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Research Article

Investigation of Natural Occurring Radioactive Material Activity Level in Falluja-Anbar (Iraq)

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Abstract:

Radiation may be defined as the energy in the form of electromagnetic waves or particles that pass through space and even heavy dense materials. The radioactivity is a continuously decreasing quantity which is a function of the half-life of the responsible radionuclides. The natural sources of radiation came from terrestrial radionuclides which are widely distributed in the earth's crust.
Field radiological surveys were conducted by the GR-460 mobile detection system, the only mobile system in Iraq and the region. This system is dedicated to the radiological scanning process for large areas and in less time. The system is attached to a GPS satellite positioning device so that the measurement points are coupled with the spatial coordinates of the radiometric area.
In this study, the concentration of naturally occurring radioactive materials had been determined experimentally of AL-Falluja / Anbar Governorate- Iraq for (66) km^2 using GR-460 portable gamma spectrometer system. The results showed that the high level of uranium concentration (^{238}U) was 8.1 ppm in the industrial area, the low level was 0.1 ppm in most districts. The high level of Thorium (^{232}Th) concentration was 17.5 ppm and less than 0.1 ppm in most neighbourhoods are within Iraq's natural background.

1. Introduction

Radiation and radioactivity were discovered more than 100 years ago, this phenomenon of radioactivity occurs when energy from an atom is spontaneously released, ionizing radiation is part of nature and human activities in medicine, research, industry, energy production, and some special military applications [1 - 3].

The main source of radioactivity belongs to two classes; natural and man-made resources. The natural source of radiation comes from terrestrial radionuclides, terrestrial radionuclides are widely distributed in the earth's crust, and sources originate from cosmic rays. Other sources come from radiation and human activities related to the use of radioactive materials, where radionuclides can form in the environment [4 - 6].

Iraq needs to measure radioactivity and determine its rates on an ongoing basis due to the events of 2003, as well as the presence of many nuclear programs in the neighboring countries of Iraq. Therefore, radiological survey programs to determine the concentrations of radioactive isotopes such as uranium and thorium are important in normal cases because of the possibility of needing these results in emergency situations or when nuclear accidents happen [7].

Fallujah considered one of the districts that belong to the Anbar Governorate and is located near the capital, Baghdad, about 50 km from it. Radiological measurements had been done using the latest pertable spectroscopy systems to determine the concentration of ^{238}U and ^{232}Th in Fallujah.

2. Material and Methods

2.1. Material

The GR-460 detection system used is considered one of the advanced systems in the field of mobile radiological surveys. This system is characterized by high accuracy in conducting field measurements and recording data while specifying the coordinates of the measurement sites with extreme accuracy because it includes a GPS device [7, 8]. This system contains a gamma-ray detector kind NaI(Tl) and is characterized by its ability to measure radioactivity and radiation dose because it contains a spectra analyzer that contains 512 channels.

This system contains two NaI detectors with a size of (793 x 216 x 177 mm), this system capable of separating different energies and identifying the radioactive isotope [9, 10]. Figure 1 shows the layout of the measurement system. The system is installed inside a suitable car at a height of one meter above the ground, GR-460 detection system and the detectors attached to it are connected via dedicated cables. When starting to record field measurements, the wheel speed must be between (8 - 20 km/h) so that the detector can sense the signal and convert it into a reading known from the measuring device to the calculator attached to them. The detectors are calibrated to the radioactive source ^{137}Cs with radioactivity (0.25 μCi) before starting the field survey process [7, 11].

Figure 1. *Two sodium iodide detectors NaI (Tl) inside the radiological survey field vehicle*

2.2. Methods

Radiation investigation and measurements were made for areas belonging to Fallujah district (Table 1), whose area is estimated at 66 km^2, and the main roads and streets were chosen as paths for the implementation of these surveys, and the distance between two path is approximately 200m in some areas, and other areas the distance between one path and another is estimated at 80 - 250 m due to the presence of some areas that are built in a random way and do not allow the organization of the path with equal distances, and the total paths that were conducted surveys were within 235 km as shown in the Figure 2.

3. Results and Discussions

Some areas were taken as main fixed points for measuring the concentrations of uranium and thorium as shown in Table 1, the results of the radiometric measurements were in ppm units for all the measurement points.

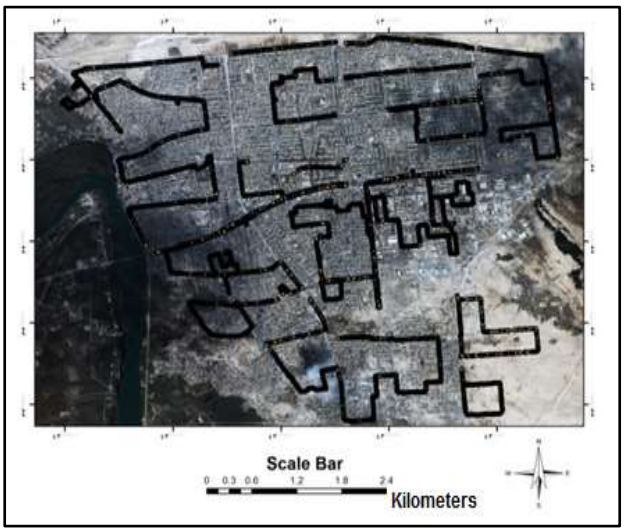

Figure 2. *The path of the measurements points in Faluja district*

Table 1. *The ^{238}U and ^{232}Th concentration in ppm unite of Fallujah district of Fallujah district*

	^{238} U ppm					^{232}Th ppm		R/hμ	
Location (District)	Average	Max	Min	Av	Max	Min	Av	Max	Min
Widows	2.6	7.2	0.1	5.7	12.5	0.2	4.0	5.4	3.1
Andalusia	2.4	5.9	0.1	4.8	14.7	0.1	3.3	4.3	2.7
Tamim	1.4	5.7	0.1	5.1	14.7	0.1	3.7	4.8	3.0
Golan	2.5	6.3	0.2	5.3	14.0	0.1	3.7	4.5	3.0
Green	2.6	6.2	0.1	5.6	14.8	0.2	3.9	5.3	3.2
Al-Resalla	2.8	7.9	0.1	5.4	16.7	0.1	4.0	5.8	2.7
Al-Salam	2.2	6.2	0.1	4.1	11.2	0.1	3.4	4.6	2.8
Police	2.2	6.1	0.1	4.2	12.1	0.1	3.4	4.4	2.6
Industrial	2.3	8.1	0.1	5.6	15.8	0.2	300	800	150
Officers	1.8	5.0	1.8	4.7	12.0	0.2	3.4	4.5	2.7
Qadisiyah	2.3	6.6	0.1	5.0	13.9	0.1	3.8	7.3	2.8
Al-Mu'tasim	2.7	6.5	0.1	5.5	17.5	0.1	3.9	6.7	2.9
Teachers	2.1	6.1	0.1	5.1	17.5	0.1	3.6	5.0	2.7
Mansour	2.6	6.4	0.2	5.3	16.6	0.2	3.8	5.5	2.7
Al Wahda	2.3	6.1	0.1	4.3	11.2	0.2	3.8	5.7	2.7
Yarmouk	2.6	6.4	0.2	5.8	14.8	0.1	3.9	5.2	2.9

The recorded data were fully analysed, the results of radiological measurements in Anbar Governorate\ Fallujah were as follows: The recorded natural

uranium ^{238}U concentration rates were (2.8 ppm) in Al-Resala neighbourhood and the lowest reading was 1.4 ppm in Al-Tameem neighborhood. The recorded natural thorium ^{232}Th concentration rates were the highest reading 5.8 ppm. In the Yarmouk neighbourhood and the lowest reading 4.1 ppm in the Al-Salam neighbourhood, all readings were within the limits of the rates of the natural radiation background of the environment of Iraq. See Figure 3 and Figure 4.

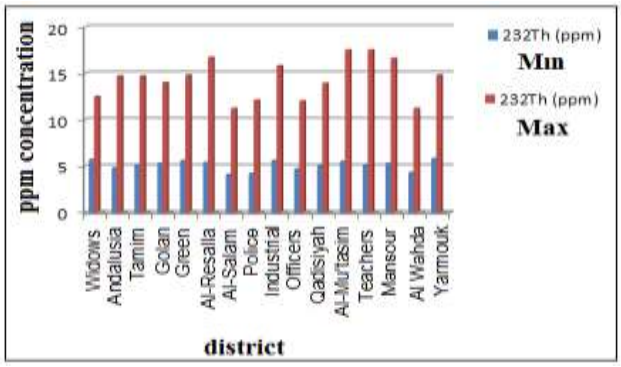

Figure 3. *The minimum and maximum concentration of* ^{232} *Th*

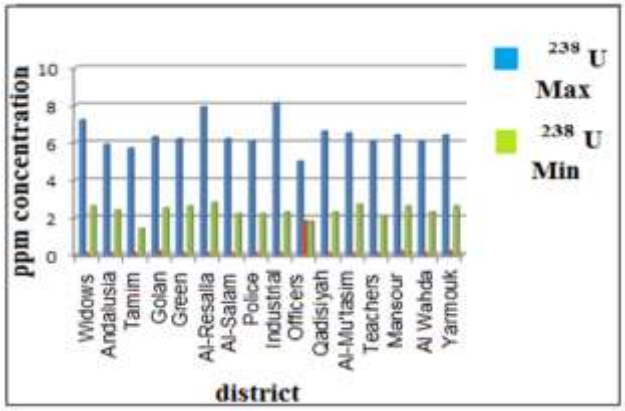

Figure 4. *The minimum and maximum concentration of* ^{238}U

4. Conclusions

It is known that Iraq considered one with the normal natural radiological background as proven in the studies and investigations conducted in this field.

The results showed that all the radiological measurements of uranium and thorium were within the limits of the radioactive background of Iraq.

The radiation survey system kind GR-460 is considered one of the advanced systems for measuring radioactive isotope concentrations over large areas due to the ease of measurement and speed in analyzing and giving results**.**

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
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