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Evaluation of Uranium Concentration in Soil Samples of Basrah Governorates using ICP-Mass Techniques

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Abstract: Naturally occurring radionuclides such as uranium, thorium and their decay products (^{226}Ra, ^{222}Rn) are present in a number of geological settings in Basrah Governorates. The uranium concentration of 78 soil samples using ICP-Mass (inductively coupled plasma mass spectrometry) was found to be ranging from 1.2 ppm in Eastern star1 to 15.75 ppm in **AL-Liheise10** in soils. The results are presented and compared with other studies . The measurements of uranium concentration of soils samples measured had a uranium content of less than 100 ppm, a concentration that characterizes overburden and tailings quality, rather than minable reserves. This paper presents and evaluates the concentration of uranium in Basrah Governorates .The study further reveals that 78 surface soil samples have uranium below detection limit.

Keywords: - *Uranium, Soil samples, ICP-Mass, Basrah Governorates*

I. INTRODUCTION

Uranium is a very widely distributed element in the earth's crust, is presented naturally everywhere in soil,sand and rock in various concentration from one place to another. Uranium is a radioactive and chemical element, represents by (U) symbol, and it is a heavy metal with a very high density (18.95 g /cm^3, 1.7 times higher than lead's density of 11.35 g /cm^3). Metallic uranium has a high melting point (1132 ^{O}C) and boiling point (4131 ^{0}C), has a tensile strength similar to most steels and it is chemically very reactive [1]. Natural uranium consists of three isotopes. Their concentrations by mass are ^{238}U 99.276%, ^{235}U 0.718% and ^{234}U 0.0056% [2-4].

Uranium is a naturally occurring element with an average abundance in the earth crust of about 2 mg per kg (range 0.1 to 20 mg per kg). It is more abundant than silver or gold. It has adverse effects on the human health. The major health effect of uranium is its chemical toxicity, rather than its radiological hazard [5-8]. The chemical toxicity was thought to be similar to lead. The elemental and isotopic abundances of uranium have been extensively used to explore biogeochemical and physical processes in diverse fields of the Earth sciences [9]. Low uranium concentrations ([U]) and low abundances of ^{234}U in most natural samples, however, constrain many applications due to measurement limitations. Alpha spectrometry methods have been used to quantify uranium radionuclides for five decades [10,11] but large sample size requirements and the advent of techniques with vastly improved throughput and analytical precision have pushed alpha-counting techniques toward obsolescence.

Monitoring uranium content in environmental samples is typically performed using alpha spectrometry and inductively coupled plasma atomic emission spectrometry (ICP-AES). However, due to the relatively low sensitivity of these techniques for uranium, a large number of samples and long measurement times are generally required to obtain reliable results. Moreover, the accuracy of alpha spectrometry allows only a rough estimation of uranium levels. Mass spectrometry, which boasts both high sensitivity and accuracy, is considered one of the best alternatives to the aforementioned methods [12,13]. The general aim is to investigate the complex interactions and exchanges with soil samples, and to estimate how much hazards brought with soiles. In fact, the study area is located inside Basra Governorate which is located in the extreme southern part of Iraq, see Fig. 1.

Fig. 1. Basra Governorate, dots represent the places where samples taken from, numbering in station number (S) (Basra map is from Google earth).

II. EXPERIMENTAL TECHNIQUE

In Basra governorate, the samples from 91 stations and locations were collected during April 2014. The measurements of Boron concentration soil samples were carried out by using ICP/Mass method[13]: Inductively Coupled Plasma Mass Spectrometry or ICP-MS is an analytical technique used for elemental determinations. The technique was commercially introduced in 1983 and has gained general acceptance in many types of laboratories. Geochemical analysis labs were early adopters of ICP-MS technology because of its superior detection capabilities, particularly for the rare-earth elements (REEs). ICP-MS has many advantages over other elemental analysis techniques such as atomic absorption and optical emission spectrometry, including ICP Atomic Emission Spectroscopy (ICP-AES), including: Detection limits for most elements equal to or better than those obtained by Graphite Furnace Atomic Absorption Spectroscopy (GFAAS),Higher throughput than GFAAS. The ability to handle both simple and complex matrices with a minimum of matrix interferences due to the high-temperature of the ICP source. Superior detection capability to ICP-AES with the same sample throughput. The ability to obtain isotopic information.

2.1. Plasma-source MS.

The ICP–MS is the result of coupling an extremely efficient ion source (ICP) with an extremely sensitive ion detection technique (MS). Both ICP–OES and ICP–MS share ICP as the ionization source and both have the same systems for introduction. In the case of ICP–MS, ions generated in the plasma (at atmospheric pressure) pass through an assembly of a sampler and a skimmer cone to a highly evacuated MS area. An ion optic system focuses ions to the MS which measures mass-to-charge ratios of the ion(s) of interest. The commonly used quadruple MS acts as a mass filter that allows only a given mass-to-charge ratio of ions to pass to the detector. The ions passing through the MS are deflected to an ion detector that converts the ionic energy to electric energy which forms the basis for the measurement of the analytic concentration. For multielement analyses, the parameters are sequen- tially changed to allow the passage of other ions of differing mass-to-charge ratios to the detector. Thus, multielement analysis by ICP–MS is, in fact, sequential single element analysis. The advantages of ICP–MS over other methods are higher sensitivity, lower detection limits and simultaneous measurement of U concentrations and U isotope ratios. The ICP–MS can carry out U determination by the isotope dilution method which is considered the most precise for quantitative analysis. Some researchers have used FI technique for separation/preconcentration of U and determination by the isotope dilution method to improve sensitivity and precision and detection capabilities [14,15].

2.2. Collection of soil samples

Soil Samples were taken from seventy eight locations of study Basrah Governorates soil, the samples taken from depth 10-15cm. Then the samples were cleaned, dried in an oven at 70 ^{0}C for few hours finally they were powdered and sifted by using special sieve, **75 *μm*** in diameter.

Table 1: Measurments of Uranium concentration in soil samples from different areas of Basrah Governorate by using ICP-Mass

No	No of site	Location of sample	Concentration of Uranum by ICP-mass (ppm)
1	S_1	Al-zubiar-Safwan road /Eastren star1	1.2
2	S_2	Madinah /Alemaber	1.25
3	S_3	Allhis1	1.25
4	S_4	Madinah /Alfatha	1.5
5	S_5	Madinah / Hor Alkhuyt	1.5
6	S_6	Madinah /Alknazerai	1.5
7	S_7	Alshafe	1.5
8	S_8	Abu Khasib/Suleiman's door	1.5
9	S_9	Abu Khasib center	1.5
10	S_{10}	Al-zubiar-Safwan road /Eastren star2	1.5
11	S_{11}	Allhis2	1.5
12	S_{12}	Madinah/ Riverbank Euphretes	1.75
13	S_{13}	Madinah/Alhwar/Hor akab	1.75
14	S_{14}	Alsubas/between Madinah and Hor Chabaish	1.75
15	S_{15}	Madinah/Alhwer/Ezzedine Salim	1.75
16	S_{16}	Qurna Center	1.75
17	S_{17}	Abu Khasib/Near the port of Abu Flus	1.75
18	S_{18}	Abu Khasib/babtwel	1.75
19	S_{19}	Safwan1	1.75
20	S_{20}	Allhis3	1.75
21	S_{21}	Altnoma / Athba	1.8
22	S_{22}	Madinah/Riverbank Ezz2	2
23	S_{23}	Madanah/Algalal	2
24	S_{24}	Aldair	2
25	S_{25}	center of Almdiana	2
26	S_{26}	Talha/nahait Al_emam Alsadeq	2
27	S_{27}	Abu Khasib/mhagran	2
28	S_{28}	Abu Khasib/Alsaragy	2
29	S_{29}	Altnoma /Kut Algoa	2
30	S_{30}	Altnoma /Alsalhia	2
31	S_{31}	Alntnoma /krdland	2
32	S_{32}	Altnoma /gasm rever	2
33	S_{33}	Hatrtha	2
34	S_{34}	Allhis4	2
35	S_{35}	Gurf Al-Gurna	2.25
36	S_{36}	Abu Khasib/Alekta	2.25
37	S_{37}	Abu Khasib/Al-Asmeda factory	2.25
38	S_{38}	Abu Khasib/Alasforia/bab tuel	2.25
39	S_{39}	Abu Khasib/Albhadrai	2.25
40	S_{40}	Abu Khasib/doad	2.25
41	S_{41}	rever Abu-flus	2.25
42	S_{42}	Khor Al-Zubair /Alrafedia	2.25
43	S_{43}	Alzubair/ southren star1 /verses liquad gaz plant	2.25
44	S_{44}	Al-zubair/Alnagme/Almulehat	2.25
45	S_{45}	Alhadama/Umm Qacer Safwan road 17	2.25
46	S_{46}	Allhis5	2.25
47	S_{47}	Madanah/Al-Abarah	2.5

48	S_{48}	Abu Khasib/River kuz	2.5
49	S_{49}	Hamdan /Abu -Al-khasib	2.5
50	S_{50}	gekor/Abu-Alkhasib	2.5
51	S_{51}	AL-zubiar-safwan roud 17/eastren star3	2.5
52	S_{52}	Almuelhat	2.5
53	S_{53}	Alzobair-safwan roud 17/southren star2	2.5
54	S_{54}	Eastren star4	2.57
55	S_{55}	Abu flos/Near the water project	2.75
56	S_{56}	Alsebeliat/Abu-Alkhasib	2.75
57	S_{57}	mhala/Abu_Alkhasib	2.75
58	S_{58}	Kteban/Al-tanoma	2.75
59	S_{59}	Alzubair/southren star3/ near lekuid gas	2.75
60	S_{60}	Alzubiar/Versus liquid gas plant	2.75
61	S_{61}	Alfao	3
62	S_{62}	Alzubair//eastren star5	3
63	S_{63}	AL-Zubair/ eastren star6/ Sfwan-Alzobair road	3
64	S_{64}	Al-zubair/southren star4/safwan roud	3
65	S_{65}	Alhadama1/ Amm Qsr -Zubair street 17	3
66	S_{66}	Alhadama2/ Amm Qsr-Zubair street	3
67	S_{67}	Abu-mgera river-Abu-Alkhasib	3.25
68	S_{68}	Safwan2	3.25
69	S_{69}	Allhis6	3.25
70	S_{70}	Madinah/Riverbank Ezz1	3.5
71	S_{71}	Allhis7	3.75
72	S_{72}	Allhis8	3.75
73	S_{73}	Alamuelhat/Alnagme/safwan street	4
74	S_{74}	Alzobair/southren star5 /safwan street 71	4
75	S_{75}	Allhis9	4.5
76	S_{76}	kor azobiar	9.75
77	S_{77}	Al-zubair/safwan-Amm Qasr street	9.75
78	S_{78}	Allhis10	15.75

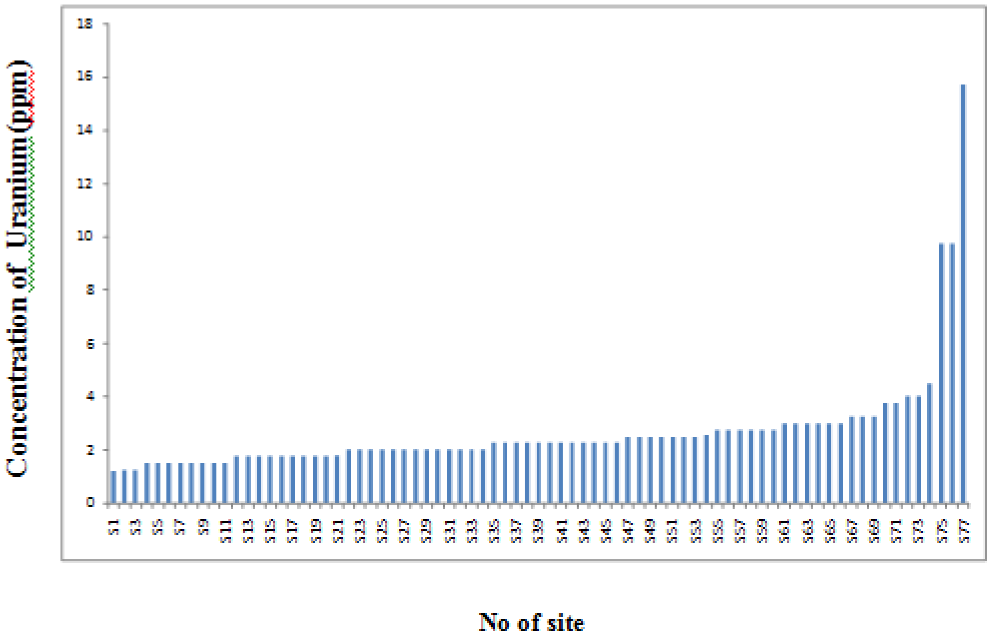

Fig. 2. Uranium Concentration in soil samples from different areas of Basrah Governorate analysis by ICP- mass

III. RESULTS AND DISCUSSION

The results for Uranium concentration in Soil samples determined in the present study are presented in Table 1 which are collected from some areas in Basrah Governorate, southern Iraq. For the measurement of Uranium concentration level soils, table 1 and Fig. 2, reflect the fact that, there was some less than level of Uranium concentration in this soil samples less than from the U.S Environmental Protection Agency (EPA) . The results for these 77 samples categorized into 77 locations, from S1 to S77, shown in Fig. 2. Uranium content found maximum (**15.75** ppm) in **Allhis10** belt and minimum (1.2ppm) was recorded in **Al-zubiar /Eastren star1** belt. Out of the 78 soil samples 3 samples recorded higher which are beginning from **9.75** ppm to 15.75 ppm while the 14 soil samples are beginning from 3 ppm to 4.5 ppm but 44 soil samples which are beginning from 2 ppm to 3 ppm and 22 soils samples are beginning from 1.2 ppm to 2 ppm than the prescribed EPA limit (30 ppm). The maximum contaminant level (MCL) of uranium was determined to be about 30 µg/L by U.S Environmental Protection Agency (EPA)[16].it is important to reliably monitor uranium concentrations in environmental samples. Monitoring uranium content in environmental samples is typically performed using alpha spectrometry and inductively coupled plasma atomic emission spectrometry (ICP-AES). However, due to the relatively low sensitivity of these techniques for uranium, a large number of samples and long measurement times are generally required to obtain reliable results. Moreover, the accuracy of alpha spectrometry allows only a rough estimation of uranium levels. Mass spectrometry, which boasts both high sensitivity and accuracy, is considered one of the best alternatives to the aforementioned methods [12,13].

IV. CONCLUSION

This study is the first Uranium concentration measurement in oil sources that is performed in the area of Basrah Governorate (Iraq). In general, well soil samples within the investigated area are highly mineralized. The correlation analysis revealed the strong positive association between uranium and some chemical compounds in soil samples. Access to safe soil samples is essential to human well being and is a key public health issue. The maintenance of good quality of soil samples were achieved both by protecting the raw soil samples supply and soil water treatment. It is possible to protect the raw soil samples supply by means of pollution control measures that prevent undesirable constituents from entering the soil samples and by good watershed management practices.

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