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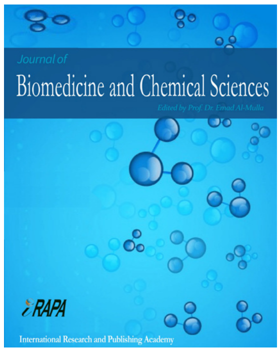

The Uranium Concentration of Soil Samples in the South of Amara Governorate was Measured Using the CR-93 Detector

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ABSTRACT

The amount of uranium was evaluated in soil samples taken from various residential, industrial, and agricultural areas in the southern Amara Governorate in southern Iraq using the neutron activation technique of CR-39 solid nuclear track detectors. Uranium values in soil samples ranged from 0.795 parts per million to 2.05 parts per million, according to the results. Soil samples were collected at a depth of 10 cm. The results were compared to publicly available data and found to be within acceptable ranges.

INTRODUCTION

Uranium is a shiny, silvery metal that has a long half-life as a natural radionuclide. Uranium is the heaviest element in the world. It is one of the most important environmental hazards due to its radioactivity. Uranium and its compounds are highly toxic and pose a threat to human health and the environment (Salman & Algrifi, 2022a; Salman & Algrifi, 2022b; Todorov & Ilieva, 2006). Uranium is a common element that may exist in a solid, liquid, or gaseous state. It may be contained in food, water, soil, rocks, natural materials, and the environment.When uranium combines with other elements, it easily produces uranium oxide, silicates, hydroxides, and carbonates (Salman & Algrifi, 2022b; Dockery, et al., 1993). The physiological action of uranium compounds is determined by their solubility. The chemical toxicity of soluble uranium is regulated, but the radiological properties of insoluble (less soluble) uranium are not.However, because of its slow absorption through the lungs and long residence time in human tissues, it will cause the greatest damage to internal organs through radiation damage (the risk of cancer death) rather than posing a significant chemical risk to the kidneys (US Department of Health & Human Services, 1990).

Uranium may enter the human body through a variety of pathways. It enters the body directly, either by inhaling dust particles containing uranium or drinking water contaminated with uranium, or indirectly through the food chain from the fertile soil layer (Salman & Algrifi, 2022a; Craig, 2001). The use of the CR-39 detector is more effective for detecting trace levels of uranium in geological and biological materials (Cléro, et al., 2019). Given the importance of the problem and its impact on the environment and human health, researchers looked at the concentration of uranium in soil samples (Zarkadas, et al., 2001; Salman & Algrifi, 2022; Algrifi & Salman, 2023). The goal of this study is to use the neutron activation technique

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for nuclear track detectors CR-39 to assess the uranium content in chosen soil samples acquired from various residential, industrial, and agricultural sectors in the Southern Omara governorate in southern Iraq. Due to a lack of prior research and the construction of a database on the number of uranium concentrations in soil samples, this study was conducted in the governorate of Southern Omara.

MATERIALS & PROCEDURES

Sample Collection

In this study, 25 soil samples were obtained from 25 different locations in the southern Amara Governorate in southern Iraq, one from each (see Figure 1). Ground samples were taken at a depth of 10 cm from the ground. Table 1 shows the research areas, which included residential, agricultural, and industrial areas. The required amount for the fission path analysis technique was obtained after cleaning 25 soil samples and removing stones, gravel, and root parts. Lypropylene containers labelled with sample codes were used to store samples.

A solid-state nuclear track detector (CR-39, Pershore Molding Ltd., UK) was used to determine the uranium content in soil samples. After drying in an electric oven at 70 °C for 6 hours, the soil samples were crushed with a grinder. As a binder, 0.5 g of crushed soil was mixed with 0.1 g of methylcellulose. The mixture was crushed into a pellet using a hand press with a diameter of 1 cm and a thickness of 1.5 mm. The CR-39 track detector is covered on both sides with pellets of size 1.5*1.5 cm. The pellets were then irradiated for 7 days in a paraffin wax dish at a distance of 5 cm from the neutron source (Am-Be). With a thermal rebound of 3.024105 n.cm-2.s-1 to cause potential damage to the detector resulting from the 235U(n,f) reaction. After irradiation, the detectors were chemically etched in a NaOH solution under controlled conditions, as previously described (Salman & Algrifi, 2022a). The density of the induced fission tracks was measured using a magnifying 400 optical microscope, and the tracks were viewed using an optical camera. As shown in Equation 1, the density of fission paths (ρ) was estimated by dividing the average of the paths by the area of the field view.

Experimental Method

Path density (ρ×) = average path/area of field view..........................(1)

Calculation

The uranium content in soil samples was estimated using the previously mentioned equation [1, 2] by comparing the track densities observed on the soil sample detector with those detected on the reference sample detector.

$$C_x = C_s \, \rho_x / \rho_s \quad \text{.............................(2)}$$

where ρ_x and ρ_s are the induced fission path densities (tracks/mm^2) for the unknown and standard samples, respectively, and C_x and C_S are the uranium concentrations (ppm) for the unknown and standard samples, respectively.

Fig. 1. The sample collection locations in the southern Amara Governorate

Table 1
Use of ICP-MS to determine uranium concentration in soil samples from areas of the southern Amara Governorate

Sites numbers	Sites	Tracks density(tracks/mm²)	Uranium Concentration in ppm
S1	Almajar Alkabir1	452.32	1.1±0.33
S2	Almajar Alkabir2	616.8	1.5±0.40
S3	Almajar Alkabir3	431.76	1.05±0.37
S4	Almajar Alkabir4	546.89	1.33±0.35
S5	Almajar Alkabir5	407.08	0.99±0.26
S6	Almajar Alkabir6	349.52	0.85±0.14
S7	Almajar Alkabir7	378.30	1.92±0.19
S8	Almajar Alkabir8	357.74	0.87±0.30
S9	Almajar Alkabir9	805.95	1.96±0.59
S10	Almajar Alkabir10	818.28	1.99±0.62
S11	Aleadl1	842.96	2.05±0.42
S12	Aleadl2	324.84	0.795±0.22
S13	Aleadl3	361.85	0.88±0.31
S14	Aleadl4	365.96	0.89±0.29
S15	Aleadl5	608.57	1.48±0.38
S16	Aleadl6	781.28	1.9±0.54
S17	Aleadl7	489.32	1.19±0.32
S18	Aleadl8	711.37	1.73±0.41
S19	Aleadl9	394.75	0.96±0.27
S20	Aleadl10	398.86	0.97±0.28
S21	Alwadia1	353.63	0.86±0.21
S22	Alwadia2	374.19	0.91±0.24
S23	Alwadia3	370.08	0.9±0.25
S24	Alwadia4	456.43	1.11±0.34
S25	Alwadia5	402.97	0.98±0.36

RESULTS & FINDINGS

Table 1 shows the analytical data obtained from the soil samples that were used in this investigation. The highest uranium content in the surface soil sample was 2.05 ppm in sample S11 of lead 1, while the lowest uranium content was 0.795 ppm in sample S12 of lead 2, so uranium concentrations were found in soil samples taken from the surface. The average concentration of uranium in the surface soil samples of the Southern Amara Governorate is less than the permissible limit indicated by (Salman & Algrifi, 2022a). The results reveal that as soil depth increases, the amount of uranium in the soil decreases. The reason for these results can be attributed to the erosion and washing of soil surface layers. The highest amount of radioactivity is seen near the soil surface during the first months after soil contamination, where wind and rain can remove up to 90% of radioactive material (Durrani & Bull, 2013; Kakati, et al., 2013; Baykara & Dogru, 2006; Geraldo, et al., 2010; Kadhim & Kadhim, 2018). In addition to the mineral composition of Iraqi soil, which contains a significant amount of calcium carbonate and iron and aluminium oxides, the interaction of these components with the solid component of the soil reveals the soil's ability to retain radioactive pollutants and impede their movement. Figure 2 depicts the general average uranium concentration in soil samples in the Southern Amara Governorate as a function of location.

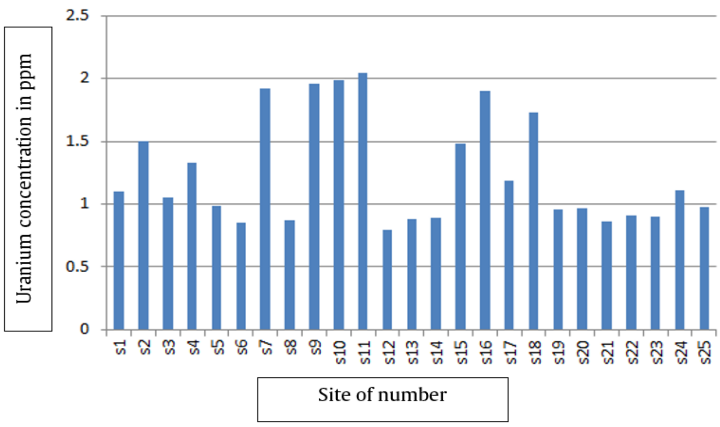

Fig. 2. the average uranium content in soil samples as a function of geographic location

Human activities and the exposure of some industrial areas to uranium contamination during the Gulf Wars led to these results. The presence of uranium in agricultural soil samples may be related to the use of agricultural fertilizers. The presence of uranium in soil samples is classified as industrial > agricultural > residential.

CONCLUSION

Uranium content in soil samples was determined using solid nuclear track detectors (SSNTDs). The results of this study showed that the concentration of uranium increases more in industrial areas than in residential areas, although the results were within acceptable levels and do not cause concern at the present time.

Competing Interest

The authors had no competing interests.

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