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Measuring Uranium Concentrations in Soil Samples of Midland Refineries Company - Doura - Baghdad – Iraq

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Abstract:

In this study, the CR-39 detector technique was used, to estimate the uranium concentration from the soil in midland refineries Company (Doura refine) , Baghdad, Iraq. Uranium concentrations in soil samples have been measured using solid state nuclear track detector type CR-39. Nine soil samples were collected from different areas within the Doura refinery and other soil samples were collected form Abu Tayara Street and ALshortaa District outside the refinery for comparison. The results showed variable values for uranium concentrations. The average value of uranium concentration was found to be 0.37 ppm in doura refinery. For areas outside the refinery, the concentration of uranium was 0.008 ppm. These results were less than the global limit.

Key words: Alpha particles, Cancer, CR-39, Soil, Uranium.

Introduction:

Some human activities may result in an increase in the exposures and need to be controlled by regulations. In this context, materials that are giving rise to the increased radiation exposures are known by the Naturally Occurring Radioactive Material (NORM). NORM is an acronym for the Naturally Occurring Radioactive Material, which includes all radioactive elements, existed in the environment. Long-lived radioactive elements include uranium, thorium and potassium and any of their decay products, such as radium and radon (1, 2, 3).

These elements exist in the Earth's crust, atmosphere and specifically concentrated at certain places such as uranium ore bodies. The calculable health risks from exposure to low levels of ^{226}Ra and ^{238}U are little, and short term exposures cause solely very little risks (4, 5).

When uranium is high in the soil, it can cause to ^{222}Rn and its airborne progeny is a significant internal health hazard (6). Uranium as a heavy metal is a natural constituent of the earth's crust and the presences of it in soil are natural and anthropogenic when the main sources of anthropogenic exist in various industrial sources and agricultural activities such using fertilizer while the result of these activities are causing soil pollution by these types of heavy metals.

The maximum permissible levels of metal concentrations in soil complyed with the idea of preventing toxic exposure of plants, animals and humans (7, 8).

On average, the human body contains approximately 90µg of uranium, which comes from the normal consumption of food, air and water. About 66% are concentrated in the skeleton, 16% in the liver, 8% in the kidneys and 10% in other tissues (9) .Uranium decomposes primarily through the emission of alpha particles that do not penetrate the outer layers of the skin, but may affect the body's internal cells (which are most vulnerable to the ionizing effects of alpha particles) when ingested or inhaled uranium exposure to alpha and beta particles as a result of the inhalation of insoluble uranium particles may damage lung tissue and increase the risk of lung cancer (10). If taken through the digestive system it has a multiplier effect when uranium enters through the mouth and food digested into the bloodstream and is transferred to all members of the body to concentrate mostly in kidney, bone, and liver. The kidney is one of the most sensitive members of uranium in the body (11).

The main objective of this research is to determine the level of uranium concentration in soil samples in different areas; Laboratory Gas Analyzes, Casinos tanks, API depot (1), Industrial Water Treatment Unit, Assembling barrels of Ferfera l (fat), Chemical storage containers, Cabs for barrels, Storage of chemicals and API depot (2)

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within the Midland Refineries Company (Doura refinery) and soil samples from Abu Tayara Street and ALshortaa District outside of the refinery for comparison as well as to determine the risk of lung cancer in people in these areas.

Materials and Methods:

The small piece of detector were used (1x1) cm^2, was sensitive to the alpha particles that released by radon and its progeny, fixed at the top of the cup (can technique) (12). Soil samples were collected in May 2017 from the study areas. Samples were taken from nine areas of operational units deployed inside the refinery (Three samples from each site).

The study area from which samples are taken within the refinery limits is approximately 3.43 km^2 as shown in Fig . 1.

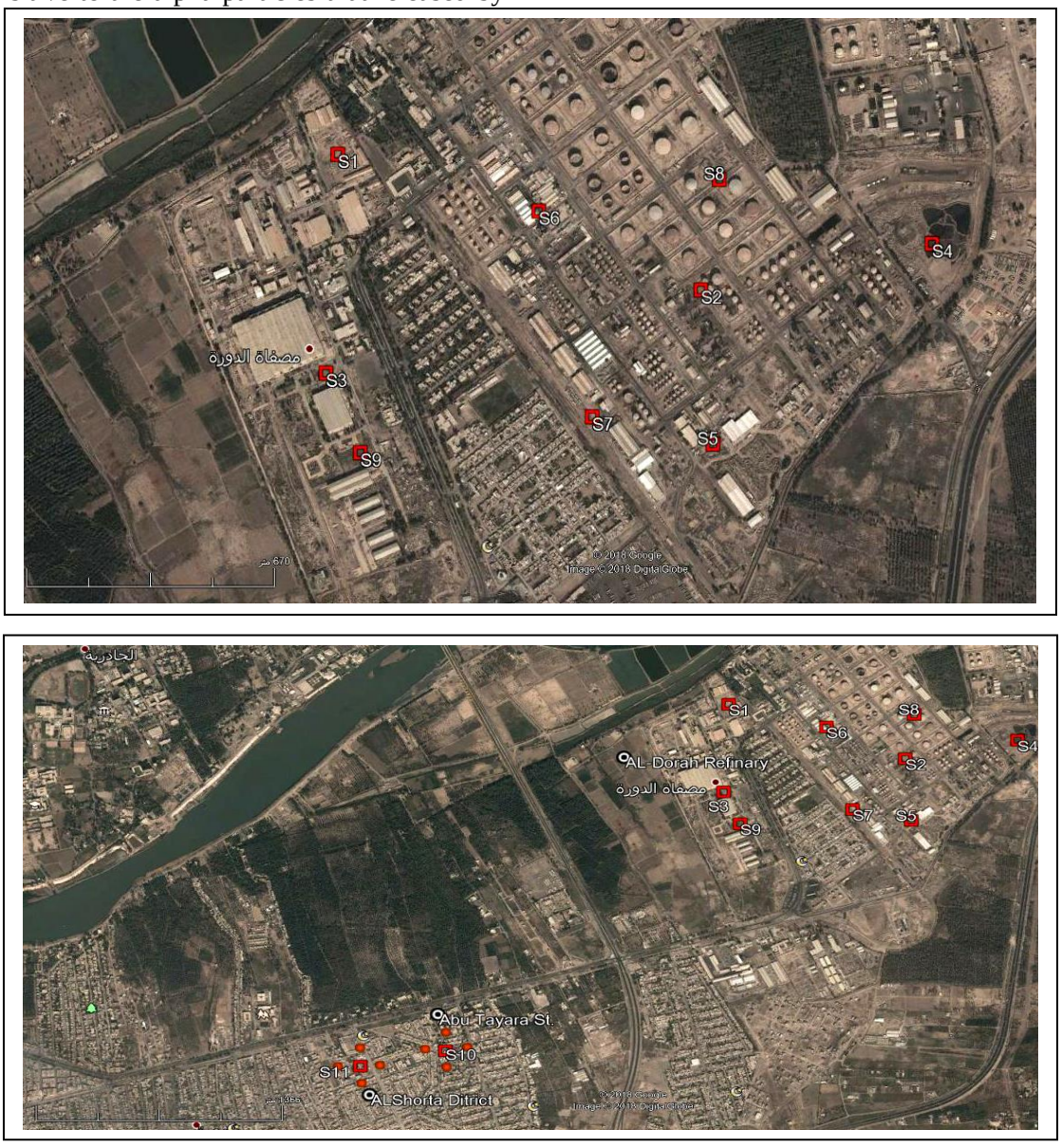

Figure 1 . Maps of the studied area inside the refinery.

Samples were collected from the area of the Abu Tayara Street and ALshortaa District that outside distance 3.3 km from the refinery, and then the sampling rate for each area was taken , as shown Fig. 2. The samples were taken for depths (3-10) cm. After collecting the soil samples, weight 12 g is was placed in cup (can technique) and left for 50 days to obtain the radiative equilibrium state.

The CR-39 detectors were etched at several conditions. The optimum condition for the etching of the CR-39 detectors was 6.25% N - NaOH at 70°C with accuracy of ± 0.1°C and an etching time of 6 h. After etching, the detectors were washed in distilled water and allowed to dry in air.

The numbers of track in 20 fields were scanned for each detector using an optical microscope and CCD camera which was used to determine the track density per cm^2 (13).

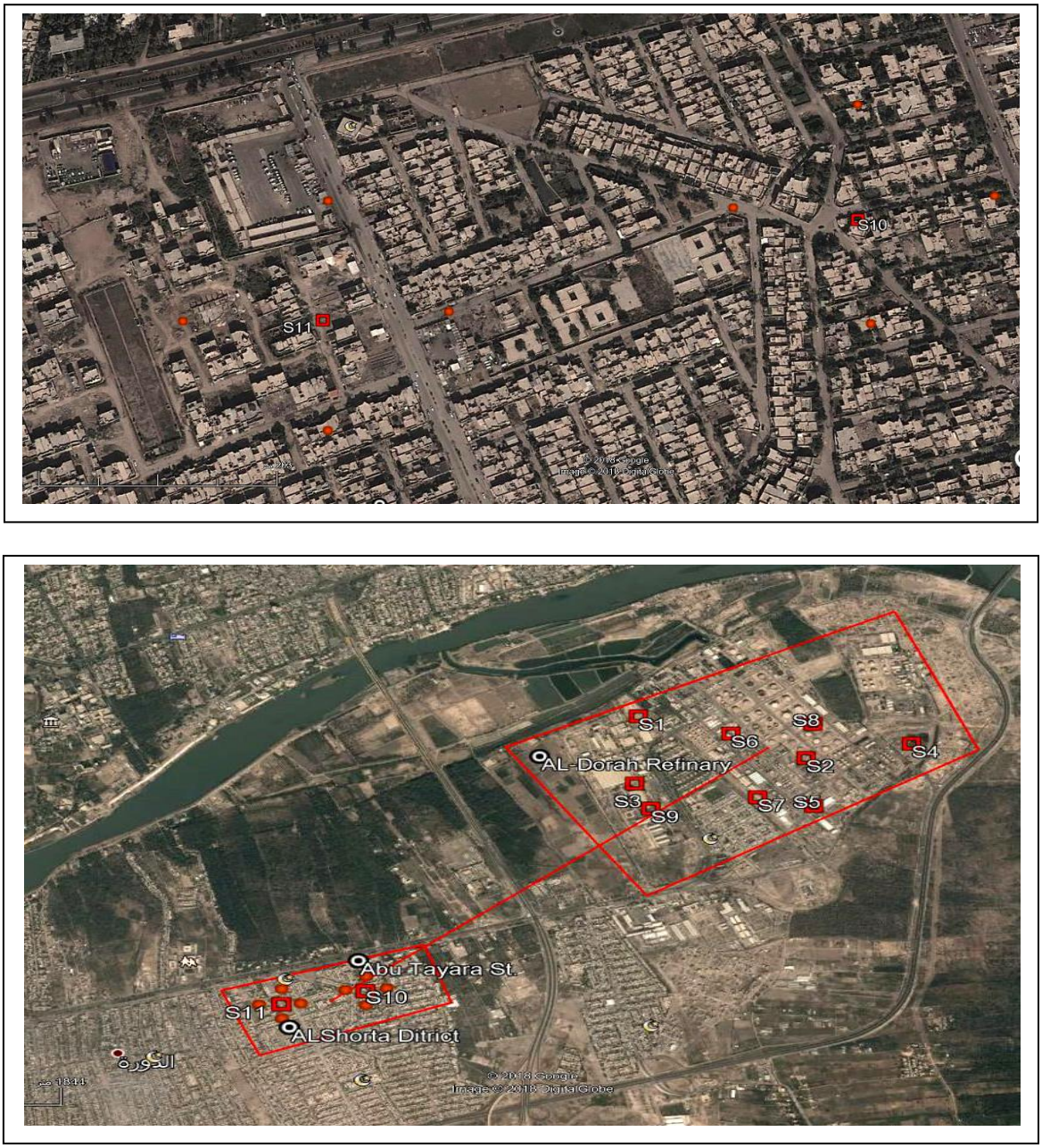

Figure 2 . Maps of the studied area outside the refinery.

For chemical scavenging technology, we use NaOH solution and standard 6.25 N. The straw solution is placed in a water bath for heating up to 70 °C for 6 hours. At this stage, the effects are detected by selecting the appropriate magnification of 40 X objective lens, and then counting the effects of the area unit using a special lens divided into several squares and calculating the average number of effects taken for each sample (14, 15).

ρ_x is the track density of studied samples which can calculated by (15):

$$\rho_X = \frac{N_{ava}}{A} \quad \ldots 1$$

$$\frac{C_\times}{\rho_\times} = \frac{C_S}{\rho_S} \quad \ldots 2$$

Uranium concentrations C_x were calculated in soil samples from the following relationship:

$$C_X = \frac{\rho_X}{slope} \quad \ldots 3$$

Slope = 100, represents the relationship between track density ρ_s and standard uranium concentration C_s as shown in Fig .3 (16, 17).

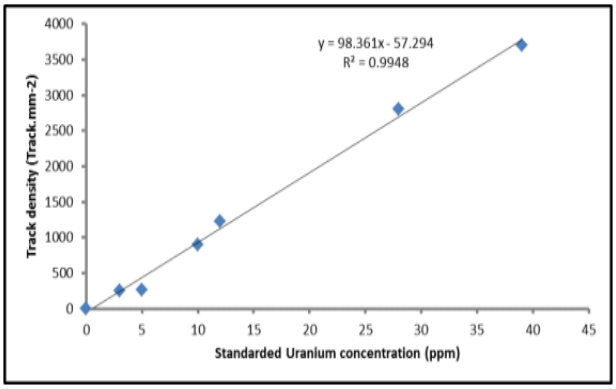

Figure 3. The relation between track density and uranium concentration for standard geological soil samples. followed Al-Baidhani (16) and Qusy (17).

Results and Discussion:

United Nation Environment Program (UNEP) proved that uranium can diffuse into soil with 15cm for 8 years. Therefore, uranium concentration (UC) was measured for 3-10 cm depths of soil samples collected from 11 districts. (Each sample represent the average value of three samples were taken from the site).

Table 1 shows the results of track density and concentrations of uranium in these areas. The results show that the maximum values of track density were 36.3 Track/mm^2 in casinos tanks and the minimum values were 4.2 Track/mm^2 in Storage of chemicals site, whereas, the average values were 14.07 Track/mm^2 .

In this study, uranium concentrations were determined at different sites inside Doura refinery and shows that the highest concentration of was 0.36 ppm in S_2 (casinos tanks). The lowest concentration was 0.04 ppm in S8 (Storage of chemicals). The average value for all sites was 1.15 ppm.

Table 2 presents the results track density and concentrations of uranium for different samples in areas outside the refinery. Then the samples rate for each area was taken (Samples were taken from nearby areas and away from the refinery to see how affected they were).

The results shows that the average value of track density was 1.7 Track/mm^2 and the average value of uranium concentrations was 0.01 ppm in S10 (Abu Tayara Street) while the average value of track density and uranium concentrations were 0.7 Track/mm^2 and 0.007 ppm in S11 (Al-Shortaa District) respectively as shown in Figs 4 and 5.

It is observed that the concentration of uranium in the soil outside the refinery is less than the concentration of uranium in the refinery soil. These results can be attributed to the fact the refinery in an industrial area and is exposed daily to industrial waste while the areas outside the refinery are far away and surrounded by agricultural land.

The concentrations of uranium values in the study areas remain within the permissible global limit (18, 19). This is a clear indication that uranium radiation activity is acceptable compared to other studies (20, 21).

Table 1 and 2 show that the concentration of uranium that calculated in the study areas fluctuates between 0.04-0.36 ppm, these values are within the permissible limit as the allowable limit is less than 11.7 ppm according to UNSCEAR (19).

Table 1. The uranium concentration of soil samples inside the refineries company – Doura.

Code Sites	Latitude	Longitude	Name of Location	Track Density (Track/mm^2)	Uranium Concentration ppm
S1	33^0 21' 34"	44^0 33' 25"	Laboratory Gas Analyzes	22	0.22
S2	33^0 51' 22"	44^0 22' 03"	Casinos tanks	36.3	0.36
S3	33^0 17' 15"	44^0 02' 24"	API depot (1)	11.9	0.119
S4	33^0 51' 26"	44^0 06' 27"	Industrial Water Treatment Unit	9.2	0.09
S5	33^0 44' 09"	44^0 27' 40"	Assembling barrels of Ferfera l (fat)	12.3	0.12
S6	33^0 07' 29"	44^0 45' 46"	Chemical storage containers	8.7	0.08
S7	33^0 50' 11"	44^0 13' 52"	Cabs for barrels	14.6	0.14
S8	33^0 25' 32"	44^0 56' 05"	Storage of chemicals	4.2	0.04
S9	33^0 59' 08"	44^0 29' 27"	API depot (2)	7.5	0.07
Average				14.07	1.15

Table 2. The uranium concentration of soil samples outside the refineries company – Doura.

Code Sites	Name of Site	Track Density (Track/mm^2)	Uranium Concentration (ppm)
S10	Abu Tayara Street	1.7	0.01
S11	ALshortaa District	0.7	0.007
Average		1.2	0.008

Figure 4 shows the relationship between uranium concentration and code samples in studied areas while Fig. 5 represents the relationship of the track density relative to code samples.

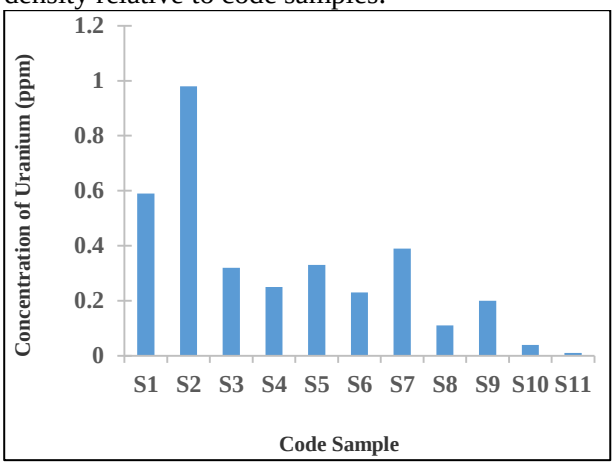

Figure 4. The relationship between uranium concentration and code samples in studied area.

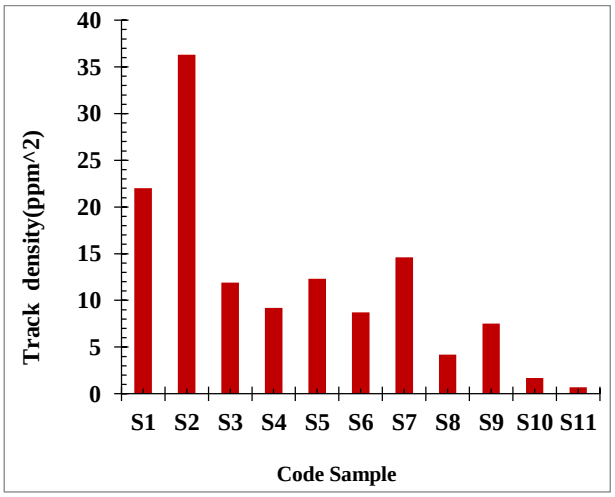

Figure 5. The relationship between track density and code samples in studied area.

Conclusions:

The average uranium concentration in industrial soil collected from doura refinery are 0.37 ppm and in areas outside the refinery are 0.008 ppm. These values of concentrations are within the permissible limit as the allowable limit is less than 11.7 ppm according to UNSCEAR **.**

This study showed that uranium concentrations is available, even if a few, so we recommend to take special preventive measures to prevent the occurrence of any incidents of radiation exposure in any time by speeding up the work and to wear protective clothing.

Conflicts of Interest: None.

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قياس تركيز اليورانيوم في عينات تربة شركة مصافي الوسط الدورة - بغداد – العراق

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الخلاصة:

في هذا البحث استخدمت تقنية CR-39 لحساب تركيز اليورانيوم في عينات من تربة شركة مصافي الوسط (مصفى الدورة) ، بغداد، العراق، تركيز اليورانيوم في عينات التربة تم قياسها من خلال عد اثار جسيمات الفا المنبعثة من اليورانيوم في كاشف الاثر النووي CR-39. تم جمع تسع عينات تربة من مواقع مختلفة داخل مصفى الدورة و عينات اخرى من التربة لمناطق شارع ابو طيارة وحي الشرطة تقع خارج المصفى للمقارنة. اظهرت النتائج وجود قيم متغيرة بمعدل تراكيز اليورانيوم هو 0.37 ppm داخل المصفى، اما بالنسبة للمناطق التي تقع خارج المصفى وجد ان معدل تركيزاليورانيوم هو 0.008 ppm وكانت هذه النتائج أقل من الحد العالمي المسموح.

الكلمات المفتاحية: جسيمات الفا ،كاشف CR-39، سرطان، التربة ، اليورانيوم.