Evaluation of Natural Radioactivity in Dust Storms Samples from Al-Najaf//Iraq

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Abstract: ^{40}K , ^{238}U and ^{232}Th in dust storms samples from Al-Najaf Holy Area – Iraq in year 2013 were measured using a high efficiency gamma ray spectroscopy NaI(Tl) detector. From the measured gamma rays spectra, the specific activity were determined for ^{40}K (range from 237.166 to 368.689 Bq/kg), ^{238}U (range from 11.531 to 34.997 Bq/kg) and ^{232}Th (range from 2.805 to 11.162 Bq/kg). Hazard indices (external hazard index, internal hazard index, radium equivalent activities and absorbed effective dose rates) were calculated for the measured samples to assess the radiation hazards arising from dust storms samples, which is the average of Hazard indices equal (0.214, 0.192, 25.359 nG/y and 50.855 Bq/Kg), respectively. All results of Hazard indices were compared with safe limit values recommended by UNSCEAR (2008) below the safe limit .

Key words: Dust storms in Najaf, natural radioactivity, gamma-ray spectroscopy.

1. Introduction

A dust storm or sand storm is a meteorological phenomenon common in arid and semi-arid regions. Dust storms arise when a gust front or other strong wind blows loose sand and dirt from a dry surface. Particles are transported by saltation and suspension, a process that moves soil from one place and deposits it in another place[1].

Iraq is considered one of the region's most vulnerable countries to climate change and it faces a unique set of environmental challenges. Rising environmental degradation and increasing frequency and intensity of extreme weather events, especially sand and dust storms, take an enormous toll on socioeconomic life and human development across the region [2].

Dust and sand storms are persistent problem in Iraq and Middle East Region. The regional dust storms had bad effects on health of human life which can cause asthma, bronchitis and lung diseases as well as the effects of natural radioactivity that contain of dust

storms.

The aim of this work is to measure natural radioactivity due to ^{238}U , ^{232}Th and ^{40}K in Al-Najaf area for some samples of dust storm in different data time 2013 using gamma ray spectroscope and determine the Radiation Hazard (the absorbed dose rate, radium equivalent activities, external hazard index and Internal hazard), which are calculated based on guidelines provided by UNSCEAR (2008) [3-5].

2. Materials and Methods

The natural radionuclides were measured in 8 dust storms samples. These samples were collected from different local area of Najaf at different date from 1/1/2013 to 1/7/2013 . In this work, a 1 L polyethylene marinelli beaker was used as a sampling and measuring container.

Each sample was measured with a gamma-ray spectrometer consisting of a NaI(Tl) ("3 × 3") setup and multichannel analyzer 8192 channel, with the following specifications: resolution (FWHM) at 1.33 MeV ^{60}Co is 60 keV relative efficiency at 1.33 MeV ^{60}Co is 6.9%. The detector was shielded in a chamber of two layers starting with stainless steel (10 mm thick) and lead

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(30 mm thick). This shield serves to reduce different background radioactivity.

The sample was placed on the NaI(Tl) detector and counted for 18,000 sec. The spectra were either evaluated with the computer software program Maestro(EG&G ORTEC). The specific activity of ^{238}U and ^{232}Th were determined from the energy 1764.49 keV gamma transition energy of ^{214}Bi (15.96% possibility) and from the 2614 keV gamma transition energy of ^{208}Tl , (99% possibility) respectively, whereas ^{40}K activity is determined by using the 1,460 keV gamma ray line (11% possibility) [6].

The specific activity of each radionuclide can be calculated using the following equation [7].

$$A(\text{Bq/kg}) = \frac{C}{\varepsilon \cdot \gamma \cdot m \cdot t} \quad (1)$$

where A is the specific activity of the radionuclide in Bq/kg, C is net peak count (background subtracted), ε is the counting efficiency, γ is the percentage of gamma emission probability of the radionuclide under study, t is the counting time in second and m is the mass of the sample in kg [7].

Based on the measured values of ^{238}U , ^{232}Th and ^{40}K , the radiation hazard for all dust storms samples can be calculated such as the radium equivalent activity (Ra_{eq}), the external hazard index (H_{ex}), internal hazard index (H_{in}), and the total air absorbed

dose rate (D) as following:

The radium equivalent activity was calculated using the relation [8-10]:

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

The external hazard index (H_{ex}) and internal hazard index (H_{in}) were calculated by the following equation [11-13]:

$$H_{ex} = A_{Ra}/370 + A_{Th}/259 + A_K/4810 \quad (3)$$

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

The absorbed dose rates were calculated by the conversion factor[14]:

$$D = 0.461A_{Ra} + 0.623A_{Th} + 0.0414A_K \quad (5)$$

3. Results and Discussion

The summarized values of specific activity (^{40}K , ^{226}Ra and ^{232}Th radionuclides) and radiation hazard (Ra_{eq} , H_{ex} , H_{in} and absorbed dose rate) for 8 dust storm samples are shown in Table 1.

From the result in Table 1, the specific activity values have been found to range from (334.939 ± 8.281) to (368.689 ± 17.697) Bq/kg with an average from (308.168 ± 46.124) Bq/kg, from (11.531 ± 2.080) to (34.997 ± 2.683) Bq/kg with an average value of (21.4775 ± 8.406) Bq/kg and (2.805 ± 0.370) to (11.162

Table 1 Results of the activity concentration of ^{40}K , ^{226}Ra and ^{232}Th (Bq/kg) with total radium equivalent activity (Bq/kg), (external and internal) hazard and total absorbed dose (nG/y) in different dust storms samples.

Sample Code	Date	Specific activity in (Bq/Kgm)			Radiation Hazard			
		^{40}K	^{226}Ra	^{232}Th	Ra equivalent (Bq kg ⁻¹)	External hazard index	Internal hazard index	Absorbed dose rate(nGyh ⁻¹)
1	23/02/2013	296.975 ± 5.373	23.089 ± 2.514	4.333 ± 0.450	52.152265	0.217871	0.203276	25.939186
2	06/03/2013	332.349 ± 5.788	13.687 ± 2.095	5.482 ± 0.454	47.117133	0.199581	0.164245	23.823424
3	17/03/2013	265.057 ± 4.679	11.531 ± 2.080	3.775 ± 0.390	37.338639	0.156765	0.13201	18.898366
4	05/04/2013	237.166 ± 5.834	12.952 ± 1.615	2.805 ± 0.370	35.224932	0.146277	0.130148	17.756826
5	16/04/2013	277.622 ± 6.455	22.451 ± 2.297	5.115 ± 0.479	51.142344	0.215953	0.198823	25.336776
6	02/06/2013	334.939 ± 8.281	34.997 ± 2.683	3.362 ± 0.604	65.594963	0.269625	0.271788	32.407904
7	09/06/2013	368.689±17.697	23.063 ± 4.612	11.162 ±1.638	67.413713	0.295247	0.244412	33.350696
8	20/06/2013	352.548 ± 7.881	30.05 ± 2.26	7.533 ± 0.538	67.968386	0.289033	0.264812	33.556434
Range		234 - 370	11 - 35	2 - 12	35 - 70	0.1 - 0.3	0.1 - 0.3	17 - 34
Mean ± S.D		308.168±46.124	21.4775±8.406	5.446±2.738	52.994±13.041	0.224±0.0569	0.201±0.057	26.384±6.263

Fig. 1 A comparison of specific activity with the worldwide average and permissible limit for dust storm samples.

Fig. 2 A comparison of hazard indexes with the worldwide average and permissible limit for dust storm samples

± 1.638) Bq/kg with an average value of (5.446 ± 2.738) Bq/kg for ^{40}K , ^{226}Ra and ^{232}Th , respectively, also the values of radiation hazard of Ra_{eq} , H_{ex} , H_{in} and absorbed dose rate have been found to range of 35.224932 Bq/kg to 67.968386 Bq/kg with an average of 52.994 Bq/kg, from 0.146277 to 0.295247 with an average value of 0.224, from 0.130148 to 0.271788 with

an average value of 0.201 and from 17.756826 nGy/h to 33.556434 nGy/h with an average value of 26.384 nGy/h, respectively.

The results are comparable to the world average activity concentration which are 412, 32, and 45 Bq kg⁻¹ For ^{40}K , ^{226}Ra and ^{232}Th , respectively, as reported by UNSCEAR 2008 [5], therefore all results indicates

that the activity concentrations of ^{40}K , ^{226}Ra and ^{232}Th were under the worldwide average as shown in Fig. 1, while comparing between the results of radiation hazard in this study with the worldwide average reported by UNSCEAR 2008 [5] were under the worldwide average as shown in Fig. 2. The reasons found some of radioactivity in dust storm samples to nuclear reaction between cosmic ray with some elements that found in atmosphere such as Oxygen and Nitrogen, but the reason for vibration in radioactivity concentration in all samples in this study could be a function of meteorological parameters of the dust storm samples such as wind velocity, humidity, rain and air temperature.

4. Conclusions

Radioactivity has been found in all samples. All results natural radioactivity and radiation hazard for dust storm samples of Najaf area from (1/1/2013) to (1/7/2013) were lower than the worldwide recommendation. The buildup of absorbed dose in dust storm over one year was effective on healthy of human therefore, the exposure in dust storm must be reduced.

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