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ORIGINAL STUDY

Using the ICP-MS Method, the Concentration of Uranium in Soil Samples from the Northern Basrah Governorate was Determined

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Abstract

In the laboratories of the Zarazma Mineral Studies Company in Tehran, the Islamic Republic of Iran, measurements of Uranium content in soil samples were made utilizing ICP-MS (inductively coupled plasma mass spectrometry) in 36 samples of surface soil from selected locations (Some of which, according to the authors, were measured for the first time) in the Northern Basrah governorate. Uranium concentrations were found to range from (0.9 ppm) in Al-Awjan to (1.5 ppm) in Al-Ez River soils. The findings are given and contrasted with those of other research. The soil samples analyzed were uranium less than 100 ppm, which implies an amount of overburden and reserves instead of mineable reserves. The concentration of uranium in the Northern Basrah Governorates is presented and evaluated in this article. The study also indicates that uranium levels in 36 samples of surface soil are below the detection limit. The current findings demonstrate that the uranium contents in the surface soil samples examined were lower than the UNSCEAR-recommended limit of 11.7 ppm.

Keywords: Basrah governorate, Concentration of uranium, Soil sample, ICP-MS

1. Introduction

Uranium is a common element found throughout the earth's crust, and it may be found in varying proportions in soil, sand, and rock. The symbol of uranium is (U) and has a density of 18.95 g/cm^3, which is 1.7 times higher than lead's density of 11.35 g/cm^3. Uranium is a chemical as well as a radioactive element. Metallic uranium has a high melting point (1132 °C) and boiling point (41310 °C), and its strength is equivalent to that of most steels. It is also chemically extremely reactive [1]. Natural uranium is divided into three isotopes. ^{238}U 99.276 percent, ^{235}U 0.718 percent, and ^{234}U 0.0056 percent are the mass concentrations [2–4]. Uranium is a plentiful naturally occurring element in the earth's crust, with around 2 mg per kilogram (range 0.1–20 mg per kg). It is more widely used than gold or silver. Human health suffers as a result of this. The principal health consequence of uranium is its chemical toxicity, not its radiation risk [5–8]. The toxicity of the chemical was assumed to be similar to that of lead. The quantity of elemental and isotopic uranium has been extensively utilized to analyze biogeochemical and physical processes in numerous fields of earth science [9]. Due to measurement difficulties, small quantities of uranium and small abundance of ^{234}U preclude numerous uses in most natural samples. For the last fifty years, alpha spectrometry methods have been employed to measure uranium radionuclides [10,11], however alpha-counting processes have become obsolete due to large sample size restrictions and the emergence of technologies with substantially improved productivity and precision. Uranium content is routinely determined using inductively coupled alpha spectrometry and plasma spectrometry (ICP-AES). Because these technologies are so sensitive to uranium, it's usually required to collect a lot of data and measure for long periods of time to get solid

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findings. Furthermore, alpha spectrometric accuracy only allows for a crude calculation of uranium levels. One of the better alternatives to the previous approaches is mass spectrometry with excellent sensitivity and accuracy [12,13]. Its major aim is to look at the many interactions, exchanges, and risks that come with soil samples. The area of study is in the Northern Basrah Governorate in southern Iraq (see Fig. 1).

2. Material and method

2.1. Soil sample collection

Thirty-six soil samples were spread in Al Traba, Saleh River, Center Al-Madina, Anter River, Al-Huwair, Al-Ahwar, Al-Sura, Al-Neherat, Al-Khas, AL-Housh, Abu Karib, Majnon, Al-Alwa Al-Qurnah, Al-Awjan, Mzieraa, Al-Basha River, Al-Sharish, Ahmed bin Ali, Al Alwa Al-Huwair, Al-Aghmieg, Talhah, Um Al-Shuwayj, Al-Shafi Seid Saleh, Al-Ez River, Al-Naem, Adam's tree, Al-Huwair Al-Sagher, Al-Awja, Huwair Al-Sada, Al-SEDA, Al-Fatheia, Al-Samaid,Al-Ardhania, Oil Street, Khmesa and Al-Fesla in Northern Basrah Governorate were collected in April 2021 from the research site at a depth of (5−15) cm, cleaned, then dried for a few hours in an oven at 70 °C before being pulverized and filtered through a sieve (75 μm) in diameter [7].

2.2. ICP-MS

ICP-MS comes from combining a very efficient source of ions (ICP) with a highly sensitive method of ion sensing (MS). ICP is used as an ionizing source in both ICP−OES and ICP−MS, and both use identical input systems. When it comes to ICP-MS, plasma-created ions (at atmospheric pressure) are transferred to a highly vacuumed MS area through a sampler and a skimmer cone. The ions are focused onto the MS using an ion optic system, which measures the mass-to-charge ratios of the ions of interest. The usual quadruple MS is a mass filter that can pass into the detector only the mass-to-charge ratio of ions. Ions moving through MS are converted into an ion detector, which converts the ionic power into the power supply, allowing the analytical concentration to be measured. The parameters are changed sequentially for multi-element analyses so that other ions with different mass-to-charge ratios can pass through the detector. ICP/MS multi-functional analysis is a single-element sequential analysis. More sensitivity, lower detection, and simultaneous U concentration and U-isotope ratios are benefits of ICP−MS over other approaches. U determination can be performed by the ICP−MS by an isotope dilution method considered to be the most accurate in quantitative analyses. to boost sensitivity, accuracy, and detecting skills, For U preconcentration and determination by isotope dilution method, several scientists have utilized the Fully Implicit (FI) approach [14].

3. Results and discussion

Table 1, which is collected from several regions of Northern Basrah Governorate, South Iraq, presents the findings of the current study on Uranium

Fig. 1. Northern Basrah Governorate, the figure represents the places where samples were taken from.

Table 1. ICP-MS was used to determine the uranium content in soil samples from the Northern Basrah Governorate.

No. of site	Sites	Concentration of Uranium using ICP-MS (ppm)
S-1	Al-Traba	1.0
S-2	Saleh River	1.2
S-3	Center Al-Madina	1.0
S-4	Anter River	1.0
S-5	Al-Huwair	1.1
S-6	Al-Ahwar	1.0
S-7	Al-Sura	1.3
S-8	Al-Neherat	1.4
S-9	Al-Khas	1.3
S-10	AL-Housh	1.4
S-11	Abu Garib	1.4
S-12	Majnon	1.4
S-13	Al-Alwa Al-Qurnah	1.4
S-14	Al-Awjan	0.9
S-15	Mzieraa	1.2
S-16	Al-Basha River	1.3
S-17	Al-Sharish	1.19
S-18	Ahmed bin Ali	1.5
S-19	Al-Alwa Al-Huwair	1.2
S-20	Al-Aghmieg	1.4
S-21	Talhah	1.2
S-22	Um Al-Shuwayj	1.1
S-23	Al-Shafi Seid Saleh	1.07
S-24	Al-Ez River	1.5
S-25	Al-Naem	1.1
S-26	Adam's tree	1.4
S-27	Al-Huwair Al-Sagher	1.2
S-28	Al-Awja	1.4
S-29	Huwair Al-Sada	1.2
S-30	Al-SEDA	1.0
S-31	Al-Fatheia	1.3
S-32	Al-Samaid	1.1
S-33	Al-Ardhania	1.2
S-34	Oil Street	1.0
S-35	Khmesa	1.0
S-36	Al-Fesla	1.3

content in soil samples. Table 1 and Fig. 2 show that the concentrations of uranium in the soil in these soil samples were somewhat lower than that of the U.S. Environmental Protection Agency (EPA) in

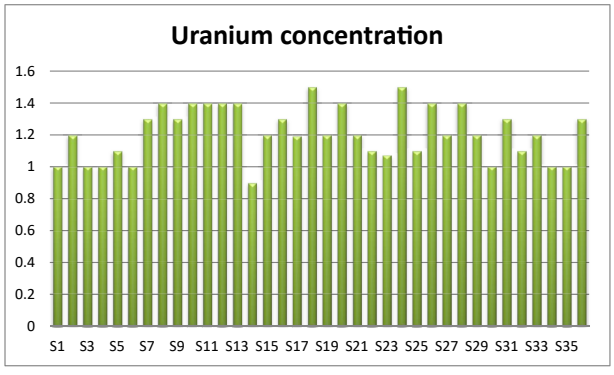

Fig. 2. Uranium concentration using an ICP-MS analysis in soil samples from the various locations of northern Basrah.

the U.S. The US Environmental Protection (EPA) Agency has established the maximum pollutant limit (MCL) for uranium at around 30 mg/L. Table 1 and Fig. 2. For these 36 samples, the results were categorized in 36 sites from S-1 to S-36 in Fig. 2. Uranium content was found in Al Ez River at a maximum of (1.5 ppm), and Al Awjan at a minimum of (0.9 ppm). Uranium levels in environmental samples need to be monitored reliably. Uranium content is frequently evaluated using inductively linked alpha spectrometry and plasma atomic emission spectrometry (ICP-AES). Because these technologies are relatively sensitive to uranium, however, it is generally necessary to achieve reliable results by taking a huge sample count and lengthy measurement durations. In addition, alpha spectrometric precision permits only a rough uranium level estimation. One of the finest alternatives to the previous approaches is mass spectrometry with excellent sensitivity and accuracy [12,13]. Measuring uranium levels, the content of radium and radon in Iraqi building materials, for example, Uranium was found in these samples, ranging between 0,074 and 5,055 ppm with the average value of 0,755 ppm. The most important thing is to determine the uranium ratio according to several factors. Uranium levels in specific locations in the Northern Basrah Governorate have risen as a result of the recent war and the presence of nuclear weapons remnants in such places [11].

4. Conclusion

The concentrations of uranium in soil sources in the North Basrah region have never been tested before (Iraq). Soil samples are generally highly mineralized within the area under investigation. The analysis shows that uranium and some chemical compounds are highly positively associated in soil samples. Safe land samples are essential to the welfare of people and are a major public health issue. The excellent quality of soil was maintained by ensuring the supply of unprocessed soil samples and treating groundwater. Pollution control techniques that restrict the introduction of undesired components into soils and proper watershed management practices can protect the provision of raw soil samples. The highest uranium level in the ground samples was less than the allowable limit (11.7 ppm) in both samples (S14) and (S24). In contrast to other areas, the contamination ratio with uranium in the region (Al-Ez River) is the highest, meaning that residents of this place are the most sensitive to uranium from other regions. Individuals in this region are the most exposed to uranium from

other locations since the region's (Al-Ez river) pollution ratio is the greatest compared to other areas.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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