

Measurement the natural radioactivity of soil samples from selected regions in Salahaddin governorate

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Abstract :

Measuring natural radioactivity in soil samples from various Salahaddin governorate locations using a (HPGe) detector according to the investigations, Th-232, K-40, and U-238 had mean specific activity concentrations of 28.392 Bq/kg, 182.121 Bq/kg, and 23.297 Bq/kg, respectively, the parameters were determined to be lower than their respective allowed limits since their values were lower than the global mean supplied by (UNSCEAR,2000).

Keywords: Soil samples, HPGe detector, Natural radioactivity, Salahaddin governorate.

قياس النشاط الإشعاعي الطبيعي لعينات من التربة من مناطق مختارة بمحافظة صلاح الدين

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مستخلص:

قياس النشاط الإشعاعي الطبيعي في عينات التربة لمواقع مختلفة من محافظة صلاح الدين باستخدام كاشف (HPGe) وكانت تراكيز النويدات المشعة Th-232 و K-40 و U-238 تبلغ 28.392 بيكريل / كغم، 182.121 بيكريل / كغم، و 23.297 بيكريل / كغم، على التوالي، تم تحديد المعلمات لتكون أقل من الحدود المسموح بها لأن قيمها كانت أقل من المتوسط العالمي الذي قدمته (UNSCEAR,2000).

Introduction

A collection of radionuclides with a variety of half-lives are produced by the natural radioactive chains from ^{232}Th , ^{235}U , and ^{238}U . Since the majority of radioisotopes are alpha emitters, they dramatically increase the radiation dosage that individuals experience when they are swallowed or breathed [1]. However, because ^{232}Th and ^{238}U are constantly present in soil, their gamma radiation results in external exposures and subsequently absorbed dosages [2].

The study of natural soil radioactivity is one of the most important topics that researchers teach to aligned to the subject of the environmental importance of the effect on human health, especially when we consider the existence of areas containing high concentrations of natural radioactive isotopes due to the geological composition of these areas, where the concentrate was on natural chains of (^{232}Th , ^{40}K and ^{238}U), which is considered the most ionizing3]].

The amount of gamma radiation that is naturally present in the environment and the accompanying external

exposure to it in each location of the world varies depending on the geological and geographical factors. According to their physical and chemical makeup, different varieties of soil exist (UNSCEAR,2000) [4]. Humans have always been subject to environmental radiations of a natural kind. Because of naturally existing radioactive materials in soil and rocks, cosmic rays entering the earth's atmosphere from space, and internal exposure via biological processes, people are exposed to ionizing radiation from natural sources.

Preparation and Collection of the sample

In the Salahaddin Governorate see Fig.(1), samples of the surface soil were collected from several areas. By utilizing an electrical mill to smash the samples into tiny bits and fine powder, the samples' grain sizes of around one kg and $300\mu\text{m}$ were subsequently achieved (mesh). To obtain the secular equilibrium for ^{232}Th and ^{238}U with their respective progenies, the samples were dried at (60°C) for one hour before being packaged in a one liter Marinelli beaker. The sealed Marinelli beaker was then maintained for one month prior to tests [5].

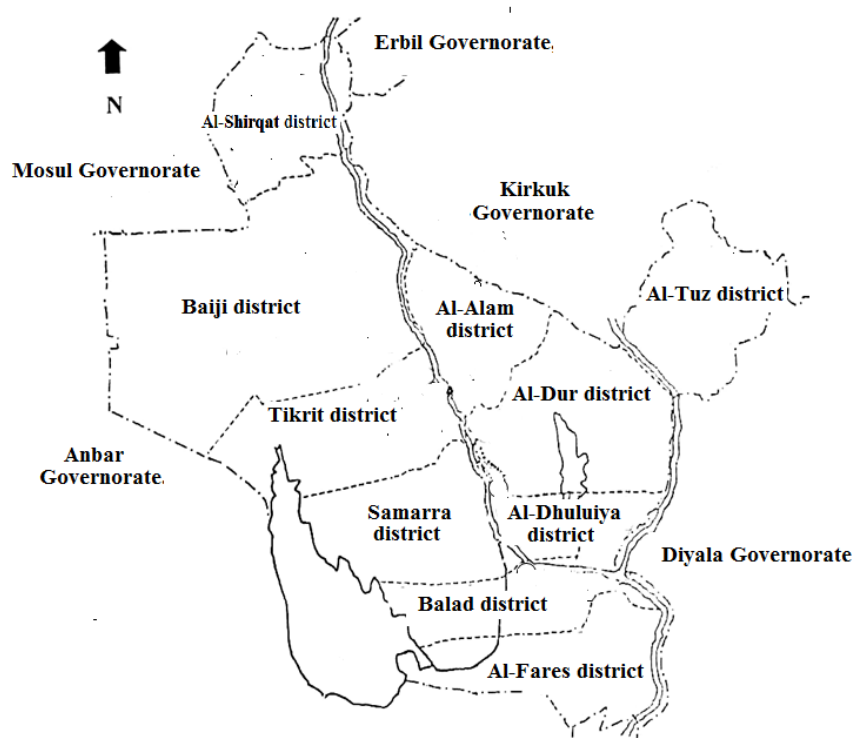


Figure (1) Sketch map showing locations of the studied sites in Salahaddin governorate.

Activity Concentration

It has been the concentrate of effectiveness of a series of ^{238}U by focusing effectively account for nuclide Bismuth -214 (1764 keV), and in ^{232}Th series has been the concentrate of effectiveness of the radioactive nuclide ^{232}Th because all the elements of radioactive chains effective in the case of late balance so it is possible to calculate the concentration of an element in the series in terms of the concentration of another element. [6]:

$$A = \frac{NET}{\varepsilon * I_{\gamma} * m * t} \dots\dots\dots (1)$$

Where:

A: activity concentrations

ε : Energy efficiency,

m: mass of sample units kg,

t: time measurement

High Purity Germanium (HPGe) Detector

In the current investigation, ^{60}Co was detected using a (HPGe) detector with a 40% efficiency and a 2.6 keV energy resolution. The high purity N-type semiconductor detector has a closed-end coaxial design.

By submerging the (HPGe) detector in a liquid-nitrogen tank at (-196

°C), the leakage current is maintained at a manageable level. To lessen background radiation, a lead barrier with a thickness of around 10 cm surrounds the detector [5].

1- Radium Equivalent [6] :

$$Ra_{eq} = 0.077A_K + 1.43A_{Th} + A_U \quad (2)$$

Where A_K, A_U, A_{Th} activity concentration of $^{40}K, ^{238}U$ and ^{232}Th series.

2- Absorbed Dose Rate [7]]:

$$D_y = 0.0417A_K + 0.604A_{Th} + 0.462A_U \quad (3)$$

The Annual Effective Dose [8] :3-

$$(AED)_{in} = D_y \text{ (nGy/h)} \times 10^{-6} \times 8760 \text{ h/y} \times 0.80 \times 0.7 \text{ Sv/Gy} \quad \dots\dots\dots(4)$$

$$(AED)_{out} = D_y \text{ (nGy/h)} \times 10^{-6} \times 8760 \text{ h/y} \times 0.20 \times 0.7 \text{ Sv/Gy} \quad \dots\dots\dots(5)$$

4- Activity Concentration Index (I_y) [9]:

$$I_a = \frac{A_U}{300} + \frac{A_F}{200} + \frac{A_K}{3000} \quad (6)$$

5- External Hazard Index [9] :

$$H_\alpha = \frac{A_U}{370} + \frac{A_F}{259} + \frac{A_K}{4810} \quad (7)$$

6- Internal Hazard Index [10] :

$$H_n = \frac{A_U}{185} + \frac{A_F}{259} + \frac{A_K}{4810} \quad (8)$$

Results and Conclusions

Table 1 summarizes the findings of the current study, and it reveals the ac-

companying:

The Al-Dur region had the greatest value of A_{Th} which was equivalent to (32.640 Bq/kg; the Baiji region had the lowest value, which was equal to (23.230 Bq/kg); the mean value was (28.392 Bq/kg) ,see Fig.(3). According to the current findings, the A_{Th} in the Salahaddin governorate were lower than the (30 Bq/kg) [4].

The highest value of A_K was found in (Al-Sharqat) region which was equal to (251.420 Bq/kg), while the lowest value of A_K (^{40}K) was found in (Baiji) region which was equal to (152.470 Bq/kg), with an mean value of (182.121 Bq/kg) ,see Fig.(3). The present results have shown that values of A_K in Salahaddin governorate were less than the recommended value of (400 Bq/kg) 2000) [4].

The Al-Fares region had the greatest value of A_U which was equivalent to (28.430 Bq/kg; the Al-Tuz region had the lowest value, which was equal to (10.340 Bq/kg); the mean value was (23.297 Bq/kg),see Fig.(3). According to the current findings, the A_U in the Salahaddin governorate were lower than the (35 Bq/kg) [4].

The highest value of Ra_{eq} was found

in (Al-dor) region which was equal to (38.114 Bq/kg), while the lowest value of Ra_{eq} was found in (Al-Tuz) region which was equal to (27.153 Bq/kg), with an mean value of (89.952 Bq/kg). The present results have shown that values Ra_{eq} in Salahaddin governorate were less than the recommended value of (370 Bq/kg) [4].

The highest value of (D_v) was found in (Tikrit) region which was equal to (38.209 nGy/h), while the lowest value of (D_v) was found in (Al-Tuz) region which was equal to (27.153 nGy/h), with an mean value of (35.506 nGy/h). The present results have shown that values of (D_v) in Salahaddin governorate were less than the recommended value of (55 nGy/h) [4].

The highest value of (AED)_{in} was found in (Al-dor) region which was equal to (0.187 mSv/y), while the lowest value of (AED)_{in} was found in (Al-Tuz) region which was equal to (0.133 mSv/y), with an mean value of (0.174 mSv/y). The present results have shown that the (AED)_{in} in Salahaddin governorate were less than the recommended value of (1 mSv/y) [4].

The highest value of (AED)_{out} was found in (Al-dor) region which was

equal to (0.047 mSv/y), while the lowest value of (AED)_{out} was found in (Al-Tuz) region which was equal to (0.033 mSv/y), with an mean value of (0.044 mSv/y). The present results have shown that values of (AED)_{out} in Salahaddin governorate were less than the recommended value of (1 mSv/y) [4].

The highest value of I_v was found in (Al-dor) region which was equal to (0.302), while the lowest value of I_v was found in (Al-Tuz) region which was equal to (0.218), with an mean value of (0.280). The present results have shown that values of I_v in Salahaddin governorate were less than the recommended value of (1) [4].

The highest value of H_{in} was found in (Tikrit) region which was equal to (0.298), while the lowest value of H_{in} was found in (Al-Tuz) region which was equal to (0.189), with an mean value of (0.273). The present results have shown that values of H_{in} in Salahaddin governorate were less than the recommended value of (1) [4].

The highest value of H_{ex} was found in (Al-dor) region which was equal to (0.227), while the lowest value of H_{ex} was found in (Al-Tuz) region which was equal to (0.161), with an mean val-

ue of (0.210). The present results have shown that values of H_{ex} in Salahaddin governorate were less than the recommended value of (1) [4].

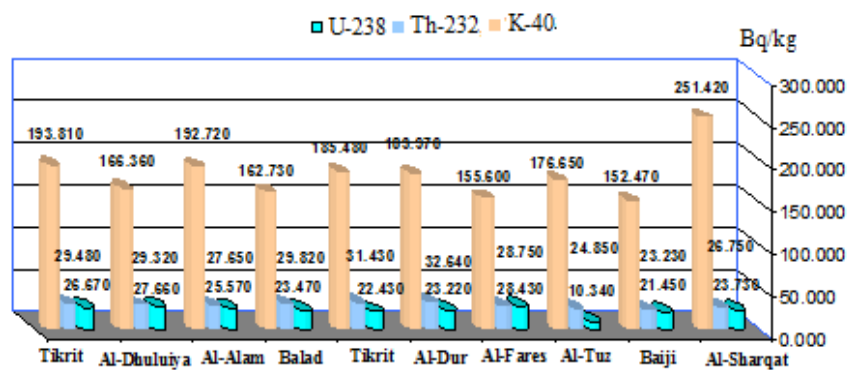


Figure (3) specific activity of (^{238}U , ^{232}Th and ^{40}K) for all regions studies.

Table (1) specific activities of radionuclides with some other parameters in soil samples in Salahaddin governorate.

Location	Th-232 (Bq/kg)	K-40 (Bq/kg)	U-38 (Bq/kg)	Ra_{eq} (Bq/kg)	D_y (nGy/h)	(A.E.D) (mSv/y)		I_y	Hazard index	
						Indoor E_{in}	Out-door E_{out}		H_{in}	H_{ex}
Al-Shar-qat	26.750	251.420	23.730	97.360	37.604	0.184	0.046	0.297	0.284	0.220
Baiji	23.230	152.470	21.450	66.409	30.299	0.149	0.037	0.238	0.237	0.179
Al-Tuz	24.850	176.650	10.340	59.478	27.153	0.133	0.033	0.218	0.189	0.161
Al-Fares	28.750	155.600	28.430	81.524	36.988	0.181	0.045	0.290	0.297	0.220
Al-Dur	32.640	183.970	23.220	116.650	38.114	0.187	0.047	0.302	0.290	0.227
Tikrit	31.430	185.480	22.430	126.760	37.081	0.182	0.045	0.294	0.281	0.221
Balad	29.820	162.730	23.470	78.643	35.640	0.175	0.044	0.282	0.276	0.212
Al-Alam	27.650	192.720	25.570	78.960	36.550	0.179	0.045	0.288	0.285	0.216
Al-Dhu-luiya	29.320	166.360	27.660	87.380	37.425	0.184	0.046	0.294	0.297	0.223
Tikrit	29.480	193.810	26.670	106.360	38.209	0.187	0.047	0.301	0.298	0.226
Ave.	28.392	182.121	23.297	89.952	35.506	0.174	0.044	0.280	0.273	0.210
Min.	23.230	152.470	10.340	59.478	27.153	0.133	0.033	0.218	0.189	0.161
Max.	32.640	251.420	28.430	126.760	38.209	0.187	0.047	0.302	0.298	0.227
world-wide mean [4]	35	30	400	370	55	1	1	1	1	1

Conclusions

The specific activity values for (^{40}K , ^{232}Th , and ^{238}U) and the determination of the parameters to be lower than their respective permissible limits, and as a consequence will pose very little harm to human health.

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