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ORIGINAL STUDY

Uranium Concentrations in Soil Samples From the North of Basrah Governorate

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Abstract

In the College of Education for Pure Sciences Ibn al-Haytham, irradiation of soil samples was conducted to obtain measurements of uranium content in soil samples using CR-39 in 36 surface soil samples from selected sites (some of which, according to the authors, were measured for the first time) in the North Governorate Basra. It was found that uranium concentrations ranged from (1.1 ppm) in the Al Madina center to (1.6 ppm) in Talha. Results are presented and compared with other research findings. The concentration of uranium in the governorates north of Basra has been presented and evaluated in this article. The present results show that the uranium contents in the surface soil samples examined were below the UNSCEAR recommended limit of 11.7 ppm.

Key words: Basrah governorate, Concentration of uranium, Soil sample, CR-39, Irradiation

1. Introduction

As a natural radionuclide, Uranium is a silvery, glossy metal with a long half-life. Uranium is one of the heaviest elements in the world. Due to its radioactivity, it is one of the most severe pollution hazards. Uranium and its compounds are very poisonous, and-pose a danger to human health and the environment [1–3]. Uranium is a common element in solid, liquid, or gaseous forms. It can be found in food, water, soil, rocks, natural materials, and the environment. Uranium efficiently produces uranium oxide, silicates, hydroxides, and carbonates when it reacts with other elements [2,4]. The solubility of uranium compounds determines their physiological activities. The chemical toxicity of soluble Uranium was controlled, whereas the radiological characteristics of insoluble (less soluble) Uranium were regulated. However, owing to its slow absorption via the lungs and extended retention period in human tissues, it causes the most harm to internal organs through radiological damage (cancer mortality risk) rather than a significant chemical threat to the kidneys [5]. Uranium can enter the human body via several routes. It enters the body directly via inhalation of uranium-bearing dust particles, drinking uranium-contaminated water, or indirectly through the food chain from the fertile soil layer [1,6]. When measuring uranium trace levels in geological and biological materials, It is more efficient to use a CR-39 detector [1,2,7]. Because of the relevance and impact of the problem on the environment and human health, studies investigated the concentration of Uranium in soil samples [8–11]. This study aims to examine the uranium content in selected soil samples taken from diverse residential, industrial, and agricultural sectors in the Northern Basrah governorate in southern Iraq using the neutron activation technique for nuclear track detectors CR-39. This study was carried out in the governorate of Northern Basrah due to a lack of previous research and the creation of a database on the number of uranium concentrations in soil samples.

2. Material and Procedure

2.1. The collection of samples

In this work, 36 soil samples were collected from 36 different locations in April 2021 and the Northern Basrah governorate of southern Iraq, one from each (see Fig. 1). Soil samples were collected at depth

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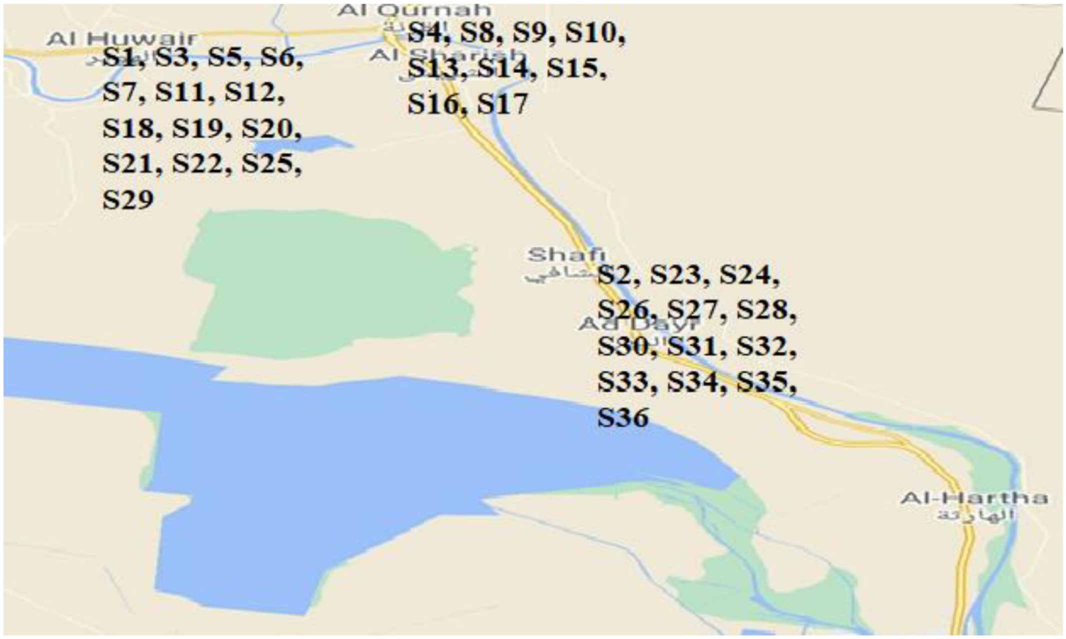

Fig. 1. Northern Basrah governorate is shown on a map of Iraq.

inside the soil (15 cm). Table 1 depicts the research areas comprising residential, agricultural, and industrial zones. After cleaning 36 soil samples and removing stones, pebbles, and root portions, the needed quantity for the fission track analysis approach was obtained. The samples were kept in polypropylene vials labeled with sample codes.

2.2. Experimental method

Solid state nuclear track detector was used to quantify the uranium content in soil samples (CR-39, Pershore Moulding Ltd, UK). The soil samples were dried in an electric oven at 70 °C for 6 h, after which they were ground with a grinder. (0.5 g) powder soil was combined with (0.1 g) methylcellulose as a binder. A manual piston with a diameter of 1 cm and a thickness of 1.5 mm was used for crushing the mixture into a pellet. A CR-39 track detector with a size of (1.5 × 1.5 cm) was coated on both sides of the pellets. The pellets were subsequently irradiated in a paraffin wax dish for seven days at a distance of 5 cm from the neutron source (^{241}Am-^{9}Be) with a thermal flounce of (3.024×10^5 $n.cm^{-2}.s^{-1}$) to cause latent damage on the detector due to the ^{235}U reaction (n,f). After the irradiation technique, the detectors were chemically etched in (NaOH) solution under controlled conditions, as described before [1,12]. The densities of induced fission tracks were measured using an optical microscope with a magnification of 400×, and the tracks were seen using an optical camera. The density of fission tracks (ρ) was calculated by dividing the average of tracks by the area of field view, as shown in Equation (1):

$$\text{Track density}(\rho x) = \frac{\text{average of tracks}}{\text{area of field view}} \tag{1}$$

2.3. Calculation

Using the equation previously stated [1,2], the uranium content of soil samples was determined by comparing track densities detected on the detector of soil samples to those found on the detector of standard samples.

$$Cx = Cs\frac{\rho x}{\rho s} \tag{2}$$

where ρ_x and ρ_x represent the induced fission track density in (tracks/mm^2) for unknown and standard samples, respectively, and C_x and C_S represent the uranium concentrations in unknown and standard samples, respectively, in (ppm).

3. Discussion of the Findings

Table 1 shows the analytical data acquired from the soil samples used in this investigation. The greatest uranium content in a surface soil sample was 1.6 ppm in sample S21 from Talhah. In comparison, the lowest was 1.1 ppm in sample S3 from Center Al

Table 1. Uranium content in soil measured using the SSNTDS technique in Northern Basra Governorate.

No of site	Location of samples	The concentration of Uranium (ppm)
S1	Al Traba	1.2
S2	Saleh River	1.4
S3	Center Al Madina	1.1
S4	Anter River	1.3
S5	Al Huwair	1.3
S6	Al Ahwar	1.5
S7	Al Sura	1.44
S8	Al Neherat	1.56
S9	Al Khas	1.48
S10	AL Housh	1.43
S11	Abu Ghraib	1.46
S12	Majnon	1.53
S13	Al Alwa Al Qurnah	1.44
S14	Al Awjan	1.3
S15	Mzieraa	1.51
S16	Al Basha River	1.38
S17	Al Sharish	1.22
S18	Ahmed bin Ali	1.58
S19	Al Alwa Al Huwair	1.24
S20	Al Aghmieg	1.47
S21	Talhah	1.6
S22	Um Al Shuwayj	1.51
S23	Al Shafi Seid Saleh	1.33
S24	Al Ez River	1.6
S25	Al Naem	1.21
S26	Adam's tree	1.43
S27	Al Huwair Al Sagher	1.28
S28	Al Awja	1.5
S29	Huwair Al Sada	1.23
S30	Al Seda	1.3
S31	Al Fatheia	1.38
S32	Al Samaid	1.48
S33	Al Ardhania	1.23
S34	Oil Street	1.25
S35	Khmesa	1.2
S36	Al Fesla	1.39

Madina, with uranium concentrations in soil samples taken from the surface averaging 1.38222 ppm. The mean uranium concentration in Northern Basrah governorate surface soil samples is below the permissible threshold indicated by [13]. The findings reveal that as soil depth increases, the amount of Uranium in the soil decreases. Such results can be attributed to erosion processes and the removal of soil top layers. The highest radioactivity is seen near the soil surface during the first months following soil contamination, where winds and rains can remove up to 90% of radioactive material [14]. In addition to the mineral composition of Iraqi soil, which contains a considerable amount of calcium carbonate, iron oxides, and aluminum, the interaction of these components with the solid component of the soil exposes the soil's capacity to retain radioactive contaminants and hinders their mobility.

Fig. 2 depicts the overall average uranium concentration in Northern Basrah governorate soil samples as a function of location. The maximum uranium content in soil samples was 1.6 ppm, detected in Talhah village. This result is lower than the uranium concentration safety threshold of 2.8 ppm.

During the Gulf conflicts, human activity and the exposure of certain industrial zones to uranium contamination resulted in such outcomes. The presence of Uranium in agricultural soil samples may be connected to fertilizer use in agricultural areas; the presence of Uranium in soil samples is classified as industrial > agricultural > residential.

The findings of this experiment were compared to those of other researchers in different areas, and the

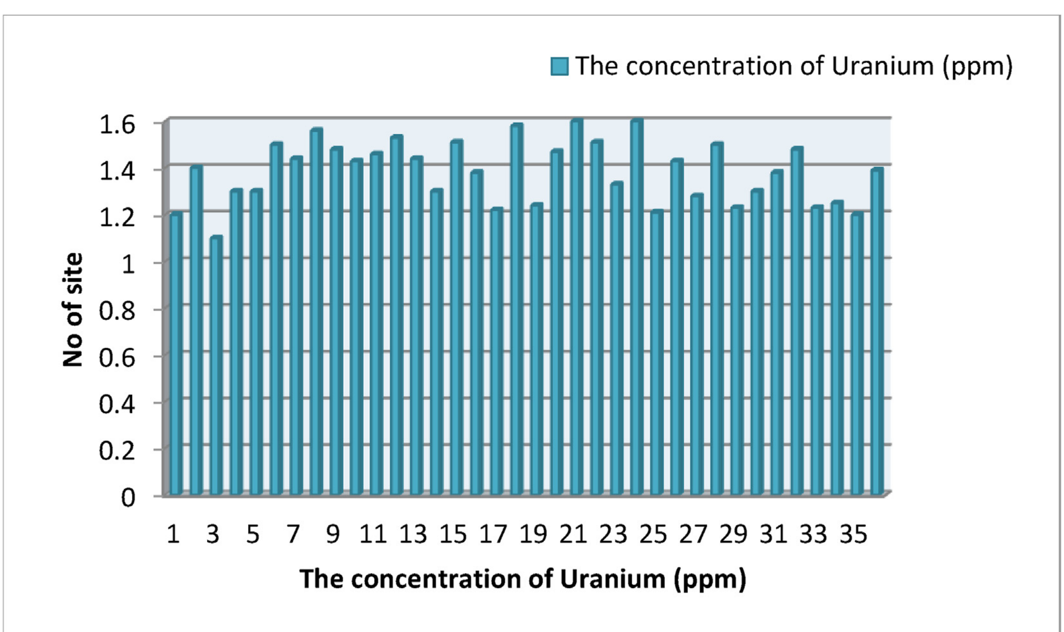

Fig. 2. Shows the average uranium content in soil samples as a function of geographic location.

Table 2. Compares the current work's uranium content (ppm) to those of other sites

No.	Places	Average	Range	References
1	Mexico	… …..	2.6–13.7	[8]
2	India	4.62	1.47–10.66	[15]
3	Turkey	… …..	1.01–11.7	[16]
4	Brazil	3.21	… …..	[17]
5	Baghdad, Iraq	1.05	0.40–2.53	[18]
6	Thi-Qar, Iraq	2.077	0.77–2.89	[9]
7	Northern Basrah	1.38222	1.1–1.6	Present work

results are reported in Table 2. Because this was the first study of its kind to look at uranium levels in soil samples from different parts of the Northern Basrah governorate, the findings are now being used as a source of information for future studies.

4. Conclusion

Solid-state nuclear track detectors (SSNTDs) were used to evaluate uranium contents in soil samples. This research showed that the concentration of Uranium increases in industrial places more than in residential areas. Still, the results were within the permissible limits and did not a present concern.

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