the sampling sites are located.

Fig. (1): Map of Baghdad showing the sampling located

3. Materials and method

The sample was measured by a gamma – ray spectroscopy type (DSA2000) with (HPGe) detector as shown in (Fig. 2). The resolution at (1332 keV) ^{60}Co was (2. 2 keV), and relative efficiency was 40% using GENIE-2000 program to calculate the natural radioactivity [2].

In this study, gamma spectroscopy was used to determine the activities of ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs. The gamma ray lines of 609 keV from ^{214}Bi and 352 keV gamma-rays from ^{214}Pb were used to determine the ^{238}U. The gamma ray lines of 583 keV from ^{212}Pb and 911 keV gamma rays from ^{228}Ac were used to determine the ^{232}Th. The activity of ^{40}K was evaluated using its 1460. 8 keV gamma ray line. The activity of ^{137}Cs was evaluated using its 661. 6 keV gamma-ray line [3].

The total air absorbed dose rate ($nGy.\ h^{-1}$) due to the mean activity concentrations of ^{238}U, ^{232}Th and ^{40}K (Bq/kg) can be calculated by using the formula [4]:

(1) D ($nGy.\ h^{-1}$) = 0. 429A_U + 0. 666A_{Th} + 0. 042A_k

where A_U, A_{Th} and A_K are the mean activity concentrations of ^{238}U, ^{232}Th and ^{40}K in (Bq/kg) respectively.

To estimate the Annual effective dose equivalent in air the conversion coefficient from absorbed dose in air to effective dose received by an adult had to be taken into consideration. This value is published in UNSCEAR and the outdoor occupancy factor of about (0. 2) [4,5]. The annual effective dose equivalent can be calculated by using the formula:

(2) AEDE ($\mu Sv\ y^{-1}$) = D ($nGy\ h^{-1}$) × 8760 (hy^{-1}) × 0. 2 × 00. 7 ($Sv\ Gy^{-1}$) × 10^{-3}

Fig. (2): A gamma-ray spectrometer type (DSA2000) with (HPGe) detectort

4. Results and discussion:

The activity concentrations of the radionuclides ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs in 24 soil samples considered in the present study are shown in Table (1). Fig. (3) shown the activity (Bq/kg) of ^{238}U, ^{232}Th, ^{40}K and ^{137}Cs in the soil sample. The total air absorbed dose rate and the

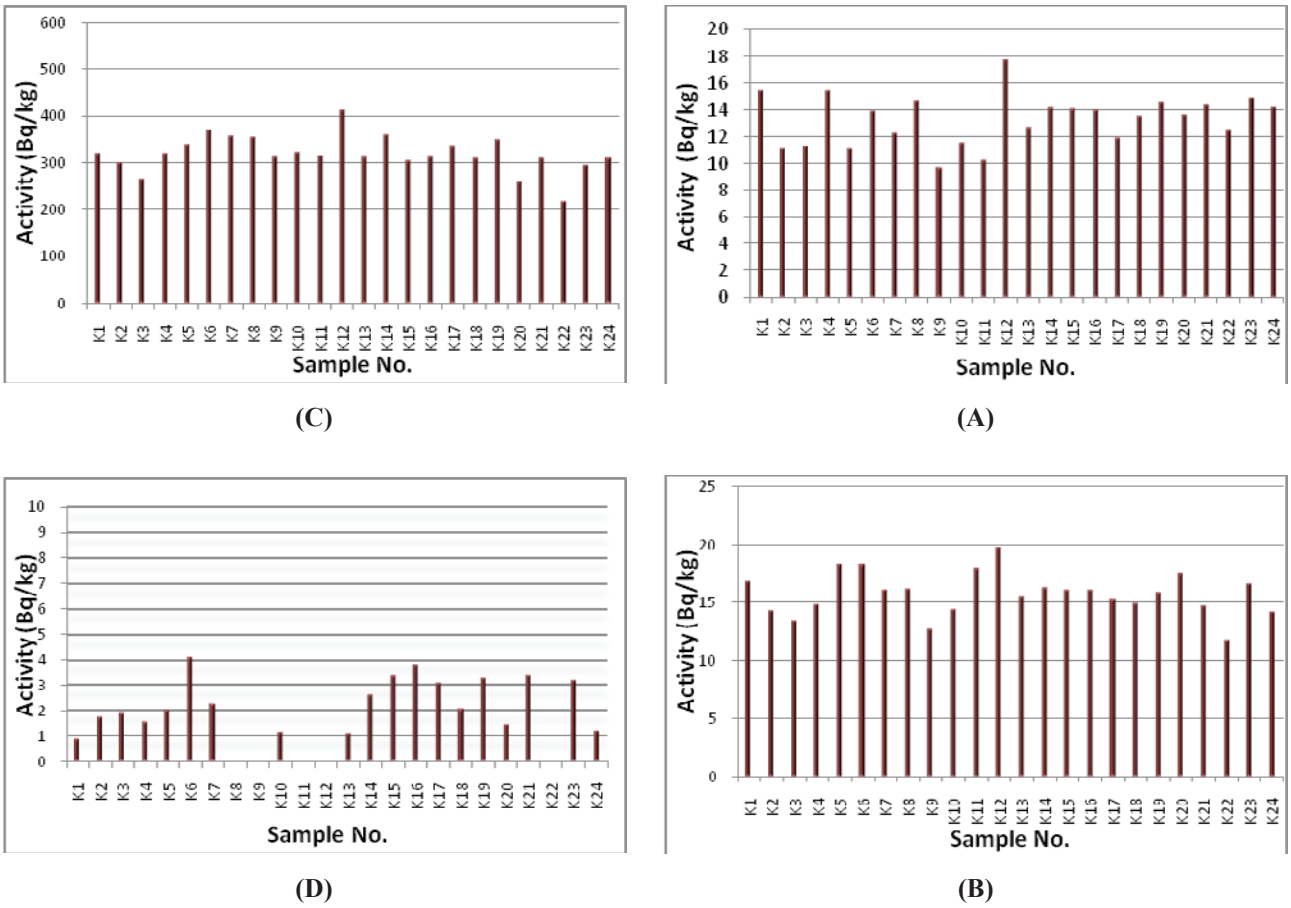

Fig. (3): Distributions of numbers of samples activity (Bq/ kg) of (A)^{238}U, (B) ^{232}Th, (C) ^{40}K and (D)^{137}Cs

annual effective dose equivalents from outdoor terrestrial gamma for 24 soil samples were calculated and presented in Table (2).

We can be seen from Table (1) the maximum value of ^{238}U is (17.70±0.87) *Bq/kg* in sample (K12), the minimum value is (9.77±0.46) *Bq/kg* in sample (K9), and the average rate of ^{238}U is (.13) 88±0.69*Bq/kg*. The maximum value of ^{232}Th is (19.77±0.92) *Bq/kg* in sample (K12), the minimum value is (11.71±0.29) *Bq/kg* in sample (K22), and the average rate of ^{232}Th is (15.73±0.86) *Bq/kg*. The maximum value of ^{40}K is (408.47±15.59) *Bq/kg* in sample (K12), the minimum value is (217.16±12.23) *Bq/kg* in sample (K22), and the average rate of ^{40}K is (317.58±14.11) *Bq/kg*. In addition, the maximum value of ^{137}Cs (4.07±0.44) *Bq/kg* in sample (K6), and appeared below the detection limit in samples (K8, K9, K11, K12, K22) and the average rate (1. 83 ± 0. 2) *Bq/Kg*.

The maximum value of the dose absorbed in air was (38.21±1.65) *nGy h*$^{-1}$ in sample (K12), the minimum value was (22.40±1.02) *nGy h*$^{-1}$ in sample (K22), and the average rate of the absorbed dose was (29.80±1.50) *nGy h*$^{-1}$. While after calculating the Annual effective dose equivalent in air of the sample found the maximum value was (46.86±2.02) *μSv y*$^{-1}$ in a sample (K12) and the minimum value was (27.47±1.25) *μSv y*$^{-1}$ in sample (K22),

Table (1): Activity Concentrations of radionuclide for each sample in (Bq/kg

Samples	Location	^{238}U	^{232}Th	^{40}K	^{137}Cs
K1	Health center (New Iraq)/ AL-Ghazaliya	15. 44±0. 79	16. 75±0. 83	318. 64±13. 50	0. 88±0. 21
K2	Pharmaceutical stores Al-Adil	13. 31±0. 71	14. 30±0. 98	297. 63±14. 79	1. 72±0. 30
K3	Hakim Hospital/Al-Shualla	11. 27±0. 29	13. 46±0. 94	264. 57±12. 18	1. 86±0. 24
K4	Conference Palace/ Garden Region	15. 42±0. 81	14. 83±0. 90	319. 42±13. 58	1. 54±0. 25
K5	National center for registration of displaced persons/ Al-harthiya	14. 46±0. 75	18. 31±1. 00	337. 57±15. 41	2. 00±0. 31
K6	Baghdad operation command/ AL-harthiya	13. 90±1. 00	18. 31±1. 12	368. 67±17. 16	4. 07±0. 44
K7	Engineers Association agricultural/AL-ma'mon	12. 30±0. 44	16. 03±0. 89	355. 69±15. 89	2. 27±0. 32
K8	Al-yarmuk Hospital/ AL-yarmuk	14. 61±0. 91	16. 16±0. 84	351. 59±14. 83	BDL
K9	Palace of Justice /AL-Huriya	9. 77±0. 46	12. 71±0. 86	310. 76±13. 22	BDL
K10	Mustansiriya University/ College of pharmacy	13. 14±0. 64	14. 41±0. 58	321. 61±13. 55	1. 18±0. 22
K11	Communication tower alm'amon	10. 71±0. 73	17. 98±0. 95	311. 99±15. 08	BDL
K12	President of court appeal al karkh	17. 70±0. 87	19. 77±0. 92	408. 47±15. 59	BDL
K13	Red crescent hospital/AL-Mansur	13. 77±0. 65	15. 51±0. 84	310. 71±13. 25	1. 1±0. 22
K14	Arab child hospital/AL-Aiskan	14. 15±0. 87	16. 29±0. 86	357. 15±14. 92	2. 59±0. 32
K15	Baghdad provincial council/ Al-karkh	14. 91±0. 70	16. 06±0. 83	302. 95±13. 63	3. 38±0. 47
K16	The Iraq state company railway/ Al-Alawi	14. 01±0. 80	16. 02±0. 89	311. 65±13. 30	3. 74±0. 47
K17	Directorate of education in Baghdad alkarkh/AL-Utaifiyya	11. 90±0. 82	15. 27±0. 83	334. 33±14. 48	3. 08±0. 358
K18	AL-Kazimiyah hospital/ AL-Kazimiyah	13. 59±0. 83	14. 89±0. 86	306. 95±13. 18	2. 08±0. 27
K19	Doura oil refinery/AL- Doura	14. 59±0. 79	15. 80±1. 08	347. 22±15. 27	3. 27±0. 62
K20	Secondary Ameriya for boys/ AL-Ameriya	13. 67±0. 95	17. 52±0. 67	258. 78±11. 48	1. 44±0. 28
K21	Secretariat of the council of ministers/Garden Region	14. 37±0. 78	14. 67±0. 82	308. 94±13. 16	3. 37±0. 35
K22	Health center/Al-Adil district	12. 43±0. 71	11. 71±0. 29	217. 16±12. 23	BDL
K23	Alakpal school girls primary/ Al-Baya	14. 95±1. 01	16. 55±1. 05	291. 29±15. 35	3. 18±0. 49
K24	AL-Diyar primary school mixed/ AL-Amal	14. 19±0. 86	14. 17±0. 80	308. 16±13. 59	1. 19±0. 22
Average	————————	13. 88±0. 69	15. 73±0. 86	317. 58±14. 11	1. 83±0. 27

*BDL:-Below the detection limit

Table (2): The dose rate ($nGyh^{-1}$) and AEDE ($\mu Sv.\ y^{-1}$) for the soil sample

Sample	D ($nGyh^{-1}$)	AEDE ($\mu Sv.\ y^{-1}$)
K1	31. 38±1. 47	38. 48±1. 80
K2	27. 95±1. 58	34. 28±1. 94
K3	25. 10±1. 27	30. 78±1. 56
K4	30. 17±1. 53	36. 96±1. 87
K5	32. 80±1. 64	40. 23±2. 02
K6	33. 90±1. 91	41. 58±2. 34
K7	31. 16±1. 46	38. 21±1. 80
K8	32. 05±1. 58	39. 31±1. 94
K9	25. 94±1. 33	31. 82±1. 64
K10	28. 98±1. 24	35. 54±1. 52
K11	29. 90±1. 59	36. 66±1. 95
K12	38. 21±1. 65	46. 86±2. 02
K13	29. 50±1. 40	36. 19±1. 72
K14	32. 18±1. 58	39. 47±1. 94
K15	30. 03±1. 43	36. 82±1. 76
K16	30. 00±1. 50	36. 78±1. 84
K17	29. 57±1. 52	36. 26±1. 87
K18	28. 86±1. 47	35. 39±1. 80
K19	31. 00±1. 71	38. 00±2. 1
K20	28. 56±1. 34	35. 03±1. 65
K21	29. 13±1. 44	35. 73±1. 77
K22	22. 40±1. 02	27. 47±1. 25
K23	29. 87±1. 79	36. 63±2. 20
K24	28. 70±1. 48	35. 19±1. 82
Average	29. 80±1. 50	36. 54±1. 84

5. Comparison with arab and international studies

Table (3) showed the comparison of the values for specific activity of radionuclides which had been calculated in the current study with the results of some Arab and international studies.

We can observed that all the values of specific activity of the current study were approaching the median value of previously studies [1, 6, 18] within the permissible limits in the world.

Table (3): The results of some studies for the Arab States and international as well as the results of the current study

Country	^{238}U	^{232}Th	^{40}K	Reference
Turkey (Istanbul)	21	37	342	[6]
Syrian	20	20	270	[7]
Kuwait	36	6	227	[8]
Mexico	23	19	530	[9]
Jordan	22	21	138	[10]
Nigeria	16. 2	24. 4	348	[11]
Cyprus	7. 1	5	104. 6	[1]
Egypt	13. 7	12. 3	1233	[12]
Pakistan	25. 8	49. 2	561. 6	[13]
Bangladesh	42	81	833	[14]
Vietnam	19. 6	31	346	[15]
Saudi Arabia (taif)	23. 8	18. 6	162. 8	[16]
western Serbia	60. 4±26. 2	49. 1±18. 5	379±108	[17]
Yemen (Juban)	44. 4±4. 5	58. 2±5. 1	822. 7±31	[18]
Baghdad (AL-Karkh)	±0. 6913. 88	±0. 86 15. 73	±14. 11317. 58	Current study

6. Conclusions:

We conclude from the above results:

The maximum value activity concentrations of the radionuclides (^{238}U, ^{232}Th, and ^{40}K) were observed in sample (K12), which represents the Presidency of the Court of Appeal Karkh side of Karkh side. It is likely that the reason for the rise in this site due to the terrorist bombing that targeted this site in 2010. The maximum value for the ^{137}Cs was observed in sample (K6), which represents the Baghdad Operations Command's area, in Harthiya however that value did not exceed the allowable global limit. There are some sites that were bombed such as secure communications tower and we noted a significant decrease in the values of specific activity in comparison with the observed values in previous studies for the same site. It is likely to be caused by a process of decontamination prior to the reconstruction of this site. Despite the high values of specific activity in some samples, all samples were within the allowable limit internationally and globally accepted and did not pose a threat to the people and other living species.

From these results we can be classified the Karkh side of Baghdad within regions radioactivity and does not constitute a danger to workers at these and near the sites.

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