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Research Article

Estimating the Concentrations of Natural Isotopes of ^{238}U, ^{232}Th, ^{40}K & Radiation Dose Rates for Wasit Province-Iraq by Gr-460 system

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Abstract:

This paper includes the measurement of the concentrations of natural radioactive isotopes of ^{238}U, ^{232}Th, ^{40}K, and radiation dose rates for selected areas of Wasit province .GR-460 system has been used for the radiological survey operations, it is a portable system, installed inside a minibus and inside the system there is a Sodium Iodide Detector (NaI), that has the ability to measure the concentrations of natural radioactive isotopes in (ppm) unit and measure the radiation dose rates in µR/h unit. The measurement results showed the absence of any significant increase in the ^{238}U ^{232}Th and ^{40}K concentrations where the average concentration of isotopes ^{238}U, ^{232}Th and ^{40}K were (3.22, 7.93 and 1.18) ppm respectively, it is authorized and acceptable. The values of radiation dose rates ranged between 5- 7.08 µR/h , and all these values are within the natural radiation background. Eleven radioactive sources type ^{226}Ra have been detected beside destroyed industrial facility because of the war 2003 they had been used in the lightning arresters technology in the last regime. These sources treated and placed in armored containers and taken to the Iraqi main store (Iraqi Organization of Atomic Energy Site), the radiation dose measurements ranged between 72- 48 µR/h, which is higher than the natural radiation background.

1. Introduction

Natural radioactivity is referred to that any source of radiation which non- made by a human, the main source of this type of radiation is cosmic rays and sources generated from the ground origin of radionuclides such as a uranium series ^{238}U and thorium series ^{232}Th and potassium ^{40}K that are found in the crust of the earth since the creation. But when the level of radiation exposure exceeds its natural limit that will be killing of human cells and possibly cause cancer diseases, especially the sources which have been produced by human [1][2]

There are many artificial radioactive sources were been made by a human, and can be used in different fields and application, such as medical section to diagnose and treat cancer disease, industrial applications, for example, Europium ^{152}Eu and Radium ^{226}Ra that used in lightning arresters technology, source of Cesium ^{137}Cs used in moisture and density measurements, and iridium source 192Ir used in industrial radiography and etc. [3][4].

There are many studies that have been done to determine the natural concentrations of radioisotope, whether by using high purity germanium detector (HPGe) or-Gamma-ray spectroscopy system NaI(Tl)[5],[6],[7], all of them, are installed inside a specific laboratory. GR-460 is a portable, modern and unique system, it is a

sodium iodide detector (NaI) with two crystal each one 256 Lang size becomes a total volume of 512 Lang cube, instilled inside the minibus, it has the ability to measure the radiation dose rate in units μR/h and the possibility to identify the type of radioactive source through displaying its spectrum. Also, it has the ability to determine the ratio of the concentrations of natural radioactive materials uranium ^{238}U, thorium ^{232}Th and potassium ^{40}K in the soil in ppm unite. The system produced by Exploranum Company (USA) as shown in Figures.1. During the war of 2003 and what resulted after this war, looting and destruction of many military and industrial facilities, especially those that used radioactive sources for a specific technique, and subsequently loss of these sources, which resulted in the negative impact on people's lives because of the long term of radiation exposure and generates cancer disease that increased in Iraq more than before 2003 according to the recent studies [8],[9],[10].

In this study, the GR-460 system and portable devices have been used to conduct the operation of the radiological survey for the Wasit province to search for missing radioactive sources and estimate the natural concentration of ^{238}U , ^{232}Th and ^{40}K.

2. Materials and Methods

Six sites have been selected for radiological surveys and these sites are the districts which affiliated to the province of Wasit (Center of Kut, AL-Hai, Al-Numania, Alazizia, Sowira and Badrah). The priorities of radiological survey it was for the areas which exposed of rocket fire by USA army during 2003 war, and scrap materials sites which possibly contain of radioactive sources. This information has been obtained from the directorate of environment and Wasit governorate council.
The areas have been divided into squares depending on the nature and size of the area based on the international atomic energy agency (IAEA) instructions[11][12]. The vehicle of the system were walked in slow speed proximately ranged between 50-40 km / h in order to analyze the measurements precisely, when observing any high level of radiation exposure, the vehicle will be stopped and then used portable devices to determine the place where the system observed high radiation activity. The background radiation of the province was estimated to be 5.7 μR/h.

3. Results and Discussions

Radiological survey has been done to the elected sties in Wasit province by GR460 system and by

Figure 1. *Two different images of GR-460 system.*

portable devices to measure the concentrations of natural radioactive isotopes ^{238}U, ^{232}Th, ^{40}K respectively in unit ppm, and the radiation dose rates in unit μR/h the results of the measurements are shown in the Figures2. Figure 3. Figure 4. and figure 5. Respectively.

The results of radiation measurements were conducted of the elected sites, showed absence of any significant increase in the concentrations of radioactive isotopes from natural limits, where the concentration values in (ppm) unit of the isotope ^{238}U ranged from (2.87-4.1), the values of isotope ^{232}Th ranged from (5.77-7.93) and the values of isotope ^{40}K ranged from (0.37-1.18) respectively and table1. Shown the maximum value for each isotope and its equivalent values to the specific radioactivity in Bq/kg unit as shown in the following equations [13],[14].

$$U\ ppm = 12.45\ U\ Bq/kg \quad (1)$$

$$Th\ ppm = 4.6\ Th\ Bq/kg \quad (2)$$

$$K\ ppm = 313\ K\ Bq/kg \quad (3)$$

All these values are acceptable and agreement with the global values of the average

Table1. *The maximum values of concentration of the radioisotopes in ppm unit and Bg/kg unit*

Isotopes	Concentration in (ppm) unit	Concentration in (Bq/Kg) unit
^{238}U	3.22	40.08
^{232}Th	7.93	36.47
^{40}K	1.18	369.34

radioactivity concentration of ^{238}U, ^{232}Th, and ^{40}K, are (40, 40 and 580) Bq/kg respectively, it is also agreement with the previous studies [15],[16],[17].

The average of radiation dose rates for all the areas ranged between 5- 7.08 µR/h where it is in the normal limits, as shown in Fig 5. it is in agreement with globally limits [18], [19].

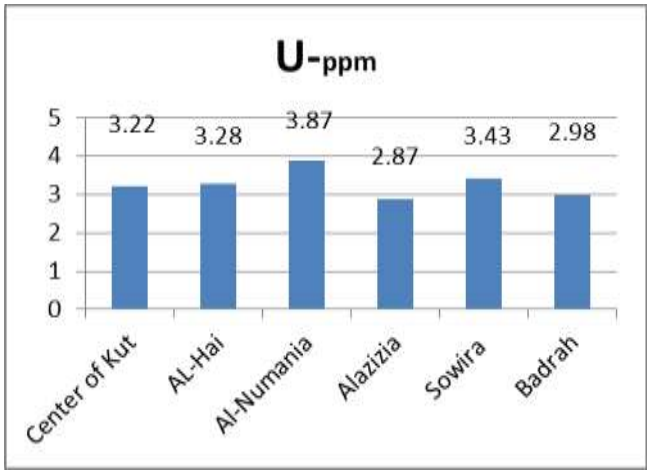

Figure 2. *The rates of concentrations of Uranium isotope ^{238}U in ppm unit.*

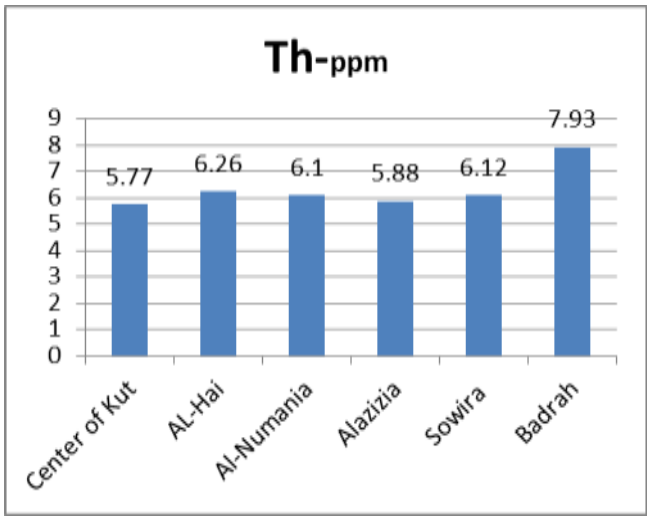

Figure 3.*The rates of concentrations of Thorium isotope ^{232}Th in ppm unit.*

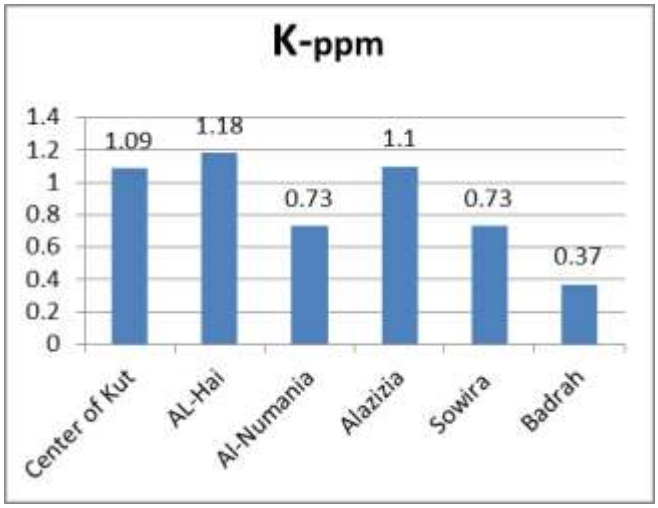

Figure 4. *The rates of concentrations of potassium isotope ^{40}K in ppm unit*

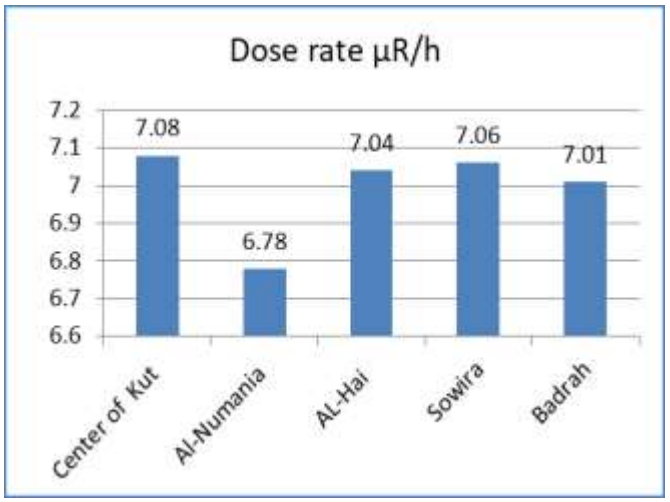

Figure 5*.Radiation dose rates for the elected areas in µR/h unit*

Abnormal radioactivity has been observed beside old destroyed industrial facilities near of Kut city, eleven radioactive sources type Radium ^{226}Ra have been detected, that separated at three locations because of the war 2003 and they were been used in the lightning arresters technology in the last regime[20]. These sources treated and placed in armored containers and have been transported to the national store in the (Iraqi Atomic Energy Organization site) according to the IAEA standards [21]. The radiation dose rate ranged between 48- 76.52µR/h, which is higher than the natural background radiation as shown in Figures 6.

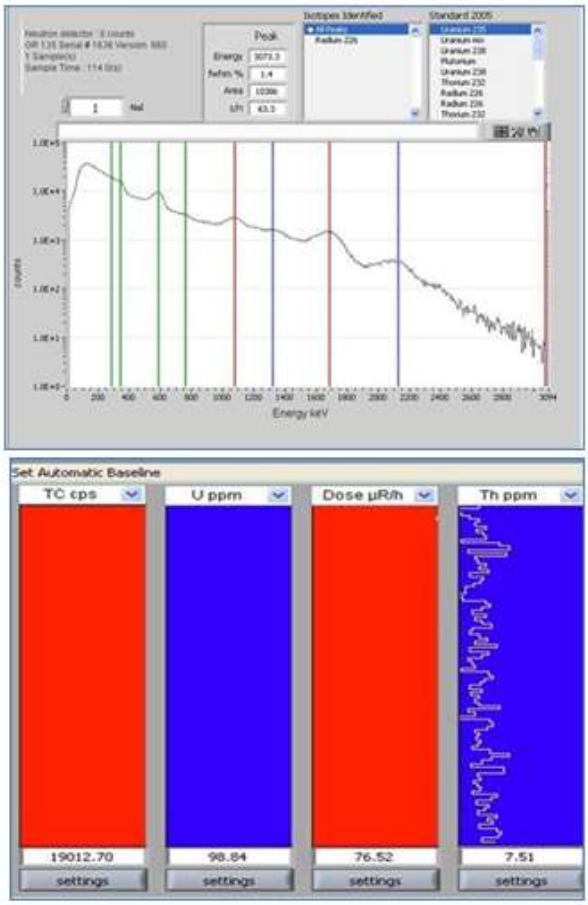

Figure 6.*Spectrum of radioactive source ^{226}Ra (in upper). Radiation dose rate of GR-460 system when observed high radiation exposure (in lower)*

4. Conclusions

According to the results of radiological survey measurements of Wasit province by GR-460 system, the concentration of thorium and uranium isotopes are within natural concentration and globally accepted, and agreement with previous studies. The average of radiation doses for all the regions were been selected, is not exceeded from the natural background, except eleven radioactive sources type ^{226}Ra have been found during radiological survey operation, they were used in the lightning arrester application before 2003 ware, and treated carefully according to IAEA standards, and transformed to the national store of Iraq.
These results have been sent to the Iraqi Ministry of Health and Environment to take place its procedures through estimating the number of individuals infected by cancer disease whether by the high level of radiation exposure or because of biological problems.

Author Statements:

- The authors declare that they have equal right on this paper.
- The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
- The authors declare that they have nobody or no-company to acknowledge.
- The authors certified that they have participated sufficiently in this work to take public responsibility for the content, including participation in the concept, design, analysis, writing and revision of the manuscript. Furthermore this article has not been published in other publication before

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