Measuring the concentrations of natural radioactive isotopes and radiation dose rates for Missan Province

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Abstract
This research included measuring the concentrations of natural radioactive isotopes U-238 and Th-232 and radiation dose rates for selected areas of Missan province, GR-460 system was used which has the potential to measure the concentrations of natural radioactive isotopes in (ppm) unit and measuring the radiation dose rates in µR/h unit. It was also used with the system the mobile device FH-40 which measures the radiation dose rates in units µSv/h the measurement results showed the absence of a significant increase in the U-238 and Th-232 concentration where the concentration of isotopes of U-238 and natural Th-232 (3.35-5.46) ppm respectively it is authorized and universally accepted. In terms of radiation dose rates it ranged between 45-65nSv/h by GR-460 system and FH-40 device and all these values are within the natural background radiation. Except for one outlying villages that affiliate to the Kahla area were found the radioactive source type 137Cs was left in a swamp of water rancid. Dose rate reached about 6 meters distance from the source 5.3 mSv/h by FH-40 device and GR-460 system 90.6 µR/h where equivalent 815 nSv/h. The radioactive source has been transferred safely to the main store in AItuwaitha site.

Key words
Radiation dose, Concentration of natural isotopes, Missan Province.

Article info.
Received: Mar. 2015
Accepted: Apr. 2015
Published: Sep. 2015

Qayes تراكيز النظائر المشعة الطبيعية ومعدلات الجرعة الإشعاعية لمحافظة ميسان
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الخلاصة
تضمن هذا البحث قياس تراكيز اليورانيوم-238 والثوريوم-232 ومعدلات الجرعة الإشعاعية لمناطق متندة من محافظة ميسان، حيث استخدمت منظومة GR-460-400000، لقياس معدلات الجرعة الإشعاعية بوحدة µR/h وقياس تراكيز النظائر المشعة الطبيعية بوحدة ppm. أظهرت النتائج أن قياس معدلات الجرعة الإشعاعية محلّولة في تراكيز اليورانيوم-238 والثوريوم-232 في المناطق المتندة الناتجة عن الجهاز المحمول FH-40 65-45 nSv/h، وقياس معدلات الجرعة الإشعاعية بواحدة GR-460 وقياس FH-40 3.5 mSv/h، وقام النظام بتلقي الصورة المعدنية 137Cs في إحدى القرى النائية التابعة لقضاء الكحلاء حيث عثر على مصدر مشع نوع ينتمي إلى المخزن الرئيسي في الثوبية.
Introduction
The natural radioactivity or what is known as background radiation, is very important for the population's exposure to radiation and the many countries of the world measuring the exposure rate that caused by natural radiation for various purposes including epidemiological studies and selection of nuclear facilities sites and emergency plans. Human exposes to multiple sources of radiation most important natural radiation sources which include ground origin of radionuclides, a uranium series U-238 and thorium series Th-232 and potassium K-40 that are found in the crust of the earth since the creation because of the long half-lives [1].

The industrial radiation sources are those resulting from man-made sources, where placed inside capsules sealed and interference in many application, such as medical research and agricultural applications for example the source of europium Eu-152 which is used in lightning arresters technology, source of cesium Cs-137 used in moisture and density measurements, and iridium source Ir-192 used in industrial radiography and other operations [2].

After the events of 2003 and the subsequent looting and destruction of infrastructure have lost many sources which has a negative impact on people's lives because of the long exposure to radiation and the resulting potential impacts including cancers which have increased in recent years [3]. So (GR-460) system and portable devices are used to conduct the radiological surveys for the various governorates of Iraq to search about the missing radioactive sources.

Working and methods

1- Studying area
Four sites were selected for the purpose of radiological surveys conducting and these sites are the districts that affiliate to the province of Missan (Alemara, Kahla, Mijer Alkabir, Castel Saleh, Almimona and Ali Elgarbi) as shown in Fig. 1. The priorities of radiological survey to the areas which injuries of cancer, birth defects that have been resulting from bombing rocket in the 2003 events, areas where witnessed the looting of industrial facilities formerly and Scrap materials sites and that based on the information that has been obtained from the Directorate of Environment and Missan Governorate Council.

Fig. 1: Map of Missan province.

2- Radiological survey operations
Radiological surveys were conducted for the elected areas by using GR-460 system and portable device FH-40,
measuring areas were divided into squares depending on the nature and size of the area based on the International Atomic Energy Agency instructions [4]. Vehicle of the system was walked in slow speed ranged approximately between 50-40 km/h in order to analyze readings recorded precisely and store inside the memory of computer that connected with the system, and when suspicion in any particular area or a note in high readings for background radiation, the vehicle will have stopped and then use a portable devices to determine the place where the system observed high readings. The background radiation of the province was measured it is 5.7 h/Rµ which equivalent to 51.3 nSv/h.

The instruments
1- GR - 460 system was used in the radiological survey operations as it allows the system to show radiation dose rate in units µR/h and the possibility to identify the radioactive source's identity through the appearance of the source name and spectrum its energies and the system is a detector Sodium Iodide (NaI) with two crystal each one 256 Lang size becomes a total volume of 512 lange cubic where offers the possibility and efficiency of high detecting to cover a wide area. The unit connected with the laptop loaded with the program (GR-660) where the program is also able to determine the ratio of the concentrations of natural radioactive materials uranium (U-238) and thorium (Th-232) in the soil, coordinates measurement sites were taken according to the (GPS) and the identity of the radioactive isotope and the system of production of Exploranum Company as shown in Fig.2 [5].

2- FH-40 G-L10 device is a portable device with a digital scale with the detector by connecting an external cable to detect contamination alpha, beta and gamma rays in units cps/h. This device is one of the counters types proportionality provided with tube proportional counter internal, has a LCD screen that shows the results, weight 410 grams, size 195mm x 73 mm x 42 mmx, can be separated the detector contamination from the device so that it becomes a device for measuring the rate of radiation doses, the extent of energies ranging from 33 keV-3MeV and units of µSv/h, consumes little power (battery number 2 voltage 1.5 V) as shown in Fig.3 [6].
Results and discussion

1- The results

Radiological surveys were conducted to the elected positions in Missan province by GR460 system and portable devices to measure the concentrations of natural radioactive isotopes $^{238}$U and $^{232}$Th in unit (ppm) and measuring radiation dose rates unit ($\mu$R/h) the results of the measurements are shown in the Figs. 4,5,6,7,8 and 9.

**Fig. 4:** The rates of concentrations of uranium isotope ($^{238}$U) for elected positions in the Missan province by GR-460 system.

**Fig. 5:** The rates of concentrations of thorium isotope ($^{232}$Th) for elected positions in the province of Missan by GR-460 system.
Fig. 6: The radiation dose rates for the elected positions in the province of Missan by GR-460 system.

Fig. 7: The radiation dose rates for the elected positions in the province of Missan by the portable device FH-40.

Fig. 8: Readings of GR-460 system for radiation dose rate when the high activity was noted.
2- Discussion
The results of radiation measurements were conducted of the sites elected within the province of Missan absence of a significant increase in the concentrations of radioactive isotopes from natural limits where the average value of the isotope U-238 (3.09 ppm) Fig. 4 is equivalent to the specific radioactivity value (38.47 Bq/kg) as shown in the following Eq. [7]:
\[ 1 \text{ U}_{\text{ppm}} = 12.45 \text{ U}_{\text{Bq/kg}} \]  
\[ 3.09 \times 12.45 = 38.47 \text{ Bq/kg} \]
The average value for Th-232 (6.75 ppm) Fig. 5 is equivalent to the value of specific radioactivity (31.05 Bq /kg) as shown in the following Eq. [7]:
\[ \text{Th}_{\text{ppm}} = 4.6 \text{ Th}_{\text{Bq/kg}} \]  
\[ 6.75 \times 4.6 = 31.05 \text{ Bq/kg} \]
All of these values are universally accepted [8].

In terms of radiation dose rates as shown in Figs. 6 and 7 all of which were within normal limits where the average value for the dose rate across Missan province (56.42) nSv/h by GR-460 system and FH-40 device respectively all of these values are within natural limits [9]. Any abnormal radioactivity in the province did not notice except one of the remote villages in Alkhala area where found radioactive source type Cesium-137 as shown in Figs. 8 and 9 the source located in a pool of water rancid with scrap metal. The site was surround by a caution tape, used pelvic car to vacuum the water, then used the excavator to reduce the effort and radiation exposure had put the source in the behind of a long vehicle and transported the source safely to the main store in AITuwaitha site (Iraqi Atomic Energy Organization site formerly). The radiation dose rates were reached about 6 meters from the source 90.6 μR/h equivalent 90 nSv/h by GR460 system and 5.3mSv/ h by FH-40 device. There were no any
radioactive contamination at the site after the lifting because the source was closed strongly.

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