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

Ahmed A. Hussein Zarkooshi[1], Qais Abdul Amir[1], Fadihl Hawi Mizban[1], Murtadh A. Saiah[2]

[1]Iraqi Radioactive Sources Regulatory Authority

[2]Ministry of Science and Technology

E-mail: ahmedeliraqi77@yahoo.com

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 ^{137}Cs 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 AlTuwaitha site.

Key words

Radiation dose, Concentration of natural isotopes, Missan Province.

Article info.

Received: Mar. 2015

Accepted: Apr. 2015

Published: Sep. 2015

قياس تراكيز النظائر المشعة الطبيعية ومعدلات الجرعة الاشعاعية لمحافظة ميسان

احمد عبد الحسن حسين الزركوشي[1]، قيس عبد الامير[1]، فاضل حاوي مزبان[1]، مرتضى عذاب صياح[2]

[1]الهيئة العراقية للسيطرة على المصادر المشعة

[2]وزارة العلوم والتكنولوجيا

الخلاصة

تضمن هذا البحث قياس تراكيز اليورانيوم- 238 والثوريوم-232 ومعدلات الجرعة الاشعاعية لمناطق منتخبة من محافظة ميسان، حيث استخدمت منظومة GR-460 المتنقلة التي لها الامكانية في قياس تراكيز النظائر المشعة الطبيعية بوحدة ppm و قياس معدلات الجرعة الاشعاعية بوحدة µR/h. كما واستخدم مع المنظومة الجهاز المحمول FH-40 الذي يقيس معدلات الجرعة الاشعاعية بوحدات µSv/ h. اظهرت نتائج القياسات عدم وجود زيادة ملحوظة في تراكيز النظائر المشعة لليورانيوم -238 والثوريوم -232 في المناطق المنتخبة حيث بلغ تركيز نظيري اليورانيوم والثوريوم الطبيعي ppm (35.3 - 46.5) على التوالي وهي قيم مصرح بها ومقبولة عالميا. اما من حيث معدلات الجرعة الاشعاعية فقد تراوحت بين (45-65 nSv/h) قيست بواسطة منظومة GR-460 وجهاز FH-40 وجميع هذه القيم هي ضمن الخلفية الاشعاعية الطبيعية. باستثناء احدى القرى النائية التابعة لقضاء الكحلاء حيث عثر على مصدر مشع نوع ^{137}Cs كان متروكاً في بركة للمياه الاسنة حيث بلغ معدل الجرعة الاشعاعية على بعد 6 امتار 3.5 mSv/h بواسطة الجهاز المحمول FH-40 اما قراءة المنظومة فقد بلغت 6.90 µR/h اي ما يعادل 815 nSv/h و نُقل المصدر بصورة امنة الى المخزن الرئيسي في التويثة.

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.

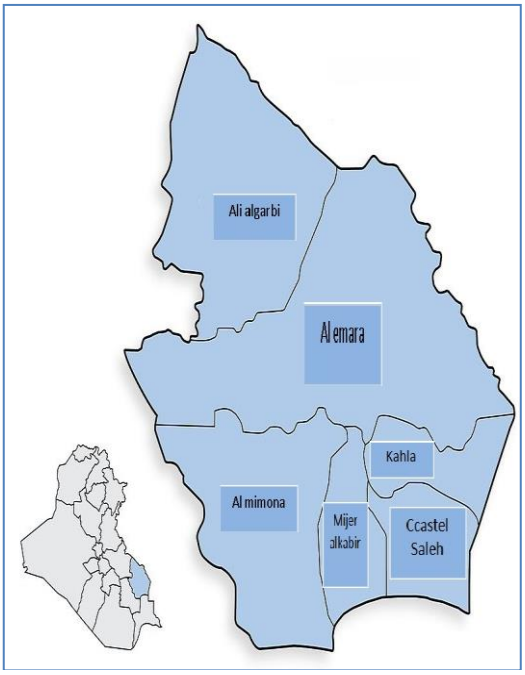

Fig. 1: Map of Missan province.

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].

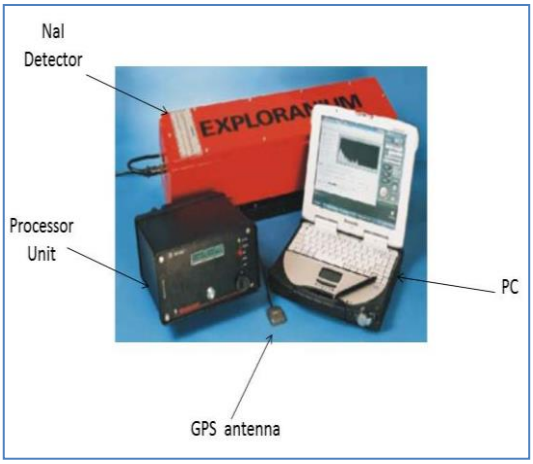

Fig. 2: Photo of GR-460 mobile detection.

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].

Fig. 3: Photo of FH-40 device.

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 U-238 and Th-232 in unit (ppm) and measuring radiation dose rates unit (μR/h) the results of the measurements are shown in the Figs. 4,5,6,7,8 and 9.

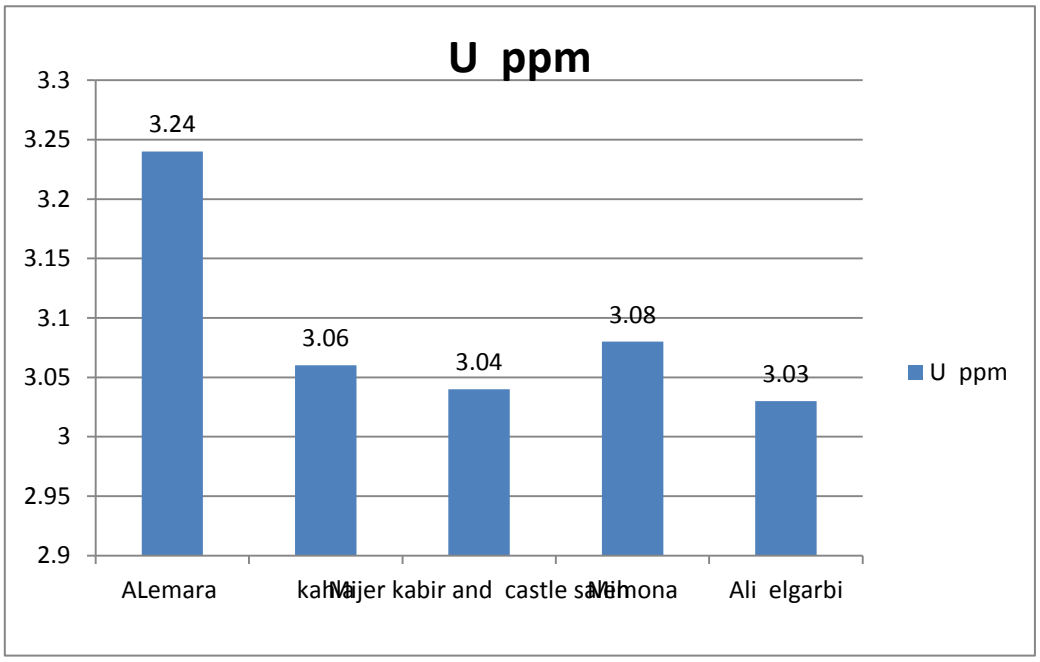

Fig. 4: The rates of concentrations of uranium isotope (U-238) for elected positions in the Missan province by GR-460 system.

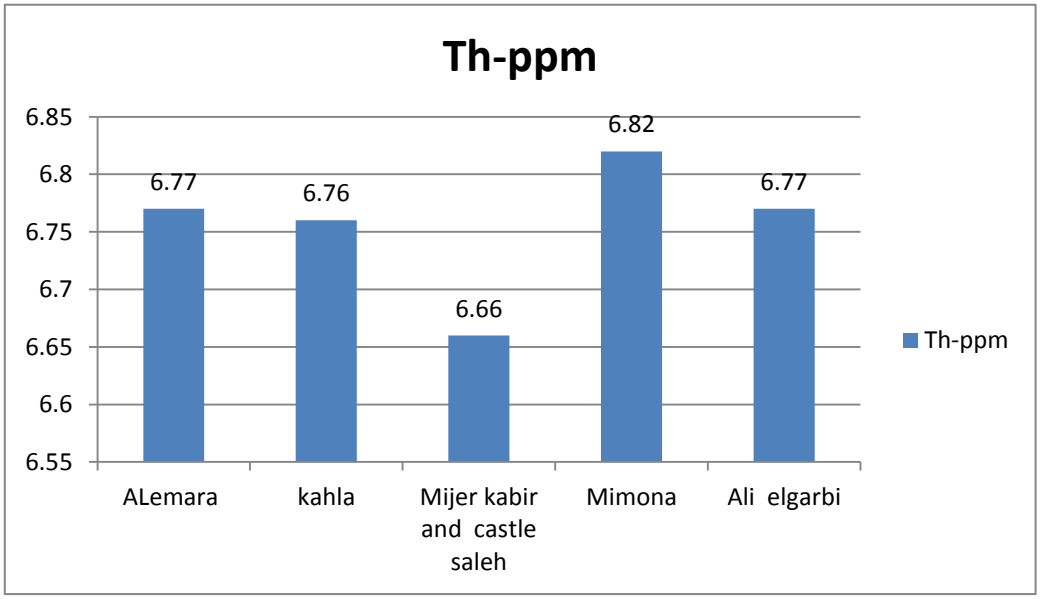

Fig. 5: The rates of concentrations of thorium isotope (Th-232) for elected positions in the province of Missan by GR-460 system.

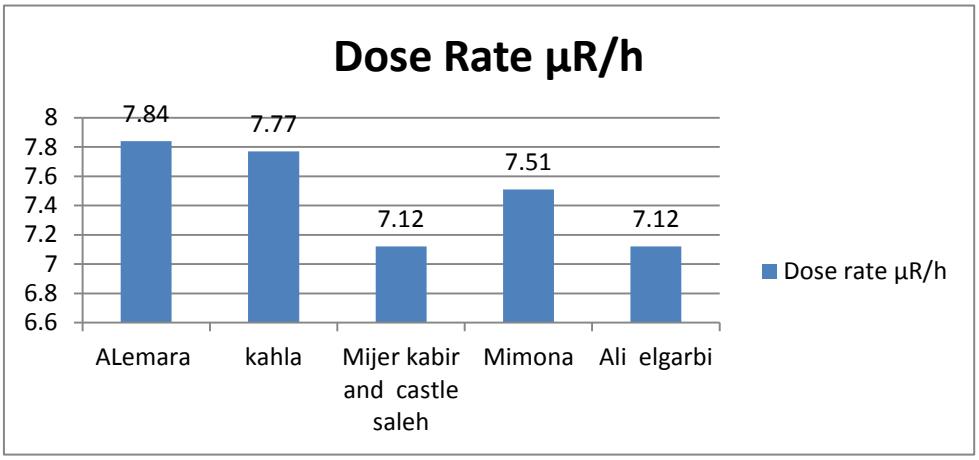

Fig. 6: The radiation dose rates for the elected positions in the province of Missan by GR-460 system.

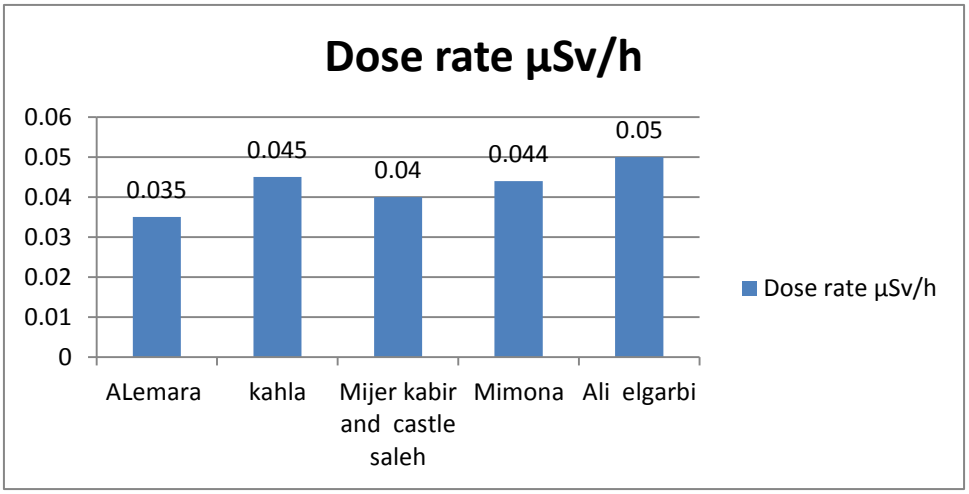

Fig. 7: The radiation dose rates for the elected positions in the province of Missan by the portable device FH-40.

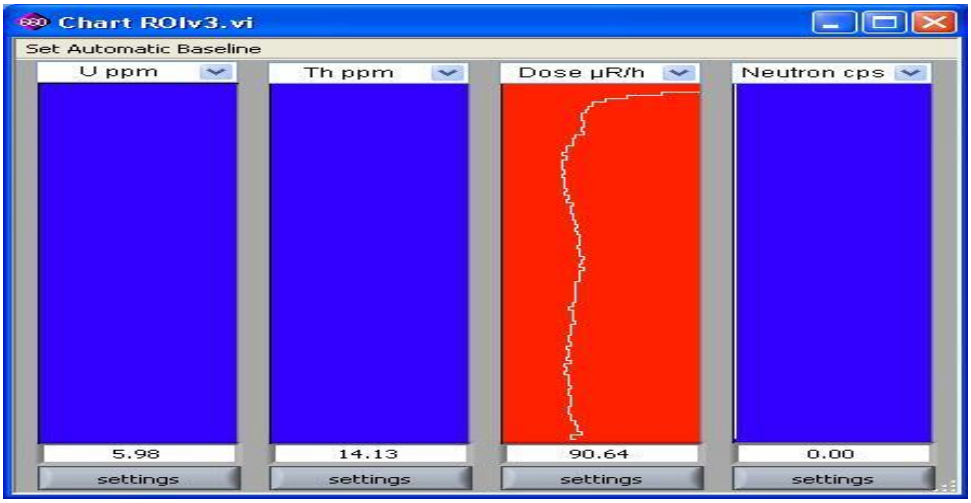

Fig.8: Readings of GR-460 system for radiation dose rate when the high activity was noted.

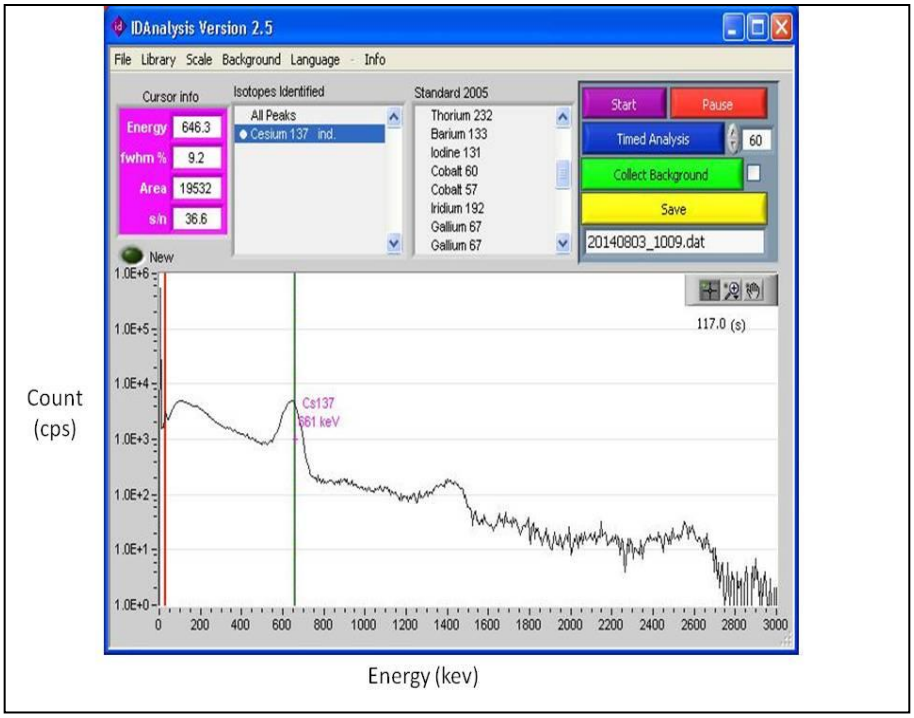

Fig. 9: Spectrum display of radioactive source Cs-137.

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]:

$1\ U_{ppm} = 12.45\ U_{Bq/kg}$ (1)

3.09 x12.45 = 38.47 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]:

$Th_{ppm} = 4.6\ Th_{Bq/kg}$ (2)

6.75 x4.6 = 31.05 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 AlTuwaitha 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.

References

[1] Berger, M, J, Journal of Applied Physics, 28 (1957) 1502-1508.

[2] IAEA, Identification of Radioactive Sources and Devices, Nuclear Series No.5, Vienna, (2007) 52-76.

[3] Dominique Loye, Robin Coupland, International Review of the Red Cross, 89 (June 2007) 866.

[4] IAEA, Generic Procedures for Monitoring in a Nuclear or Radiological Emergency, TECDOC-1092, page (37), 1999.

[5] User Manual, GR-460 Mobile Spectrometer System, USA, 2001.

[6] Operating Instruction, FH-40 G-L10, Alarming Personal Radiation Detector, Germany, 2007.

[7] Al Saif, AbdulKarem Salem, Radioecological Aspect of Hail Region Behavior of Some Radionuclide in Soil, College of Science , King Saud University, page (81), M.Sc Thesis, January 2009.

[8] IAEA, Radiation Protection and Safety of The Radiation Sources, safety standard, Vienna, 2011.

[9] Stephen Kaiser, Radiation Protection, European Commission, 1999.