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Measurement the natural radioactivity of radionuclides that exist in some soil samples from different locations in Governorate of Karbala.

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Abstract:

A method is used in the present work for the measurement of the activity concentrations for the natural radionuclides in six soil samples were collected from different regions in Governorate of Karbala by multi-channel gamma ray spectrometry NaI(TL) scintillation detector. All measuring were done for samples proved that existing the activity concentrations that returns to U^{238},Th^{232} and K^{40} series, and the ranges of these concentrations that we get for Ra^{226} ,Bi^{214} ,Pb^{214} and Th^{234} as follow (11.4 ± 4.69) to (73 ± 16.8) , (3.503 ± 1.618) to (42.295 ± 10.2) , (6.039 ± 2.206) to (70.933 ± 13.5) and (4.15 ± 2.27) to (17.885 ± 4.123) in Bq/Kg, respectively. While the highest decay concentrations series of Th^{232} (Ac^{228} , Bi^{212} , Pb^{212} and Tl^{208}) as follow (38.313 ± 21.4 , 18.994 ± 9.25 , 11.347 ± 5.477 and 33.56 ± 6.04) Bq/Kg, respectively, as well as for K^{40} is equal to (589.616 ± 7.1)Bq/Kg. Results of the present study were concerns of Ra^{226} and K^{40} compared with the known levels of similar data for the other countries and founded with the permitted limits.

Introduction:

Life on the earth has developed under the ubiquitous presence of environmental gamma and charged-particle radiation. Radiation may well be one of the conditions for life and biological development. It is however also well established that ionizing radiation may harm life and biological systems (1). Studies of natural radiation background are of great importance because it is the main source of exposure to human kind (2). Naturally occurring soil samples and processed products have radionuclide of the three most commonly known radioactive series, thorium series and K^{40} isotopes(3).High concentrations of natural radionuclide's in soil samples can result in high- dose rates, also gamma-irradiation from naturally occurring radioactive soil samples contributes to the whole body dose and in some cases β-

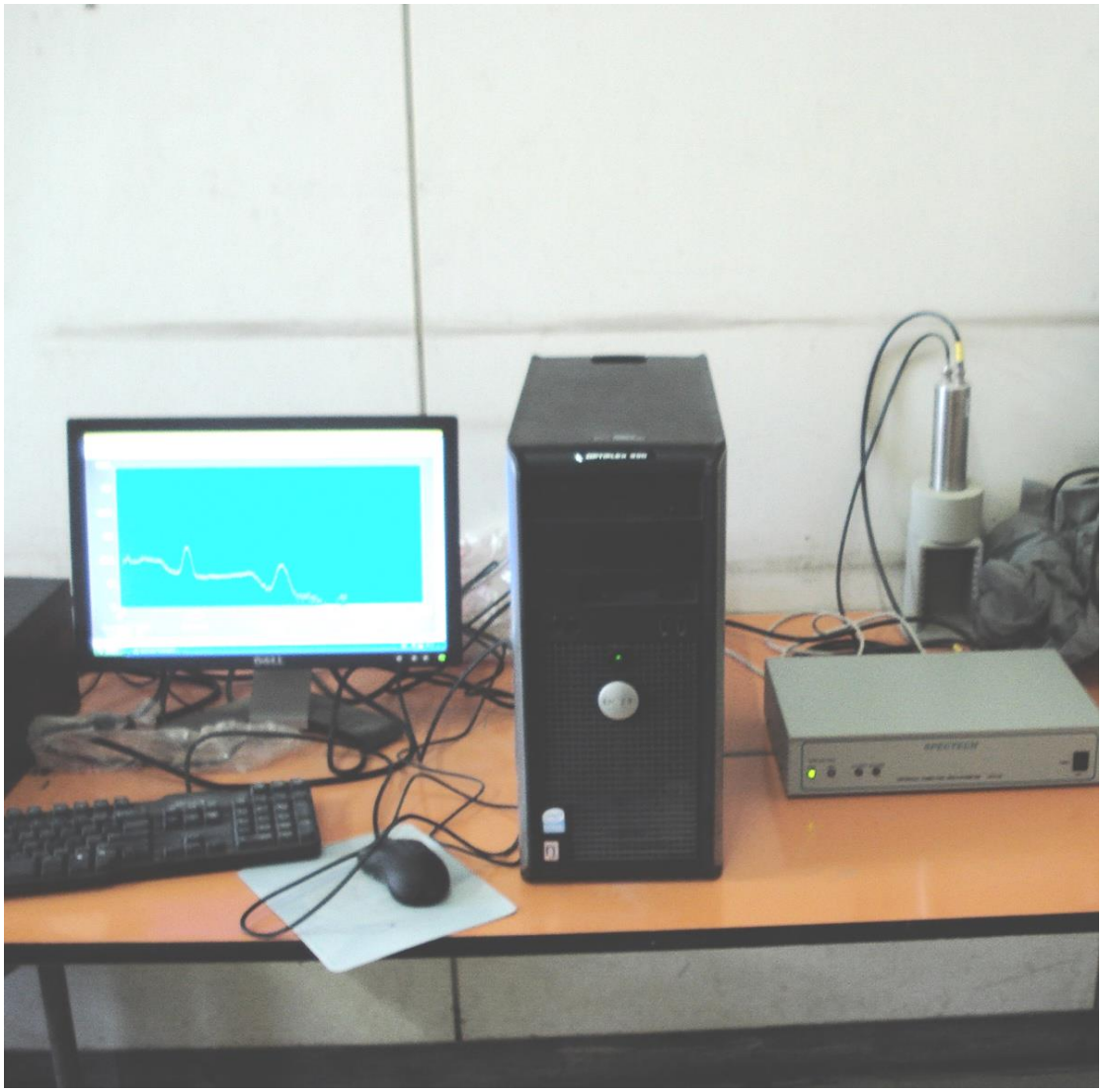
irradiation contributes to the skin dose. As β-particles have higher specific ionization than γ, they lose their energy while they are still in the skin and cannot penetrate further into the body, one is the toxicity of uranium and radium and the other is the hazardous effects of Rn^{222} on lungs (4).The concentration of natural radionuclide's in soil samples depends of areas, and the natural radioactivity is common in our soils and rocks (5,6).The harmful level of radon and radon daughters were arises from the disintegration of U^{238} and Th^{232} can accumulate over the soils and

Cause the risk of lung cancer(7).

Detection technique:

Gamma spectrometer with a scintillation detector 2 × 2 inch NaI(TL) from EG&G Ortec as shown in (Fig 1) that working at (750)volt with the efficiency of 60% . The viability of discrimination detector of energy in the limits (6.5-8.56)% for the energy values (0.662-1.332)Mev. The detector surrounded by lead shield to prevent the background radiation. The radioactive sources (Cs^{137} , Na^{22} , Co^{60} , Mn^{54}) were used to calibrate the system and calculate the efficiency of the detector as shown in (Fig 2).

Fig 1: system of measurement using gamma ray spectroscopy (NaI(TL))



scintillation Detector

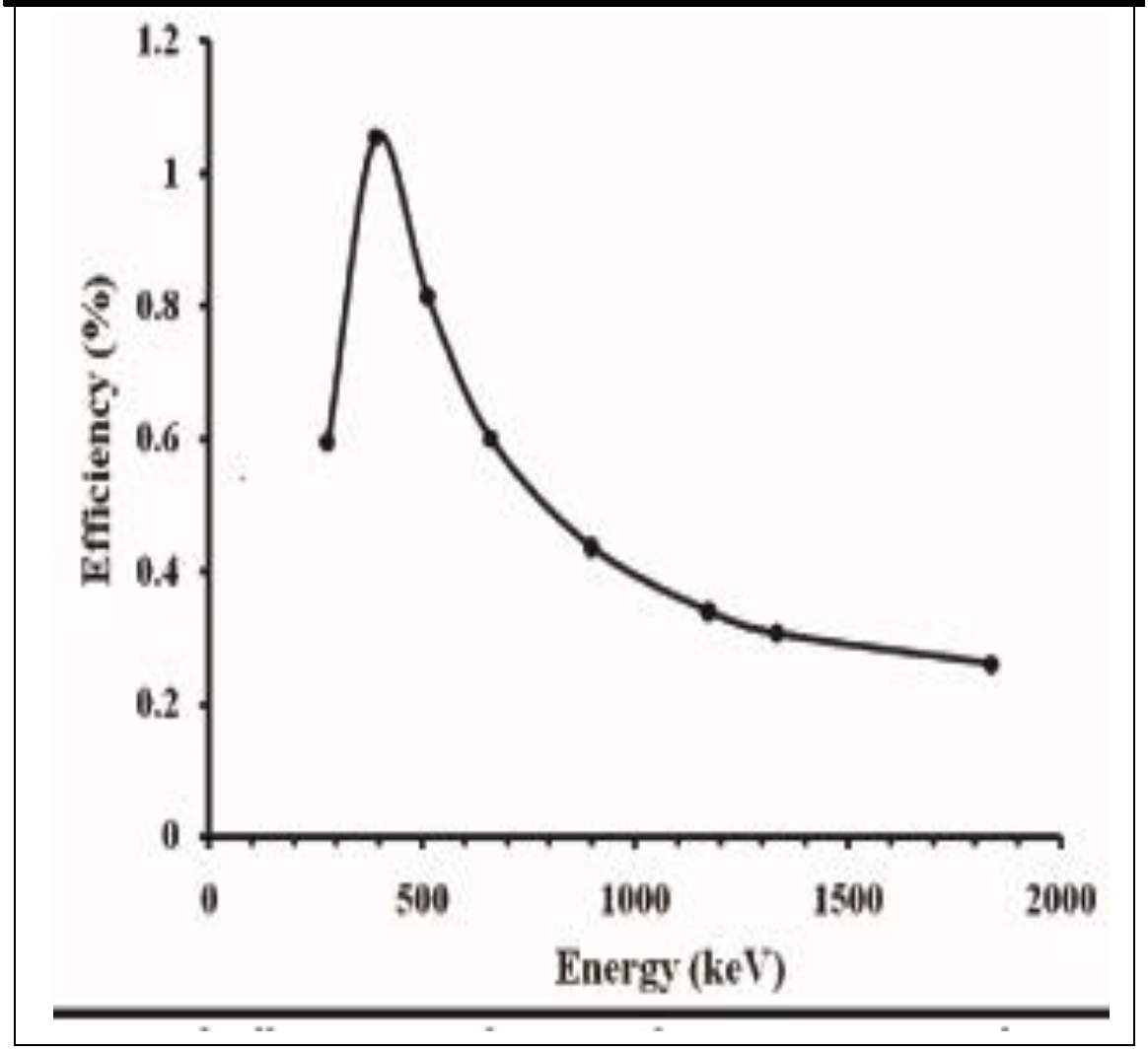


Fig 2: Full energy peak efficiency as a function of gamma ray energy for a typical NaI (TL) detector

Samples Preparation:

All samples were collected from different regions in Governorate of Karbala, after collection, samples were dried at about 100 ^{o}C to remove moisture and crushed to fine

powder, and then the homogenized samples were packed in 7.5 × 8 cm bottle and sealed tightly with cap kept aside for about month to ensure the equilibrium has been reached .

Method of calculation:

The magnitude of the activity concentrations of natural isotopes inside the soils was calculated by [9].

$$C(n) = C(E_n) - B(E_n) / m.f.t.P(E_n)$$

Where

n : is the number of soil sample , 1,2,3…..etc

C (n) : is the radioactive concentrations of natural isotopes in soil sample (n) in (Bq/Kg) .

$C(E_n)$: is the net γ-counts above continuum at the characteristic energy (E_n) .

$B(E_n)$: is the background counts at (E_n) .

m : is the mass of the sample in (Kg) .

f : is the branching ratio of the γ-emission at the energy considered .

t : is the measuring live time in (sec) .

$P(E_n)$: is the absolute efficiency at energy (E_n) .

Result and discussion:

From the results of the present study appeared that the activity concentrations existing in all soil samples were collected from different regions of governorate of Karbala as shown in tables (1) , (2) and (3) . Table (1) shows the activity concentrations of radionuclides that returns to U^{238} series with the higher concentration of Ra^{226} in sample number (3) reached to (73 ± 16.8) Bq/Kg , but for Bi^{214} , pb^{214} and Th^{234} equals to (42.295 ± 10.2) , (70.933 ± 13.5) and (17.885 ± 4.12) Bq/Kg in soil samples number (5,6 and 2) respectively . The data were given in table (2) represents the activity of the decay series of Th^{232} where the higher concentrations appeared for radionuclides (Ac^{228} , pb^{212} , Bi^{212} and Tl^{208}) as follows (64.5 ± 16 , 11.347 ± 5.47 , 18.994 ± 9.25 and 33.56 ± 6.04) Bq/Kg in samples (4 , 5 , 2 , and 1) respectively , while the upper limits of activity 589.616 ± 7.1) Bq/Kg as shown in table (3) . The mean and the ranges of the activity concentrations for all soil samples given in table (4) , but we observed different values of activities between the soil samples were collected from different regions from Karbala and this is due to the natural state and creation of soil . The results of the mean activity concentrations of the present search compared with the

similar worked in the other countries as given in table (5) and we found from these comparison all measurements results with the allowed limits .

Conclusions:

1-At the present study we observed existing the activity concentration in all soil samples were collected from different regions of Governorate of Karbala and this is due to the natural state , geological and geographical creation of soils .

2-From the comparison between the results of the activity concentration of the present work and the given data of the other countries well refers to that the concentrations in all soil samples with the permitted limits .

3- Soils can be safely used in construction of buildings and exploits for the agriculture without posing any significant radiological threat to population .

Table (1):The activity concentrations of the decay series of U^{238} in Bq/Kg

No of sample	Ra^{226}	Bi^{214}	Pb^{214}	Th^{234}
(1)	61.618 ± 10.5	3.503 ± 1.618	6.039 ± 2.206	6.075 ± 2.61
(2)	54.934 ± 18.7	39.82 ± 11.7	19.813 ± 6.082	17.885 ± 4.123
(3)	73 ± 16.8	32.77 ± 13.7	7.6 ± 3.468	4.15 ± 2.27
(4)	15.292 ± 3.07	32.24 ± 12.6	47.753 ± 23.11	8.1 ± 6.45
(5)	44.77 ± 15.3	42.295 ± 10.2	11.204 ± 6.18	6.917 ± 4.47
(6)	11.4 ± 4.69	20.855 ± 5.291	70.933 ± 13.5	8.09 ± 6.02

Table (2):The activity concentrations of the decay series of Th^{232} in Bq/Kg

No of sample	Ac^{228}	Bi^{212}	Pb^{212}	Tl^{208}
(1)	—	—	—	33.56 ± 6.04
(2)	8.252 ± 4.33	18.994 ± 9.25	—	18.735 ± 7.7
(3)	—	—	—	17.626 ± 10.09

(4)	64.5 ± 16	—	—	16.097 ± 11.9
(5)	30.626 ± 17.8	2.508 ± 0.102	11.347 ± 5.477	—
(6)	38.313 ± 21.4	—	—	11.261 ± 4.483

Table (3):The activity concentrations of K^{40} in Bq/Kg

No of sample	K^{40}
(1)	188.06 ± 3.3
(2)	395.99 ± 5.02
(3)	164.292 ± 3.14
(4)	355 ± 7.8
(5)	589.616 ± 7.1
(6)	233.74 ± 2.7

Table (4):Means and ranges of the activity concentrations for radioisotopes

Radioisotopes	Mean value (Bq/Kg)	Range value (Bq/Kg)
Ac^{228}	35.422	8.252 → 64.5
Ra^{226}	43.502	11.4 → 73
Bi^{212}	10.751	2.508 → 18.994
Bi^{214}	28.580	3.503 → 42.295
Pb^{212}	11.347	11.347→ 11.347
Pb^{214}	27.223	6.039 → 70.933
Th^{234}	8.536	4.15 → 17.885
K^{40}	321.116	164.292 → 589.616

Table (5): Comparison of the mean and the range values of the activity concentrations of Ra^{226} and K^{40} of the present work with the data of the other countries

Countries	Mean and ranges values of Ra^{226} (Bq/Kg)	Means and ranges values of K^{40} (Bq/Kg)	References
Iraq	43.502(11.4→73)	321.116(164.2→589.6)	Present

(Karbala)			work
Australia	— —	— (17→960)	[9]
Kuwait	36 (8→72)	227 (41→492)	[10]
Japan	— (5→130)	— (75→1400)	[11]
Bulgaria	— (9→77)	— (11→760)	[12]
Algeria	— (27-133)	— (184→632)	[13]
France	38 (9→62)	599 (120→1026)	[14]
Greece	212 (24→764)	1130 (258→2464)	[15]
Turkey	— —	— (220→3202)	[16]
Spain	45 (13→165)	650 (48→1586)	[17]

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قياس النشاط الاشعلعي الطبيعي للنويدات المشعة في بعض نماذج التربة من مناطق مختلفة في محافظة كربلاء

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الخلاصة:
الطريقة المستخدمة في هذا العمل الحالي هو قياس النشاط الإشعاعي الطبيعي للنويدات المشعة في ستة عينات تربة والتي جمعت من مناطق مختلفة في محافظة كربلاء وباستخدام الكاشف الوميضي لأطياف أشعة كاما متعددة القنوات NaI(TL). إن جميع القياسات التي أجريت على هذه النماذج أثبتت وجود نشاط إشعاعي والعائدة إلى سلسلة انحلال (U^{238} , Th^{232} , K^{40}) وكانت مديات هذه التراكيز للـ (Ra^{226} , Bi^{214} , Pb^{214} ، Th^{234}) هي كالآتي وعلى التوالي: من (4.69 ± 11.4) إلى (16.8 ± 73) ، ومن (3.503 ± 1.618) إلى (10.2 ± 42.295) ، ومن (2.206 ± 6.039) إلى (13.5 ± 70.933) ، ومن (4.15 ± 2.27) إلى (4.123 ± 17.885) Bq/Kg . بينما أعلى تراكيز لسلسلة انحلال Th^{232} (Ac^{228}، Bi^{212} ، Pb^{212} ، Tl^{208}) هي كالاتي وعلى التوالي (21.4 ± 38.313 ، 9.25 ± 18.994 ، 11.347 ± 5.477 ، 6.04 ± 33.56) Bq/Kg ، اضافة الى تركيز K^{40} التي تساوي (7.1 ± 589.616) Bq/Kg .تمت مقارنة نتائج قياس الخاص بـ Ra^{226} ، K^{40} لهذا البحث مع مستويات النتائج لدول أخرى ووجدنا إنها ضمن الحدود المسموحة بها .