

Measurement of uranium concentrations in soil samples of Al-Diwaniyah governorate, Iraq by using CR-39 track detector

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ABSTRACT:

The present work is concerned with the measurements of uranium concentrations in forty nine surface soils samples from selected locations (some of them were measured for the first time as far as authors know) in Al-Diwaniyah 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 soils samples in the selected regions in Al-Diwaniyah governorate was found in (Al-sdeer) region, which was equal to $(8.86 \pm 0.89 \text{ ppm})$, while the lowest uranium concentration was found in (Al-shamr 2) region which was equal to $(2.50 \pm 0.92 \text{ ppm})$. The present results have shown that the uranium concentrations in the studied surface soils samples were less than the allowed value (11.7 ppm) recommended by UNSCEAR, 1993.

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قياس تراكيز اليورانيوم في عينات التربة في محافظة الديوانية بالعراق باستخدام كاشف الأثر CR-39

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الكلمات المفتاحية:

- يورانيوم
- عينات تربة
- كاشف الأثر
- محافظة الديوانية

الخلاصة:

في هذا البحث تم قياس تراكيز اليورانيوم لتسع وأربعون نموذجاً لتربة سطحية لمناطق منتخبة (بعض منها تم قياسها لأول مرة حسب علم الباحثين) من محافظة الديوانية باستخدام تقنية عدّ آثار شظايا الانشطار النووي والنتائج من أنشطارات نواة U-235 من خلال قصفها بالنيوترونات الحرارية. وبينت النتائج إلى أن أعلى تراكيز لليورانيوم في التربة السطحية للمناطق المنتخبة في محافظة الديوانية كان في (Al-sdeer) والذي كان يساوي $(8.86 \pm 0.89 \text{ ppm})$ بينما أقل تراكيز لليورانيوم في منطقة (Al-shamr 2) والذي كان يساوي $(2.50 \pm 0.92 \text{ ppm})$. وقد بينت النتائج الحالية أن تراكيز اليورانيوم لجميع نماذج التربة السطحية المدروسة كانت أقل من القيمة المسموحة (11.7 ppm) والموصى بها من قبل اللجنة العلمية للأمم المتحدة لتأثير

الاشعاع الذري 1993. UNSCEAR

1. INTRODUCTION

Natural radiation has always been part of the human environment. Its main components are cosmic and cosmogenic radiation, terrestrial gamma radiation from natural radionuclides in rocks and soils, and natural radioactive substances in our diet and in the air we breathe[1]. Radionuclides are found in the environment as naturally occurring elements and as products or by-products of nuclear technologies, one of the most common radionuclides is uranium (U), all isotopes of uranium are radioactive, so it is very important their quantity to be under control [2]. Technique of the tracks count of the fission fragments was used for find the concentration of uranium in soil , because of its ease and accuracy in determining the emitting elements of the alpha particles even if the concentration is very small, the CR-39 detector is considered of the best detectors to record the tracks of alpha particles and nuclear fission fragments , that is because of the advantage of its high sensitivity and the efficiency[3, 4]. The research aims to determine the concentration of uranium in surface soils in the surrounding regions nuclear research center Al-Diwaniyah governorate,, and identify contaminated regions with uranium by using the solid state nuclear track detection technique. A. Radiation in Soils is the upper part of the earth's crust and is formed as a result of rock deformation by complex physicochemical processes, which include weathering, decomposition and water movement, so the soils is the result of the action of weather and human activities on the crust rocks of the earth. The soils is naturally radioactive, because of the mineral content. The natural radioactivity may vary considerably from one type of soils to another[5] . Soils radionuclide activity concentration is one of the main determinants of the natural background radiation. Volcanic

geographic structures as well as rocks that are rich in phosphate, granite and salt contain natural radionuclides like uranium-238, thorium-232 and potassium-40. When rocks are disintegrated through natural processes, radionuclides are carried in soil by rain and flows. In addition to the natural sources, soils. Many earlier studies on measuring the concentrations of uranium in soil , water , and plants are done used different techniques. The following are the most important existing researches on uranium study[6].

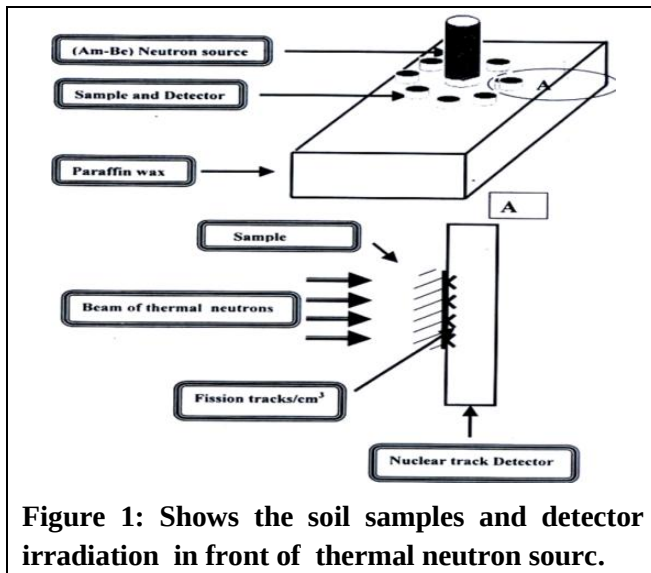
2. MATERIAL AND METHODS

1-2- Collection of soil sample:

Forty-nine samples of soils distributed in Al- Diwaniya center ,Al-ghanam, Al-shamr, Al-barakat, Al-aqarae, Al-khazraj Alamisar Al-farahina, Al-thawra, Alsabahi, Albu-shrifa Alsinidal, Alshuhada', Alhuriya, Aljumhuriu, Al-sdeer, Al-shawfa, Al-ttabu, Al-askari, Al-karama, Alzuhur, Aldawr Alshanaafia, Almuealimin, Alkhasf ,Alsaray, Al-fawar, Al-daraeia, Afak Center Aleayn, fadalallah, Alkarama, alsaray and Al- dighara districts in Al- Diwaniya governorate were taken from location of study, from depth (5-15) cm. than the sample s were cleaned. dried in oven at 70 C° for few hours finally they were powdered and sifted by using special sieve (75) μm in diameter [7]

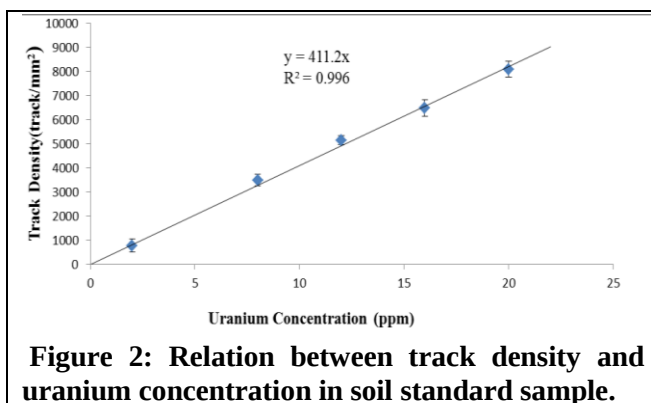
2-2-Irrdiation of the samples

Each sample was taken with the weight 0.5 gm of soil samples powder was mixed with 0.1 gm of mesh cellulose powder used as a binding material. The mixture was pressed into a pellet 15 mm diameter thickness using a hydraulic machine. 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 Am-Be with flux of thermal neutron ($5 \times 10^3 \text{ n cm}^{-2} \text{ s}^{-1}$), as shown in Fig.1 [8].



sample respectively. $C_x = C_s \rho_x / \rho_s$, and the Fig (2) shows this relation between track density and uranium concentration, when (slope = ρ_s / C_s).

$$\frac{C_x}{\rho_x} = \frac{C_s}{\rho_s}$$



3-2-Chemical etching and microscopic scanning:

After the irradiation time 7 days [4], the CR-39 detectors were removed and etched in a 6.25 N aqueous solution of NaOH maintained at 60 °C for 6 hr, which was the normal employed etching time [5]. The detectors were rinsed with distilled water and dried in air. The tracks recorded in CR-39 detectors were counted by using optical microscope at a magnification of 400X. The density of the tracks in the detectors was calculated according to the following relation:

Where:

P: Track density (Track/mm²).

N: Average of total tracks.

A: Area of field view.

4-2- Uranium Concentration:

Fission track technique was used for determination uranium concentration in the soil samples by making a comparison between track densities registered on the detectors of sample and that of the standard geological sample. The uranium content in the unknown samples was determined by using the formula [9]. Where's, C_s Uranium concentration (ppm) for standard and sample respectively, ρ_s , ρ_x track density (track/mm²) for standard and unknown. The general aim is to investigate the complex interactions and exchanges with soil samples, and to estimate how much hazards brought with soils [10]. In fact, the study area is located inside Diwaniya Governorate which is located in the extreme southern part of Iraq, see Fig.3.

3. RESULT AND DISCUSSION

In this research, the soil samples were used from surrounding regions of the nuclear research center at the sample collected from forty-nine locations distributed in six districts in different sites in Al-Diwaniya governorate by (5cm) depth. The soil samples collected from forty-nine locations distributed in different sites in Diwaniya center, Al-ghanam, Al-shamr, Al-barakat, Al-aqara, Al-khazraj, Alamisar, Al-farahina, Al-thawra, Al-sabahi, Albu-shrifa, Alsinidal, Al-shuhada', Alhuriya, Aljumhuriya, Al-sdeer, Al-shawfa, Al-ttabu, Al-askari, Al-karama, Al-zuhur, Al-dawr, Alshanaafia, Almuealimin, Al-khasf, Alsaray, Al-fawar, Al-daraeia, Afak Center, Aleayn, fadalallah, Alkarama, alsaray and Aldighara. Fig: (2) shows the relationship between uranium concentration and number of the soil sample to know the extent of contamination of these regions with, uranium concentration has been calculated by

using technique of counting the tracks of nuclear fission fragments using nuclear track detector (CR-39), and the results were arranged in the Table (1). The selection of these regions to measure the ratio of uranium, depending on several factors, the most important are the increase in uranium concentrations in some areas around the Diwaniyah center, due to the recent war in those areas and the remnants of nuclear weapons [11].

Table 1: Measurements of Uranium concentration in soil samples from different areas of AL-Diwaniya Governorate.

Site Number	site Name	tracks density (tracks/m ²)	Uranium Concentrations (ppm)
S1	Al-ghanam 1	1835±65	4.46±1.55
S2	Al-shamr 1	1500±49	3.64±1.21
S3	Al-barakat 1	1285±65	3.12±1.59
S4	Al-aqarae	2068±40	5.03±0.97
S5	Al-khazraj	2374±28	5.77±0.68
S6	Alamisar	1514±49	3.68±1.20
S7	Al-ghanam 2	3100±50	7.53±1.22
S8	Al-shamr 2	1028±38	2.50±0.92
S9	Al-barakat 2	1771±28	4.30±0.69
S10	Al-farahina	2785±15	6.77±3.76
S11	Al-thawra	2417±37	5.87±0.90
S12	Alsabahi	1811±41	4.40±1.01
S13	Albu-shrifa	1485±63	3.61±1.53
S14	Alsinidal	2157±10	5.24±2.46
S15	Al-shuhada'	1428±22	3.47±0.55

S16	Alhuriya	1271±35	3.09±0.08
S17	Aljumhuriu	2071±10	5.03±2.45
S18	Al-sdeer	3647±35	8.86±0.89
S19	Al-shawfa	3251±41	7.90±1.00
S20	Al-ttabu	2220±37	5.39±0.90
S21	Al-askari	2157±37	5.24±0.90
S22	Al-karama	2600±15	6.32±3.77
S23	Alzuhur	2528±55	6.14±1.33
S24	Al-sdeer 2	2657±78	6.46±1.91
S25	Al-askari 2	1928±45	4.69±1.10
S26	Al-karama	2785±27	6.77±0.67
S27	Aldawr1	1642±78	3.99±1.91
S28	Alshanaafia	2800±31	6.80±0.75
S29	Almuealimin	2501±34	6.08±0.83
S30	Alkhasf	1594±39	3.87±0.97
S31	Alsaray	2149±27	5.22±0.67
S32	Aldawr 2	1782±42	4.33±1.02
S33	Alkhasf 2	1242±87	3.02±2.13
S34	Alshanaafia2	2487±38	6.04±0.91
S35	Al-fawar	2157±53	5.24±1.30
S36	Al-daraeia	2438±57	5.93±1.38
S37	Afak Center	2131±37	5.18±0.90
S38	Aleayn	2114±25	5.14±0.61
S39	fadalallah	2492±46	6.06±1.12
S40	Alkarama	1985±46	4.82±1.13
S41	alsaray	1257±62	3.05±1.51
S42	Almuealimin	1342±47	3.26±1.14
S43	aldighara 1	1658 ±34	4.03±0.73
S44	aldighara 2	2014±24	5.14±0.61
S45	aldighara 3	2271±39	5.52±0.90
S46	aldighara 4	1660±30	4.03±0.75
S47	aldighara 5	2400±28	5.83±1.07
S48	aldighara 6	1863±39	4.53±0.89
S49	aldighara 7	2734±37	6.64±0.91

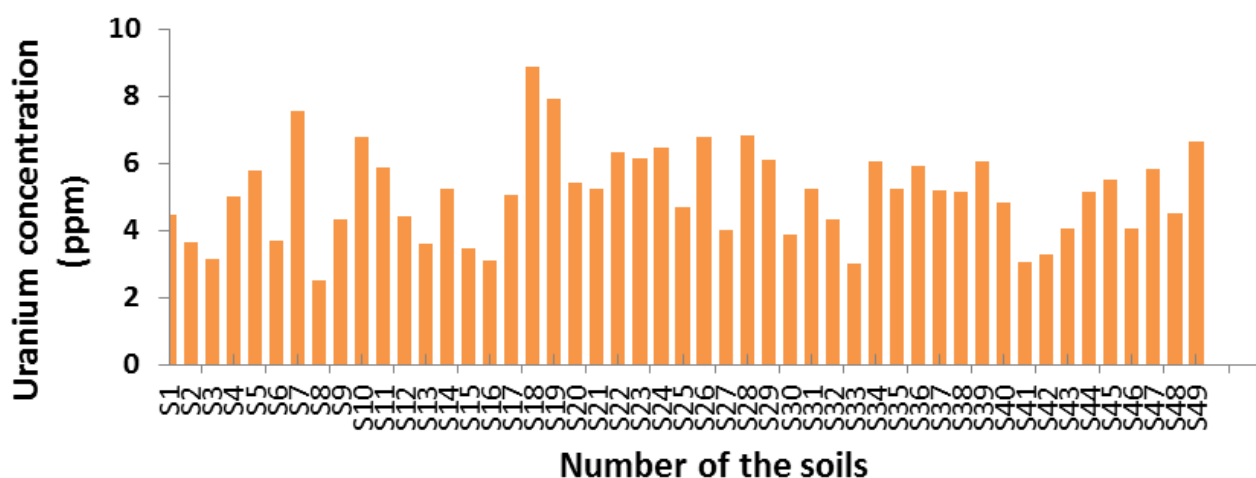


Figure 4: Uranium Concentration in soil samples of different district as a function of the number of the station by using SSNTDs.

For the measurement of Uranium concentration level soils, table 1, and Fig..2, reflect the fact that, there was some less than level of Uranium concentration in this soils samples less than from the U.S Environmental Protection Agency (EPA). The results for these 49 samples categorized into 49 locations, in Al-Diwaniya Governorate from S1 to S49, shown in Fig. 2. Uranium content found maximum (8.869)ppm in (Al-sdeer) and minimum (2.501) ppm was recorded in Al-(shamr 2) belt. Out of the 49 soils samples 3 samples recorded higher which are beginning from 7.538 ppm to 8.869 ppm while the 25 soil samples are beginning from 5.0300 ppm to 6.8093 ppm but while the 20 samples are beginning from 3.022 ppm to 4.829 ppm but while the 1 sample is beginning from 2.501 ppm than the prescribed EPA limit (30 ppm)[12]. The maximum contaminant level (MCL) of uranium was determined to be about 30 $\mu\text{g/L}$ by U.S Environmental Protection Agency (EPA)[13]. It is important to reliably monitor uranium concentrations in environmental samples. However, due to the relatively low sensitivity of these techniques for uranium, a large number of samples and long measurement times are generally required to obtain reliable results. [14]. Alia A .Kaddhima and Issraa K. Ahmed In 2014 , measured uranium concentration for twenty-eight samples of soil distributed in seven districts for Al-Durra city in Baghdad governorate using nuclear track registration technique with pm-355 detector. The maximum value of uranium was (1.478ppm) in Al-Gameaea district and the minimum value was (0.676ppm) in Al-Maeledeen district. Akram .M et al , in 2013, estimated Uranium Concentration and Its Associated Health Hazards in Drinking Water using Neutron Induced Fission Track from different location in Faisalabad Industrial city .Uranium concentrations varied from $(1.04 \pm 0.30) \mu\text{g.L}^{-1}$ (21.08 ± 2.95) $\mu\text{g.L}^{-1}$ [14].

4. CONCLUSION

The highest concentration of uranium in the soil samples was in the sample (S 18) which is equal to $(8.86 \pm 0.89 \text{ ppm})$, this value is less than the allowed limit, which is equal to (11.7 ppm). The pollution ratio in the region (Al-sdeer) with uranium is the highest in the comparison with other regions, and this means that the people of this region are the most vulnerable to uranium from the other regions. The uranium contamination ratio in (Al-sdeer) and the region (Near a Al-ghanam 2) despite being within allowed limit, but it is the ratio cannot be underestimated, the uranium ratio is relatively high, so it is advisable to processed with all means to ensure the safety of the population from continuous exposure to uranium, while the rest of the proportions of the other regions are reasonable proportions

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