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Natural Radioactivity Levels in Soil Samples for Some Locations of Missan Government, Iraq

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ABSTRACT

The level of natural radioactivity in soil of 20 mining samples collected from locations in Missan, Iraq. Concentrations of radionuclides in samples were determined by using NaI(Tl) (3''x3''). The obtained results of specific activity (Bqkg^{-1}) for each radionuclide in every soil sample and compared with the worldwide average and permissible limits as recommended by UNSCEAR 2008. The values of specific activity for ^{238}U have been found to lie in the range of 14.6±2.32 to 41.08±2.55 Bqkg^{-1} with a mean value of 21.19±2.33 Bqkg^{-1}, the values of specific activity for ^{232}Th 7.88±0.47 to 16.06±0.48 Bqkg^{-1} with mean value of 9.72±0.47 Bqkg^{-1} and the values of specific activity for ^{40}K from 372.67±4.53 to 667.83±6.01 Bqkg^{-1} with a mean value of 453.91±5.58 Bqkg^{-1}. The average values of Ra_{eq}, AD, AED (indoor and outdoor), H_{ex}, H_{in} and (I_γ) were 66.55±10.61 Bqkg^{-1}, 34.58 nGhy^{-1}, 0.169 mSvy^{-1}, 0.042 mSvy^{-1}, 0.189, 0.2825 and 50.27. It can be concluded that the study area is safe radioactive except for some samples were found high activities need to be further studies.

1. Introduction

Natural radioactivity is widespread in the earth and is present in a different environment geological formations in the soil and rocks, plants and water, food, air and building materials [1]. So the natural radioactivity of environmental studies, necessary not only for the impact of radiation, but have a great interest and importance in health physics also for their ability [2]. Natural radionuclides in soil comes from the ^{238}U series, ^{232}Th and ^{40}K, the concentration of radionuclides Taipei hive soil and found that differ greatly from one place to another [3]. The Gamma radiation emitted from natural radioactive isotopes, such as ^{226}Ra and ^{232}Th series and decomposition products, and ^{40}K, which are found in trace levels in all configurations land is the main external source of radiation to the human body [4]. Environmental radioactivity of natural and associated external exposure due to gamma radiation depends mainly on the local geographical and geological conditions and appear on different levels in every region of the world and the rate of natural gamma dose Ground is an important contributor to the medium dose that the world's population receives [5, 6]. Natural radioactivity in the soil measurement is great importance to many researchers all over the world, which led to a worldwide national surveys in the past two decades, measurement of natural radioactivity in the soil is very important to determine the amount of change of the natural background activity with time due or leak radioactive [7].

2. Experimental Methods

2.1 Area of Study

Architecture City Center of Meissen province, located in the southern part of Iraq, and lies about 375 kilometers south-east of the capital, Baghdad. The city is located on the banks of the Tigris River, and lies about 50 km from the Iran-Iraq border, and a few kilometers from the marsh area, located at longitude 47.15 degrees and 21 minutes, latitude of 31.83 degrees and 57 minutes and boarded it from the north and Wiest (city which is 220 km away about it), and the south-west Basra (city which is 180 km away from the city) indicated in Fig. 1.

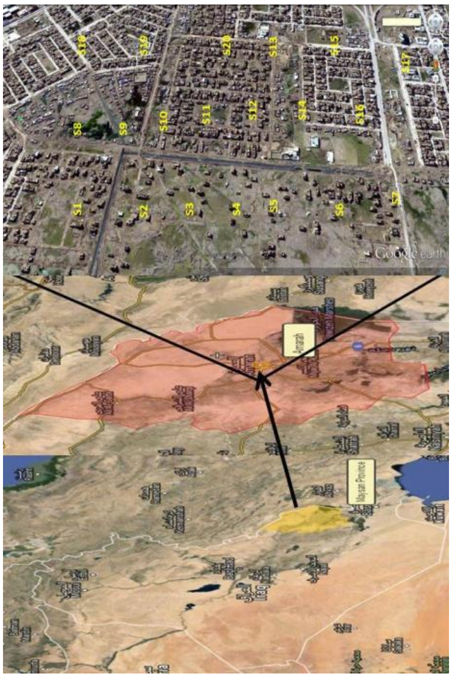

Fig. 1 Map of location samples in study area

2.2 Methodology

A total sample of soil, collected from three sites in Missan, the samples are prepared for analysis by drying and keeping them moisture-free by putting them for 24 hours in an oven at 100 °C the samples are mechanically crushed to reach a suitable homogeneity. In this work using a (1L) Marnelle beaker of constant volume and samples were packed in it and left for (30 day) to reach radioactive equilibrium before measurement.

Radioactivity measurements were performed by gamma ray spectrometry (ORTEC Part Number 931000) which consists of detector NaI(Tl) the volume of crystal is (3"x3"), supplied by (Alpha Spectra, Inc.-12I12/3), coupled with a multi-channel analyzer (MCA) (ORTEC –Digi Base) with range of 4096 channel joined with ADC (Analog to Digital Convertor) unit, through interface and desperation energy (FWHM) in the peak 1.33 KeV for 60 °C is 7%. The gamma rays levels were measured by

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integral counting using a set-up. Gamma-ray spectrometer consists of a scintillation detector NaI(Tl) system of (3"x3") crystal dimension, and the supplier of the company (Alpha Spectra, Inc.-12I12/3) coupled with a multi-channel analyzer (MCA) (ORTEC -Digi Base) that contains a 4096 channel connecting unit called ADC (Analog to Digital Convertor), through interface. The spectroscopic measurements and are analyzed by a computer program called (MAESTRO-32) software into the PC in the laboratory as it is linked to parts of the system measurements and analysis.

2.3 Calculation of Specific Activity and Radiation Hazard Indices

From ^{238}U, ^{232}Th and ^{40}K contents the natural radioactivity of soil samples is usually determined to decreased the scattering radiation from the interaction of the radiation in the sample with shield. The sample was put in the middle of room shield with time period about (30000 sec) according to radioactivity for each of ^{232}Th, ^{40}K and ^{238}U using (EC & ORTEC) program. The specific activity of ^{232}Th and ^{238}U were determined from ^{208}Tl, (99% possibility)with the gamma transition energy about 2614 keV and from ^{214}Bi (15.96% possibility) with the gamma transition energy 1764.49 keV respectively, whereas by using the 1460 keV gamma ray line (11% possibility) determined activity of ^{40}K [8].

The calculated specific activities in units of curies per kilogram by using the following equation [9].

$$A\ (BqKg^{-1}) = \frac{N}{t \times \varepsilon \times I\gamma \times m} \quad (1)$$

where N net area under photo peak, t - counting time sec, I_γ - gamma emission probability, m - sample weight (kg), ε efficiency of the detector at particular gamma energy [8].

Calculation Radiation Hazard Indices: In order to measure the radiation hazards depend on the values of ^{40}K, ^{238}U and ^{232}Th, the radiation hazard for all soil samples can be calculated as absorbed dose rate (D), the radium equivalent activity (Ra_{eq}), internal hazard index (H_{in}) and the external hazard index (H_{ex}), as following: The radium equivalent activity was calculated using the relation [10, 11]:

$$Ra_{eq.}\ (BqKg^{-1}) = A_{Ra} + 1.43_{ATh} + 0.77_{Ak} \quad (2)$$

To limit the external gamma-radiation dose from soil sample, an extensively used hazard index, the external hazard index (H_{ex}) and the internal hazard index(H_{in}) was calculated from the equation [8, 10, 11].

$$H_{ex} = \frac{ARa}{370} + \frac{ATh}{258} + \frac{AK}{4810} \quad (3)$$

$$H_{in} = \frac{A_{Ra}}{185} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \quad (4)$$

where $_{Ra}$,A_{Th} and AK the activities of ^{238}U, ^{232}Th and ^{40}K in $BqKg^{-1}$.

Absorbed Dose Rate: the measured activities of ^{40}K, ^{238}U, and ^{232}Th in soil samples were used in calculation of the gamma-absorbed dose rate in the air at 1 m over the ground calculated AD rates were by following equation[11, 12]:

$$AD\ (\mu Gyh^{-1}) = 0.462\ A_{Ra} + 0.604 A_{Th} + 0.042 A_K \quad (5)$$

To estimate the annual effective dose rates, from absorbed dose the conversion coefficient in air to effective dose(0.7 $SvGy^{-1}$)the fraction of time spent indoors and outdoors is 0.2 and 0.8 respectively [13].

$$Indoor\ (nSv) = absorbed\ dose\ nGyh^{-1} \times 8760\ h \times 0.8 \times 0.7\ SvGy^{-1} \quad (6)$$

$$Outdoor\ (nSv) = absorbed\ dose\ nGyh^{-1} \times 8760\ h \times 0.2 \times 0.7\ SvGy^{-1} \quad (7)$$

3. Results and Discussion

Table 1 show the values of specific activity in soil in this study of ^{238}U, ^{232}Th and ^{40}K radionuclides with samples code respectively. The specific activity for ^{40}K from 372.67±4.53 to 667.83±6.01 $Bqkg^{-1}$ with an average value 453.09±5.58 $Bqkg^{-1}$, the specific activity for ^{238}U found from 14.6±2.32 to 41.08±2.55 $Bqkg^{-1}$ with an average 16.81±2.84 $Bqkg^{-1}$, specific activity of ^{232}Th variated from 7.68±0.47 to 17.99±0.52 $Bqkg^{-1}$ with average 9.83±0.545 $Bqkg^{1}$. Table 2 shows the results of radiation hazard indices in all samples of soil under study. From Table 2, it is found that the value of Ra_{eq} varied from 56.56±9.63 to 105.11±10.14 $Bqkg^{-1}$ with an average 66.55±10.61, the value AD varied from 28.19 to 51.14 with an average 34.58 $nGhy^{-1}$, while the values H_{ex}, H_{in}, annual effective dose (in and outdoor) and Representative level index (I_γ) have been found to range of 0.152 to 0.319 with an average 0.189, from 0.191 to 0.409 with an average 0.282, from 0.138 $mSvy^{-1}$ to 0.286 $mSvy^{-1}$ with an average 0.169 $mSvy^{-1}$, from 0.034 $mSvy^{-1}$ to 0.071 $mSvy^{-1}$ with an average 0.042 $mSvy^{-1}$ and from 0.221 to 0.424 with an average value of 0.27. The results are comparable to the world average activity concentration which are 412, 32, and 45 $Bqkg^{-1}$ for ^{40}K, ^{238}U and ^{232}Th respectively as reported by UNSCEAR 2008 [14]. All results in specific activity of ^{40}K are found higher than worldwide average exception in two samples is less than the worldwide average, because increase in the concentration of potassium nuclide in some areas of the reason is due to the existence of agricultural land and areas containing phosphate, the specific activities for ^{238}U values found are lower than the worldwide average exception in two samples the worldwide average reported by UNSCEAR 2008 [14]. The cause of high activity in these samples is the geological layer of the area specific activity of ^{232}Th were under the worldwide average by UNSCEAR 2008 [14]. Radium equivalent and AD less than worldwide average by UNSCEAR 2008 [13]. The results of radiation hazard in this study comparing with the worldwide average reported were under the worldwide average by UNSCEAR 2008 [14].

Table 1 Results of Specific Activity in all samples of soil under study

Sample Code	Specific Activity ($Bqkg^{-1}$)		
	A_U	A_{Th}	A_K
S1	14.79± 2.5	10.07± 0.55	482.6±5.82
S2	19.25± 2.43	9.59± 0.53	438.8±5.66
S3	22.13± 3.21	11.01± 0.49	559.03± 5.17
S4	28.42± 2.77	13.44± 0.47	414.46±5.26
S5	26.27± 2.06	15.8± 0.46	618.61±4.58
S6	14.6 ± 2.32	10.69± 0.46	480.92 ±5.47
S7	25.5 ± 3.5	10.01± 0.48	468.69 ±5.1
S8	22.38± 3.21	9.45±0.55	445.39±5.35
S9	41.08± 2.55	14.7±0. 53	558.56 ±5.35
S10	24.34± 3.27	11.67± 0.51	511.51 ±5.66
S11	14.19± 2.4	7.68± 0.53	407.67 ±5.03
S12	29.98± 2.7	14.62± 0.51	573.66 ±5.27
S13	27.08± 3.22	11.65± 0.57	494.81 ±5.93
S14	22.94± 3.16	12.22± 0.53	470.6 ±5.52
S15	28.27±3.63	10.67± 0.51	461.5 ±5.4
S16	27.27± 2.06	15.87± 0.44	573.94 ±4.73
S17	29.28± 2.15	16.06± 0.48	544.25 ±4.91
S18	24.28± 2.71	12.12±0.51	477.23 ±5.54
S19	27.43± 2.42	9.07± 0.46	410.15 ±5.05
S20	27.59± 3.04	9.37± 0.52	425.22 ±4.93
Min	14.6± 2.32	7.68 ± 0.47	372.67 ±4.53
Max	41.08±2.55	16.06± 0.48	667.83 ±6.01
Mean	21.19±2.33	9.72± 0.47	453.91±5.58
worldwide average	33	45	412

Table 2 Radiation hazard indices in all samples under study

Sample Code	*Ra aq* (*$Bqkg^{-1}$*)	AD ($nGhy^{-1}$)	Indoor ($mSvy^{-1}$)	Outdoor ($mSvy^{-1}$)	H_{ex}	H_{in}	(I_γ)
S1	66.35 ±10.86	33.03	0.162	0.040	0.179	0.292	0.260
S2	66.75±10.56	32.98	0.161	0.040	0.180	0.232	0.258
S3	80.91±10.64	40.18	0.197	0.049	0.218	0.278	0.315
S4	79.55±10.32	38.53	0.189	0.047	0.214	0.291	0.300
S5	96.49±8.64	47.47	0.232	0.058	0.260	0.331	0.372
S6	66.90±10.17	33.25	0.163	0.040	0.180	0.220	0.262
S7	75.90±10.82	37.37	0.183	0.045	0.205	0.273	0.291
S8	70.18±10.9	34.62	0.169	0.042	0.189	0.250	0.270
S9	105.11±10.14	51.14	0.250	0.062	0.283	0.394	0.396
S10	80.41±10.4	39.62	0.194	0.048	0.217	0.282	0.309
S11	56.56±9.63	28.19	0.138	0.034	0.152	0.191	0.221
S12	95.05 ±10.27	46.60	0.228	0.057	0.256	0.337	0.364
S13	81.83±11.74	40.18	0.197	0.049	0.221	0.294	0.313
S14	76.65±11.09	37.60	0.184	0.046	0.207	0.269	0.294
S15	79.06±11.39	38.74	0.190	0.047	0.213	0.289	0.301
S16	94.15±8.85	46.11	0.226	0.056	0.254	0.328	0.361
S17	94.15±9.2	45.92	0.225	0.056	0.254	0.333	0.359
S18	78.35±10.67	38.43	0.188	0.047	0.211	0.277	0.300
S19	71.98±9.67	35.25	0.172	0.043	0.194	0.268	0.273
S20	73.73±10.12	36.13	0.177	0.044	0.199	0.273	0.280
Min	56.56±9.63	28.19	0.138	0.034	0.152	0.191	0.221
Max	105.11±10.14	51.14	0.286	0.071	0.319	0.409	0.424
Mean	66.55± 10.61	34.58	0.169	0.042	0.189	0.2825	0.27
worldwide average	<370	55	0.41	0.07	<1	<1	1

4. Conclusion

In the light of the study, we conclude that, the soil samples in this study have radioactivity and significant variation in various time. The uranium activities were within normal level in the studied area in all samples of exception two samples higher than the range of worldwide average, while potassium radionuclide in all sample is higher than the range of worldwide average exception some sample, and the thorium in all samples lower than the range of worldwide average. The radium equivalent activity, the absorbed dose rates (internal and external), hazard index, annual effective dose (in and outdoor) and $(I_\gamma)$of all soil samples are lower than the permissible limit and it can be concluded that the study area is safe radioactive except for some samples were found high activities need to be further studies.

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