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Measurement of Concentrations of Radionuclides and Internal and External Risk Factors for Models of the Hilla Deposits in Babil Governorate

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Abstract

The normal radioactivity levels were measured in 20 samples. This was performed using a highly efficient NaI (Tl) (3x3) detection system. Analysis and scheduling compared to the global average and allowable limits as recommended by international scientific agencies.

It was found that the specific efficacy of all the models for both ^{232}Th thorium from (0.539 ± 0.203) Bq.Kg^{-1} to (22.254 ± 1.309) Bq.Kg^{-1} and at a rate of (8.1160 ± 0.733, Bq.Kg^{-1} Uranium ^{238}U of (1.777 ± Bq.Kg^{-1} to Bq.Kg^{-1} (25.259 ± 1.375) and Bq.Kg^{-1} (18.174 ± 1.029), potassium 40K from Bq.Kg^{-1} (192.967 ± 4.102) to Bq.Kg^{-1} (388.452). According to5.825 (Bq.Kg^{-1}(334.179 ± 5.336), as per the radium equivalent and ranged from Bq.Kg^{-1}(13.041 ± 3.1382) to Bq.Kg^{-1}(85.373 ± 3.684) and Bq.Kg^{-1}). The effective concentration coefficient ranged from Bq.Kg^{-1}(0.0567 ± 0.004463) to Bq.Kg^{-1}(1.453 ± 0.01239) with Bq.Kg^{-1}(0.3121 ± 0.0105) and the internal risk coefficient ranged from Bq.Kg^{-1}(0.0543 ± 0.00399) to Bq.Kg^{-1}(0.4705 ± 0.0154) with an average of (0.2133 ± 0.00960) and the external risk coefficient ranges from Bq.Kg^{-1}(0.04928 ± 0.0029) to Bq.Kg^{-1}(0.1332 ± 0.0057) at an average of Bq.Kg^{-1}(0.1491 ± 0.00632)

By comparing the results globally, I found that the radiation levels of the studied models are within the permissible limits and do not pose a threat to humans (tourists and workers) in the region as well as those living near the studied area.

Keywords: Radiation activity; NaI(Tl); Gamma Ray; Hazard Indices

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Introduction

Environmental pollution has been a great danger to humanity since the beginning of life on earth. Therefore, it is natural for us to be sensitive and effective against all the pollutants causing danger to our lives. Radiation is in the form of either particles or waves, depending on the quantity of energy transferred, radiation be classified as either ionizing or non-ionizing radiation. The structure of the atom is important to realize the origin and nature of radiation. All previous researches carried out in recent decades have shown that under normal condition, more than 70% of a total annual radioactive dose received by people originates from natural sources of ionizing radiation, which is 54% due to inhalation and ingestion of natural radioactive ^{222}Rn,^{220}Rn and its decays [1].

Terrestrial radionuclides are common in the rocks, soil, water and in building materials used for homes. These radionuclides were existent at the creation of the planet, since some of these radionuclides have very long decay half-lives (on the order of hundreds of millions of years or more), big quantities of these radionuclides are still existent on the ground today. These radionuclides can be classification into two types:

(i) Singly occurring radionuclides and

(ii) Decay chains [2]

The concentration of the normal radioactive materials depends on situation of geology and geography and it appears at different level in soils of each different geological district [2]. Soil radionuclide activity concentration is one of the essential determinants of the natural background radiation. When rocks are disintegrated through natural operations, radionuclides are overlapped with soil by rain and drifts. In addition to natural sources of radiation, the soil radioactivity is also influenced industrial sources of radiation. One of the essential external sources of radiation to the human body is represented by the gamma radiation (background radiation) released by naturally occurring radioisotopes, so natural radioactivity is a source of continuous exposure to human beings [3]. It is well known that natural radioactivity due to potassium, thorium and, especially, uranium has harmful effects on human life. The concentration value depends on soil type, geological features and geographical conditions. The high natural radiation levels are usually associated with igneous rocks, like granite, and lower levels are usually associated with sedimentary rocks [4].

Materials and Methods

After selecting the study area, the Hilla River in Babil Governorate to study the natural radiological activity of selected samples of the sediments. After obtaining the official approvals for collecting the samples, 20 samples were distributed on 10 sites at a depth of 30 cm to 45 cm. Using Positioning Device (GPS) After positioning, the sample shall be drilled, extracted and placed in polyethylene bags with a capacity of (2Kg) and numbered according to the location and transferred to the place of preparation and measurement in the research laboratory of the Physics Department, Faculty of Science, Babil University.

To measure the radioactivity of the models, the soil should be free of moisture because the measurement of the specific effectiveness depends on the weight of the model. To get rid of this moisture, the models should be dried by exposing them to the sun for about 2 to 4 days in an exposed area to reach a fixed weight. (0.5 mm) to remove the pebbles and the roots of the suspended plants to obtain homogenous soil free from impurities. Then take 1 kg of each sample into plastic bags and leave the sample for a month until it is measured. The measurement is made in a one-liter, one-liter marnelli container Device after washing with diluted hydrochloric acid, and then washed with distilled water to be configured to measure.

Calculation of specific activity

When ^{238}U equilibrium with its radioactive births as well as thorium ^{232}Th and its births, as the effectiveness of all elements of the two radiation chains is in equilibrium, it is possible to calculate the specific effectiveness of an element in any series in terms of the effectiveness of another element, where it emits a range of gamma rays whose yield can be distinguished. The quality of both ^{232}Th by calculating the specific effectiveness of the radioactive thallium nucleus 208Tl 2614.511KeV and ^{238}U by calculating the specific effectiveness of the bismuth ^{214}Bi card of 1764.539KeV and also calculates the potency of the potassium nucleus 40K radioactive energy 1460.822KeV can be calculated by the following [5]:

$$A = \frac{N_{net}}{\varepsilon.I_{\gamma}.m.t} \pm \frac{\sqrt{N_{net}}}{\varepsilon.I_{\gamma}.m.t}\left[Bq.kg^{-1}\right] \quad (1)$$

Where:

N_{net}: net area under the top of the light curve

I_{γ}: concentration factor for effectiveness

m: mass of the model in units (Kg)

t: measurement time in units (sec)

In all direct and indirect measurements made by measuring instruments, there is a standard error (Systematic Error) accompanying the measurements.

There is also another error is the random error (Random Error) can be calculated random error associated to measure the effectiveness of a model by recording N of the count and then take the square root of it:

$$Error = \sqrt{N} \quad (2)$$

This error was calculated in the measurements made in measuring the specific effectiveness in this research.

The specific radioactivity of uranium AU-235 was calculated by the relation between it and the specific uranium AU-238 according to the following equation [6]:

$$A_{u-235} = \frac{A_{u-238}}{21.7} \quad (3)$$

The results obtained were compared with the allowed Worldwide Average [7]. The specific efficiency of each radioactive element was calculated individually and for the studied depth. The highest and lowest values were determined and the average for each depth and for all the results obtained.

Measurement of hazard indices

Depending on the specific efficacy of thorium, uranium^{238}U, potassium, several risk factors were calculated.

Radium equivalent (Ra_{eq}): This is used to estimate the risk of the specific efficacy caused by $Bq.Kg^{-1}$ and its effectiveness varies according to the different soil types and can be standardized relative to the radiation exposure resulting from it known as the Ra_{eq} radium equivalent and to compare the specific efficacy For different sizes of soil, use the following formula [8]:

$$Ra_{eq}(Bqkg^{-1}) = A_u + 1.434_{Th} + 0.077A_k \quad (4)$$

A_k, A_{Th}, and A_U have the specific efficacy of uranium, thorium and potassium respectively, and the highest value of Ra_{eq} should be less than the global limit ($Bq.Kg^{-1}$370) [7].

Activity concentration index (I_{γ}): Which is used to calculate the risk arising from Kama radiation associated with natural radioactive radionuclides (Uranium ^{238}U, Thurium ^{232}Th and Potassium 40 K) in the studied material. The I_{γ} is calculated from the following equation [9]:

$$I_{\gamma} = \frac{A_U}{150} + \frac{A_{Th}}{100} + \frac{A_K}{1500} \quad (5)$$

External hazard index(H_{ex}): External risk represents the ionized risk of natural gamma radiation. The risk of natural gamma radiation can be assessed by the external risk factor and calculated from the following equation [10]:

$$H_{ex} = \frac{A_U}{370} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \quad (6)$$

Internal hazard index (H_{in}): The inhalation of alpha particles emitted from short-lived isotopes such as radon and thoron that are associated with gamma rays are differentiated cards and can be expressed in terms of the internal risk factor (H_{in}) and are calculated by the following equation [8]:

$$H_{in} = \frac{A_U}{185} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \quad (7)$$

The amount of internal risk is preferred to be less than one in the ideal environment for job opportunity and peace for respiratory organs and for living individuals [7].

Absorbed dose rate in air (AD): The total percentage of the absorbed dose in air can be calculated in terms of terrestrial nuclei concentrations by the following equation [11]:

$$AD(nGy/h) = 0.462A_U + 0.621A_{Th} + 0.0417A_K \quad (8)$$

Where: (0.462, 0.621 and 0.0417) are the naturally occurring conversion factors for radionuclides.

The Annual effective dose: In order to calculate the effective annual dose, consideration should be given to the calculation of the effective

dose-to-dose conversion factor and the occupancy factor. To calculate the effective dose of the KAM emission factor in the air, UNSCER 2000 has published the conversion factor. 0.7Sv/Gy as a conversion factor from the absorbed dose to the annual effective dose received by adults and use 00.2% of the time spent abroad. From these data, the annual effective external dose was calculated as follows:

Outdoor (mSv/y) = AD (nGy/h)x10-6 x 8760h/y×0.20×0.7Sv/Gy (9)

Where: 8760 refers to the number of hours of the year.

Conclusion

The Hilla River in Babil Governorate can be classified as areas where natural radioactivity is within the permissible limits, depending on most of the results, except there are two areas where the potassium specific potency ratio was higher than the permissible limit because the area was a place for throwing chemical waste and agricultural fertilizers. The rate of specific efficiency of radionuclides (^{232}Th, ^{238}U, and 40K) increases with depth. With depth.

The values of the specific radioactive activity of thorium ^{232}Th isotope, uranium isotope ^{238}U, potassium isotope 40K and uranium isotope ^{235}U were distributed in varying proportions for the Hilla River and are within the global allowable limit. All the results of the radium equivalent values, effectiveness concentration coefficient, internal and external hazard coefficient, air absorbed dose and annual effective external dose of soil models were within the universally allowed range.

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