Measurement of Uranium concentrations in soil samples for selected regions in Thi-Qar governorate by using (CR-39) nuclear track detector

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Abstract

The present work is concerned with the measurements of uranium concentrations in twenty surface soil samples from selected locations (some of them were measured for the first time as far as authors know) in Thi-Qar governorate by using uranium fission fragment U-235 (n-f), obtained by the bombardment of U-235 with thermal neutrons. The results have shown that, the highest uranium concentration in surface soil samples in the selected regions in Thi-Qar governorate was found in T_1 (AL-Refai) region , which was equal to (2.896 ppm), while the lowest uranium concentration was found in T_{18} (Garmat Beni Saeed) region which was equal to (0.779 ppm), with an average value of (2.077±0.4 ppm). The present results have show that the uranium concentrations in the studied surface soil samples were less than the allowed value (11.7 ppm) recommended by (UNSCEAR, 1993).

Keywords: uranium concentration, Soil , CR-39 track detector.

قياس تراكيز اليورانيوم لنماذج من التربة في مناطق منتخبة من محافظة ذي قار باستخدام كاشف الأثر النووي(CR-39)

الخلاصة

في هذا البحث تم قياس تراكيز اليورانيوم لعشرين نموذج تربة سطحية لمناطق منتخبة (بعض منها تم قياسه لأول مرة حسب علم الباحثون) من محافظة ذي قار باستخدام تقنية عد أثار شظايا الانشطار النووي والناتج من انشطار نواة (U-235) من خلال قصفها بالنيوترونات الحرارية . بينت النتائج إلى ان أعلى تركيز لليورانيوم في التربة السطحية للمناطق المنتخبة في محافظة ذي قار كان في T_1 منطقة (الرفاعي) والذي كان يساوي (2.896 ppm) بينما اقل تركيز لليورانيوم كان في T_{18} منطقة (كرمة بني سعيد) والذي كان يساوي (0.779 ppm) وبمعدل (2.077±0.4 ppm) ، وقد بينت النتائج الحالية ان تراكيز اليورانيوم لجميع نماذج التربة السطحية المدروسة كانت اقل من القيمة المسموحة (11.7 ppm) والموصى بها من قبل اللجنة العلمية للأمم المتحدة لتاثيرات الاشعاع الذري (UNSCEAR,1993).

الكلمات المرشدة : تركيز اليورانيوم ، تربة ،كاشف الاثر CR-39

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INTRODUCTION

Uranium is a silver-white, lustrous, dense, natural, weakly radioactive element, which was discovered in 1789 by the German scientist M. H. Klaproth.It is present in all crystal and mantle rocks in trace amounts and it is as essential constituents of about 100 minerals. Its average content in Earth's crust is about (3 $mg.kg^{-1}$). In this natural state, uranium consists of three isotopes: U-238 (~ 99.27% by mass, with a half-life of 4.46×10^{9} year and a specific activity of 12.4 $Bq.mg^{-1}$), U-235 (~ 0.72%, half life: 7.03×10^{8} year and specific activity of 80 $Bq.mg^{-1}$) and U-234 (~ 0.0054%, half life: 2.44×10^{5} year and specific activity of 2.3×10^{5} $Bq.mg^{-1}$). About 48.9% of the radioactivity is associated with U-234, 2.1 % with U-235 and 48.9% with U-238. Uranium decays into many isotopes finally ends up as stable (nonradioactive) isotopes of lead [1].

The physiological behavior of uranium compounds depends mainly on their solubility. Soluble uranium is regulated because of its chemical toxicity, while insoluble (less soluble) uranium is regulated by its radiological properties. But because of its slow absorption through the lungs and the long retention time in the body tissues, its primary damage will be to its radiological damage (risk of cancer death) to internal organs rather than the risk of significant chemical damage to the renal system[2]. The aim of the present work is to measure the uranium concentrations in soil samples from selected locations in Thi-Qar governorate.

Description of Study Area

Thi-Qar governorate situated in the south east of Iraqi's, It is lies in the heart of Iraqi's marshland areas. It is bordered by Wassit governorate to the north, Al-Qadissiya governorate to the northwest, Al-Muthanna governorate to the west, Basrah governorate to the south, and Missan governorate to the northeast as shown in Figure (1). Table (1) shows symbol, and location name of the different studied sites in Thi-Qar governorate. Its largest city is Al-Nasiriyah, with location of longitude (30.33º -32º N), and latitude (45.37º -47.12º E). It is located about (4-9 m) above the sea level, with a total area of approximately (12900 km^{2}) [3].

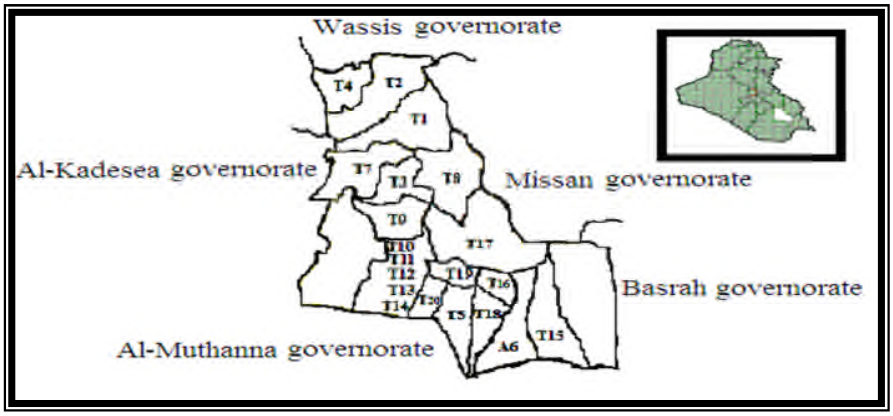

Figure (1) Sketch map showing locations of the studied sites samples in Thi-Qar governorate.

Materials and Methods

Surface soil samples were taken from different locations in Thi-Qar governorate. The soil samples were dried and cleaned from the doping grinds using special sieve (300 mm in diameter). (1 g) of soil samples were mixed with (0.1 g) of methylcellulose powder ($C_6H_{10}O_5$) used as a binding material.The mixture was pressed into a pellet of (1.6 cm) in diameter and (1mm) thickness. The pellets were covered with (CR-39) detector and put in a plate of paraffin wax at a distance of (5 cm) from the neutron source (^{241}Am-^{9}Be) of activity of about (12 Ci), with a thermal neutron flux of about (10^5 n cm^{-2} s^{-1}), as shown in Figure (2). After the irradiation time (7 days), the (CR-39) track detectors were etched in (6.25 N) (NaOH) solution at a temperature of (60 ^{o}C) for (2 h), and the tracks density was recorded using an optical microscope with a magnification of (400x). The density of the fission tracks (ρ) in the samples was calculated according to relation (1) [4].

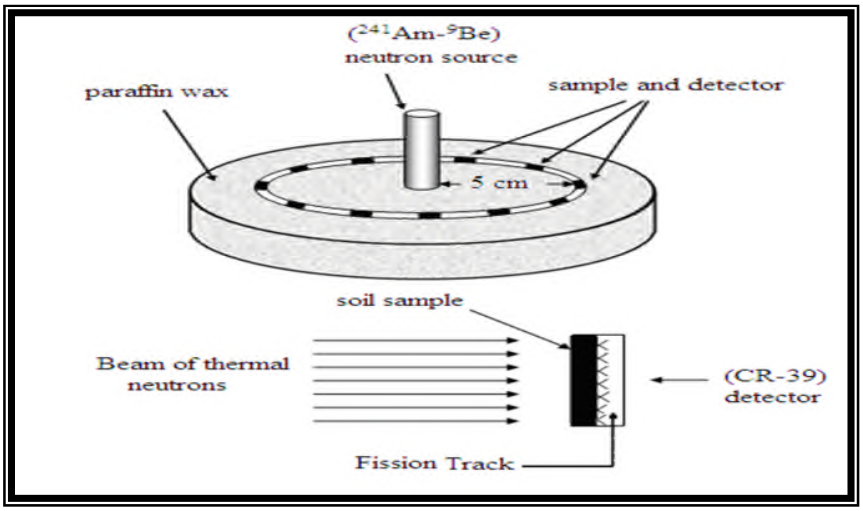

Figure (2) irradiation of the detectors and soil samples by the neutron source.

$$\text{Tracks density } (\rho) = \frac{\text{Average number of total pits (track)}}{\text{Area of field view}} \qquad \ldots (1)$$

The uranium concentrations in surface soil samples were obtained by the comparison between track densities registered on the detectors of the sample pellets and that of the standard soil sample pellets, using the relation [5] :

$$C_X = \rho_X . (C_S / \rho_S) \qquad \ldots (2)$$

Where :

C_X : uranium concentration in the unknown sample (ppm).

C_S : uranium concentration in the standard sample (ppm).

ρ_X : track density of the unknown sample (track/mm^2).

ρ_S : track density of the standard sample (track/mm^2).

Figure (3) shows the relation between track density and uranium concentrations in standard soil samples.

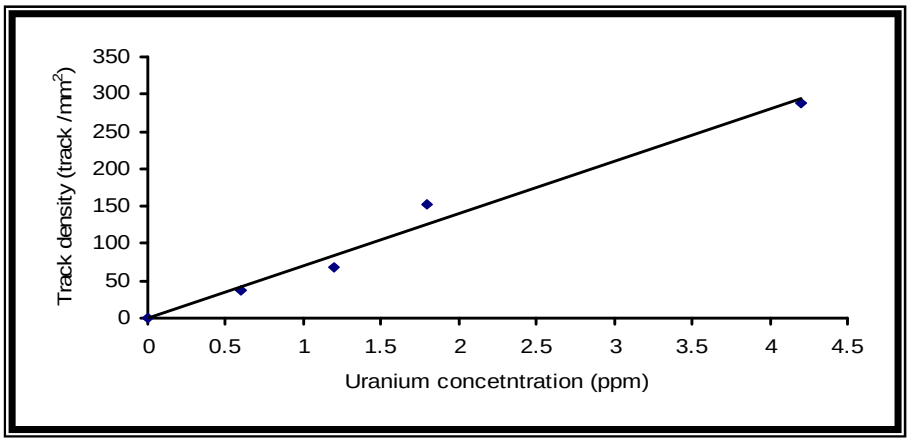

Figure (3) relation between track density and uranium concentration in soil for standard samples.

Results and Discussion

In the present work, we have measured uranium concentrations in twenty surface soil samples for selected regions in Thi-Qar governorate using fission track technique. Table (2) presents the uranium concentrations in soil samples for selected regions in Thi-Qar governorate, from which it can be noticed that, the highest uranium concentration in soil samples was found in T_1 (AL-Refai) region which was equal to (2.896 ppm) with a track density equal to (203. 76 track/mm^2), while the lowest uranium concentration was found in T_{18} (Garmat Beni Saeed) region, which was equal to (0.779 ppm) with a track density equal to (54.80 track/mm^2).The average value of uranium concentration was equal to (2.077±0.4 ppm) with an average value of track density equal to (146.108±34.41 track/mm^2),see Figure (4). The uranium concentrations in all studied surface soil samples in (Bq/kg) units (1 ppm=12.35 Bq/kg) [6] , were found to be ranged from (9.621 Bq/kg) (T_{18} region) to (35.766 Bq/kg) (T_1 region) , with an average value of (25.646±6.0 Bq/kg).The present results in Thi-Qar governorate show that the uranium concentrations in all surface soil samples were less than the recommended value (11.7 ppm) given by (UNSCEAR, 1993) [7]. It is interesting to mention that some of the present results concerning the uranium concentrations in surface soil samples such as (Garmat Beni Saeed, AL- Hammar and AL- Fajr) regions in Thi-Qar governorate were obtained for the first time as far as authors know.

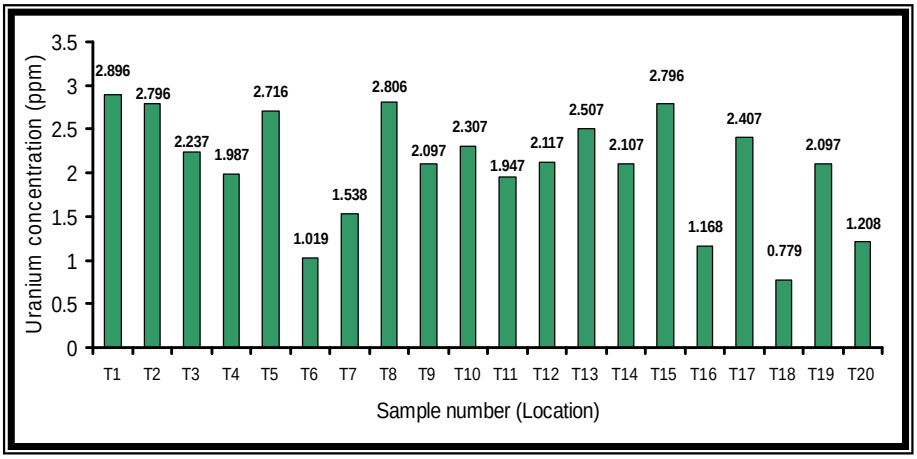

Figure (4) a histogram illustrating the change in uranium concentrations for soil samples for all regions studied in Thi-Qar governorate.

Conclusions

From the present work, it can be concluded that the highest uranium concentration in surface soil samples for the selected regions in Thi-Qar governorate, was found in T_1 (AL-Refai) region, which was equal to (2.896 ppm), while the lowest uranium concentration was found in T_{18} (Garmat Beni Saeed) region which was equal to (0.779 ppm) ,with an average value of (2.077±0.4 ppm). All uranium concentrations in surface soil samples in the selected regions in Thi-Qar governorate were found to be less than the allowed value (11.7 ppm) recommended by (UNSCEAR, 1993)**.**

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Table (1) symbol and location name of samples sites in Thi-Qar governorate.

Symbol	Location name	Symbol	Location name
T_1	AL-Refai	T_{11}	AL- Nasiriyah (Sayed Dakhil)
T_2	Qulat Sikar	T_{12}	AL- Nasiriyah (Askan District)
T_3	AL-Shatra	T_{13}	AL- Nasiriyah (AL-Askary District)
T_4	AL-Fajr	T_{14}	AL- Nasiriyah (Baghdad street)
T_5	Suq-AL-Shuyukh	T_{15}	AL- Hammar
T_6	AL-Fuhud	T_{16}	AL- Tar
T_7	AL- Nasir	T_{17}	AL-Islah
T_8	AL- Dwaya	T_{18}	Garmat Beni Saeed
T_9	AL- Garraf	T_{19}	AL-Aekeckh
T_{10}	AL- Nasiriyah (Ur District)	T_{20}	AL- Fadlia

Table (2) Sample location, track density, uranium concentration U_C in (ppm) units, and U_C in (Bq/kg) units for surface soil samples in Thi-Qar governorate.

Sample location	Track density (track/mm^2)	U_C (ppm)	U_C (Bq/kg)
T_1	203.76	2.896	35.766
T_2	196.73	2.796	34.531
T_3	157.39	2.237	27.627
T_4	139.82	1.987	24.540
T_5	191.11	2.716	33.543
T_6	71.67	1.019	12.585
T_7	108.20	1.538	18.994
T_8	197.43	2.806	34.654
T_9	147.55	2.097	25.898
T_{10}	162.30	2.307	28.492
T_{11}	137.01	1.947	24.046
T_{12}	148.95	2.117	26.145
T_{13}	176.36	2.507	30.962
T_{14}	148.25	2.107	26.022
T_{15}	196.73	2.796	34.531
T_{16}	82.20	1.168	14.425
T_{17}	169.33	2.407	29.727
T_{18}	54.80	0.779	9.621
T_{19}	147.55	2.097	25.898
T_{20}	85.02	1.208	14.919
Average	**146.108±34.41**	**2.077±0.4**	**25.646±6.0**

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