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Uranium Concentrations Analysis in Wasit Governorate Specific Areas

Al-Zahraa Qasim Hasan, and Prof. Dr. Hadi D. Alattabi

Department of Physics, College of Science, Wasit University, Wasit, Iraq.

Abstract

The ICP-OES technique was utilized to assess the uranium concentrations in the soil, yielding accurate and consistent results. Targeting three distinct locations Tiba, Al-Bashayer, and Al Askary Site Area. The results showed that uranium levels were higher than acceptable in level area at a depth of 30 cm in Tiba as the lowest concentration of 18.04 ppm was found. In contrast, the maximum concentration of 41.54 ppm was found at the surface layer (0 cm) in Al-Bashayer. This suggests that uranium concentrations are higher in the topsoil layers and noticeably lower as soil depth increases. The tendency of declining uranium levels as depth increases indicates that the sites under study have been greatly damaged by surface pollution. That may have been caused on by outside influences like wars, bombardments, or environmental changes. These findings highlight the necessity of more research into the effects of uranium contamination in locations, ecosystem, and human health.

Keywords: ICP-OES, Uranium concentration, Wasit pollution.

1. Introduction

Uranium is a common element found throughout the earth's crust and can be found in 27 different amounts in soil, sand, and rocks. Uranium's density is 18.95 g/cm^3 that is 1.7 times greater than lead's density of 11.35 g/cm^3. Metallic uranium has a high melting temperature at 1132 °C and a boiling point of 41310 °C, with strength is comparable to that of most steels.

Uranium is also very reactive chemically [1]. The element is a natural radionuclide with a silvery or shiny metal with a long half-life. Besides, it is one of the world's heaviest elements. Due to of its radioactivity, it poses one of the most serious pollution risks. The metal and its derivatives are extremely toxic and

constitute a threat to human health and the environment [2].

Moreover, uranium is a common element found in solid, liquid, and gaseous forms. It can be found in food, water, soil, rocks, natural materials, and the surrounding environment. Uranium reacts with other elements to form uranium oxide, silicates, hydroxides, and carbonate [3]. Quantitative analysis of uranium in minerals provides the foundation for uranium exploration, environmental assessment, and radiation contamination.

The frequently used quantitative examination of uranium comprises gamma spectroscopy, X-ray fluorescence, atomic absorption spectrometry (AAS), and inductively coupled plasma mass spectrometry method (ICP-MS) [4]. However, the ICP-OES has a large linear range [5]. Consequently, it is a fast, cost effective, and highly efficient analysis method [6]. As a result, it has been extensively utilized in both qualitative and quantitative analyses of minerals during geological exploration, including feldspar, uncommon polymetallic ores, soil, and water sediments [7].

The accuracy of results when using ICP-OES for the quantitative analysis of uranium in mineral samples depends on the RF power atomizer flow rate, and sample pumping rate [8]. The study analyses the uranium spectral line and determines the ideal wavelength of the spectrum peaks to increase the accuracy of the ICP-OES for uranium. The standard series of uranium concentration gradients are measured by varying the RF power, atomizer flow rate, and sample pumping rate, respectively.

Due to a dearth of prior research and the establishment of a database on the uranium amounts in soil samples, the study was conducted in Wasit Governorate. The aim of this study is to analyse the uranium content of a subset of soil samples collected from various residential, agricultural, and health sectors in the Al-Mawqia, Al-Askary area, and Tiba Health Cantered Al-Bashayer in Wasit Governorate, Iraq.

2. Uranium in different areas

Depending on regional geology and environmental factors, uranium concentrations in various nations vary greatly. For instance, India's soil contains an average of 11 mg/kg of uranium, which corresponds to a radioactivity level of 54 Bq/kg.

Portugal reports significantly higher levels of uranium concentrations that is 25.10 mg/kg or 311.24 Bq/kg of radioactivity. Japan exhibits a radioactivity of 21.57 Bq/kg and a low uranium content of 1.74 mg/kg. The radioactivity level of uranium in the soils of the United States is

43.4 Bq/kg with a concentration of 3.50 mg/kg.

The mobility and bioavailability of uranium are influenced by soil characteristics such as, pH and organic content in bisects uranium deposits [9].

3. Material and Method

3.1 Soil sample collection

The research region is in the Centre of Wasit Governorate in Iraq as can be seen in Figure 1.In April 2024, 12 soil samples were collected at a depth of 0-30 cm in Al-Bashayer District, Tiba Health Centre, and Al-Askary Site Area. Samples were cleaned, dried for two days at 150 °C in an oven. Then, grounded and filtered through a sieve with a diameter of 75 µm. After drying procedure, microwave digestion was used to break down the samples.

The digesting process was carried out at the Iraqi Atomic Energy Commission's Central Laboratories Unit. As part of a microwave digestion system, the produced samples were treated with a mixture of powerful acids to break down the soil matrix and release the target components for analysis.

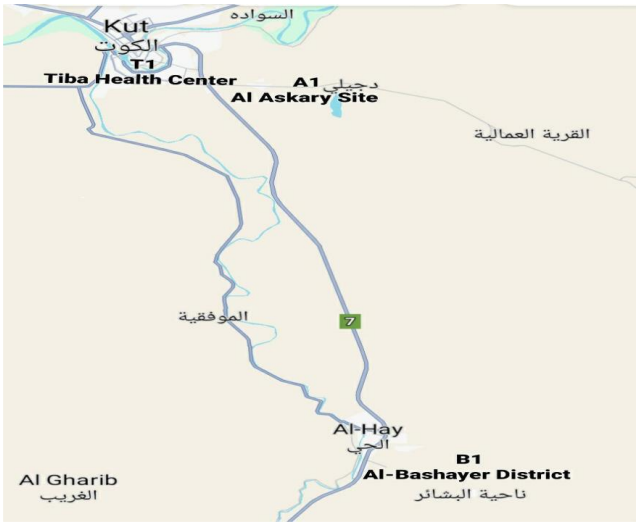

Figure 1: The map of study area.

3.2 ICP-OES

Agilent 5100 SVDV ICP-OES as shown in (figure 2) and (table 1) with a Dichroic Spectral Combiner (DSC) was used for all measurements. The DSC detects plasma's axial and radial view emissions simultaneously in a single reading across the whole wavelength range. The solid-state RF (SSRF) system running at 27 MHz and a vertically oriented torch are used by the 5100 ICP-OES to provide a plasma with the stability and resilience required for the analysis of the organic materials.

A conventional sample introduction system, which included a glass concentric nebulizer, 1.8 mm torch injector, and a glass single-pass cyclonic spray chamber, was installed on the Agilent 5100 SVDV ICP-OES. An Agilent SPS 3 autosampler was used to deliver the sample.

Figure 2: The Agilent 5100 SVDV ICP-OES.

Table 1: Agilent 5100 SVDV ICP-OES operating parameters.

Parameter	Setting
Read time (s)	20
Replicates	2
Sample uptake delay (s)	0
Stabilization time (s)	10
Rinse time (s)	3
Fast pump (80 rpm)	Yes
Background correction	Left and/or right background correction
RF power (kW)	1.4
Nebulizer flow (L/min)	Default (0.70)
Plasma flow (L/min)	Default (12.0)
Aux flow (L/min)	Default (1.0)
Viewing height (mm)	Default (8)

4. Results and discussion

Results of the current uranium investigation are shown in (table 2), that was collected from three areas of Wasit Governorate in central Iraq.

Table 2: ICP-OES was used to determine the uranium concentration in soil samples from the Wasit Governorate.

Location	Concentration of Uranium (ppm)	Depth (cm)
A1	32.97	0
A1	30.98	10
A1	30.27	20
A1	27.50	30
B1	41.54	0
B1	38.77	10
B1	38.77	20
B1	33.45	30
T1	25.63	0
T1	24.57	10
T1	18.51	20
T1	18.04	30

Uranium concentrations in soil samples were slightly higher than the natural background values reported in worldwide research, as shown in (table 2) and (figure 3).

According to the International Atomic Energy Agency (IAEA), the average background uranium concentration in soil ranges from 0.3 to 11.7 ppm, depending on geological and climatic factors. These values are used as a reference to assess the contamination levels in the examined samples [10].

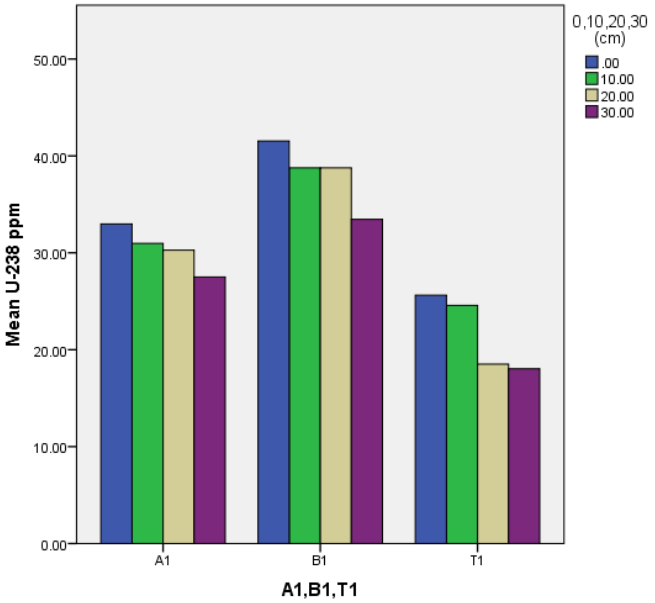

Figure 3: Uranium concentration in soil samples according to the location.

The analytical information obtained from soil samples utilized in this study is displayed in (table 1). Sample B1 from Al-bashayer had the highest uranium level in a surface soil sample, at 41.54 ppm.

Uranium values in soil samples collected from various depths averaged 30.0833 ppm, while the lowest was 18.04 ppm in sample T1 from Teba Health Centre at a depth of 30 cm. Results show that the amount of uranium in the soil decreases with increasing soil depth.

Erosion processes and the removal of soil top layers are responsible for such outcomes. The highest radioactivity is found close to the soil surface, where about 90 % of the radioactive material can be removed by winds and rain [11-12].

Moreover, (table 3) presents results of this experiment's comparison with those of other researchers in various fields.

Table 3: Compares the uranium concentration (ppm) with different studies.

Number	Places	Average	Range	References
1	Mexico	…..	2.6-13.7	[11]
2	India	4.62	1.47-10.66	[12]
3	Turkey	……	1.01-11.7	[13]
4	Brazil	3.21	…….	[14]
5	Baghdad,Iraq	1.05	0.40-2.53	[15]
6	Thi-Qar, Iraq	2.077	0.77-2.89	[16]
7	North Basrah	1.38222	1.1-1.6	[17]

5. Conclusion

Findings show that uranium concentration in the investigated regions was higher than the acceptable limit. At 40.54 parts per million, with the Al-Bashayer region (B1) having the highest concentration.

The Wasit Governorate's high uranium levels may be related to the bombardment and fighting that the region endured during the 2003 Iraqi War, and Gulf War. The usage of depleted uranium weapons, which contaminate soil over time, is also thought to be the source of these increases.

The increase in these radioactive element concentrations may also have been caused by changes in the surface soil and geological composition brought on by military operations. Due to of the possible effects on the environment and public health, results must address seriously.

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