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Determination of uranium concentrations for soil of Tigris river and rainwater of Baghdad city

Riyad Faker Jabil and Mona Ahmed Said

Department of Physics, College of Science, University of Baghdad

E-mail: dr.muna2018@yahoo.com

Abstract

In this study, phosphorescence analysis (KPA) is used for determining soil collected from the Tigris River from Al- Karrada and Bab Al-Sharq in Baghdad and samples were taken from rainwater collected from Al-Rashad, Al-Obeidi, Al-Dora and Al-Sadr City in Baghdad. The measurements were carried out by the Iraqi Ministry of Health and Environment, in the Radiation Protection Center. The collection, removal and evaporation of the samples ranged from January to the end of March 2018. The results show the presents of concentration of ^{238}U and ^{235}U in soil samples and the rainwater samples. The conclusion of this work is the concentration of uranium in soil samples is more than recommendations by ICRP value of 1.9 µg /l. While all water samples can be compared with the value of WHO, which has a safe limit of 15 µg/l which is considered acceptable.

Key words
Radioactive concentrations, soil, Tigris river, rain, Baghdad.

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تحديد تراكيز اليورانيوم في تربة نهر دجلة ومياه الامطار لمدينة بغداد

رياض فاخر جبل و منى احمد سعيد

قسم الفيزياء، كلية العلوم، جامعة بغداد

الخلاصة

في هذه الدراسة استخدم تحليل الفوسفور الحركي (KPA) لتحديد تركيزاليورانيوم في عينات من التربة التي جمعت من نهر دجلة من الكرادة وباب الشرقي في بغداد. بالإضافة إلى ذلك ، تم جمع عينات من مياه الأمطار في الرشاد والعبيدي والدورة ومدينة الصدر في بغداد. أجريت القياسات في وزارة الصحة والبيئة العراقية. في مركز الوقاية من الإشعاع. تراوحت عمليات جمع العينات وإزالتها وتبخيرها من كانون الاول 2017 إلى نهاية آذار 2018. وأظهرت نتائج هذه وجود تراكيز اليورانيوم ^{238}U و^{235}U في عينات التربة وعينات المطر. واستنتج من هذا البحث ان قيم تراكيز اليورانيوم في جميع عينات المياه ومياه الأمطار والتربة، تكون أكثر من توصيات ICRP البالغة 1.9 ميكروغرام / لتر. ولكن عند مقارنة نتائج البحث لجميع عينات المياه مع قيمة منظمة الصحة العالمية 15 ميكروغرام / لتر، والتي لديها حد آمن قدره والذي يعتبر مقبولاً.

Introduction

The environment is all things that surround us, and directly or indirectly affect the presence of living organisms on the earth's surface [1, 2], including water, air, soil, minerals, climate, even objects themselves. They can also be defined as a set of complex natural systems, which are intertwined with each other, and are specific to the survival of all objects on earth [3, 4]. People always have been exposed to natural radiation from inside and outside earth. Exposure to ionizing and non-ionizing radiation from natural and man-made sources occurs because of radioactive occurring naturally in rocks and soil, cosmic rays of the stars and sun.

Enter the earth's atmosphere from outer space and the internal exposure of radioactive elements through water, food and air, this type is name the normal radioactive [5]. In this study, the Kinetic Phosphorescence Analysis (KPA) system is one of the precise, sensitive and fast measuring systems of uranium concentration the (KPA) can detect uranium with a precision of up to 0.01µg / L using laser technology. It is a modern technology in the world. Environmental models (soil, water) and food models of all kinds in addition to urine due to the accuracy of the device, it is possible to know the precise concentrations of uranium in the above models and here comes the importance of the device in terms of accuracy and characterized by the technology used, which is characterized by such accuracy device [6]. In this device, uranium is analyzed from various samples, such as uranium nitrate solutions, uranium ore, and by the laser-derived phosphorous laser analyzer, which is based on stimulating the uranium with laser pulses of 20 pulses per second. The phosphoric flash is also measured by the concentration of uranium in the samples. The device was calibrated at the manufacturer and found that the correlation coefficient R2 is the correct one. Precision accuracy of the device was chosen by repeated measurement of the samples. The difference in the results was found to be no more than 2.5%, on a clear linear correlation coefficient. In some samples, uranium was measured at very low concentrations of 0.01 ppb. Uranium was also examined in crude samples and measured in a laser analyzer [7].

Materials and method

The study area

The study was carried out in Baghdad province in sits located at the Tigers River and some cities in the center of Iraq. The samples were collected from several sites at 6 sites at Karrada, Bab Al-Sharqi, Al-Rashed, Al-Riyasa, Al-Dawra and Al-Sadar city of Baghdad province. The measurements were carried out by the Iraqi Ministry of Health and Environment, in the Radiation Protection Center. The samples were taken during January to March 2018 was taken up to almost one kilogram at the rate of soil each aquarium The samples soil were taken from the bank and inside rivers represented in Table 1. The samples rain were taken from Al- Karrada, Bab Al-Sharqi, Al-Rashed and Al-Obeidi are presented in Table 2.

Table 1: The overall results of NORM of local soil samples taken from Tigris rivers – Bagdad

Sample No	Sample life time (second)	Reference life time second	location	R^2	U final concentration µg/kg	Active U-238 mBq/kg	Active U-235 mBq/kg
S1	310	188	Al-Akarada	0.73	5.12	152.3	43
S2	228	185	Bab Al-Sharqi	0.989	31.84	164.8	47

Table 2: The overall results of samples taken from the rain in Bagdad.

Sample No	Sample life time (second)	Reference life time (second)	location	R^2	U final concentration µg/kg	Activity U-238 mBq/kg	Activity U-235 mBq/kg
R1	312	189	Al-Rashed	0.793	5.709	88	42.9
R2	168	173	Al-Obeidi	0.99	9.88	67.6	30.9
R3	215	167	Al-Dawra	0.975	4.02	42.6	16.05
R4	215	167	Al-Sadar city	0.975	7.26	43.2	20.9

Parameters for analysis diagnostics

A combination of data parameters is available from each measurement, which provides diagnostic information about the validity of the result, hence, "Analysis Diagnostics." These are listed below with qualifying statements concerning their interpretation. The ideal set of data has a highly linear relationship between the logarithm of intensity and delay time, with a nearly ideal lifetime.

R^2: Values greater than 0.99 are typical. A small value is caused by a nonlinear plot and/or scattered data, such as near the detection limit. Curvature is caused by other sample phosphors, dirty cell windows, or suspended particles [8].

Uranium lifetimes in samples are usually shorter than 350 µs. For uranium, lifetimes less than 100 µs occur when acidity exceeds two molar. At lower acidities, URAPLEX™ (A superior uranium complexant that provides longer phosphorescent lifetime than others for better data, stronger complexing, and lower background level of uranium) typically provides lifetimes over 250 µs. URAPLEX™ improves the resistance of uranyl phosphorescence to quenching. For best results, lifetime should be >200 µs [2].

Uncertainty: The KPA is capable of excellent (1-3%) precision. Replicated results within the uncertainty are easily obtained. An unusually large uncertainty indicates the concentration is either near the detection limit or a measurement problem. Either data is scattered, curved, or the concentration is out of the analytical range [1].

Apparatus

The KPA model, which was manufactured by Chemchek Instruments (Richland, USA), was used to analyze uranium. This machine is equipped with a nitrogen / dye laser pulse to supply monochrome ultraviolet light to excite uranium atoms in the sample solution. The KPA-11 is a fully integrated computerized system for data collection and analysis. Chemchek KPA Win controls KPA-11 as well as storing and interpreting analytical data returned from KPA. The KPA-11 is equipped with a Gilson 223 (XYZ) sample transient robot that can automate sampling procedures) and 402 syringe pumps (diluted self-samples) to mix 1ml of standard solution or sample into Uraplex and inject 1.9 ml of mixed solution into the KPA-11- flow cell. Shows the various components and interpretation of the analytical data returned from KPA Fig.1 shows various components of KPA-11 [9].

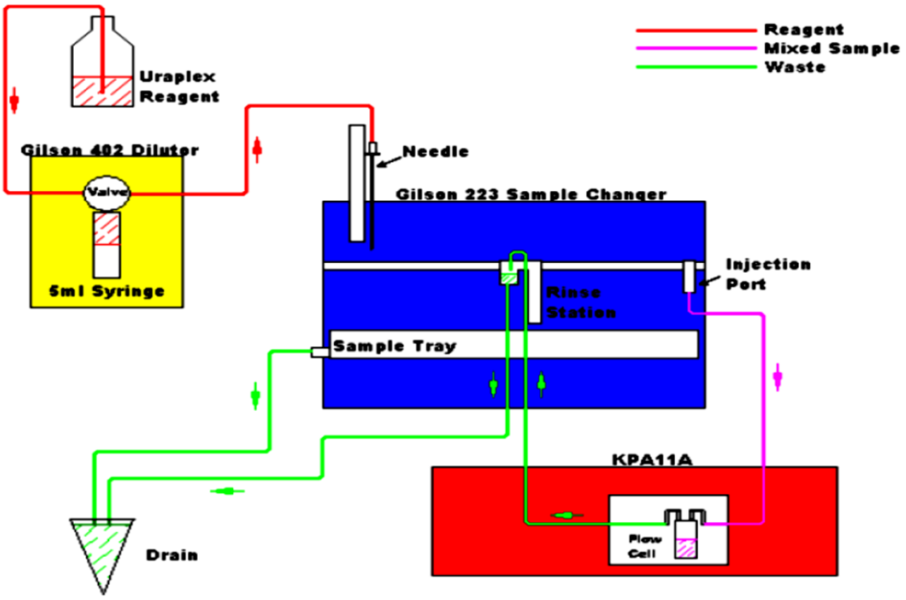

Fig. 1: Tubing diagram of the kinetic phosphorescence analyzer [10].

The sample procedure of sample (water) preparation was measured using the procedure of the American Society for Testing and Materials (ASTM).

1. Pipette 5.0 mL of the sample in a previously treated glass vial.
2. Add 1 mL of HNO_3 center and two or three drops of 30% hydrogen peroxide.
3. Place the flask on a hot plate and heat until it dries. Care should be taken not to spill the sample
4. Take out the flasks from the hot plate and add 1 mL of concentered HNO_3, two drops or three drops of 30% hydrogen peroxide, and heat until dry. Repeat this if necessary until only white or semi-transparent residues remain.
5. Add 1.0 mL of 4 mL HNO3 and gently warm, if necessary, to dissolve the residues. Then add 4.0 ml of water. Vortex for precise mixing

6- Analysis of the solution according to the instruction manual provided with the phosphorimeter Fig. 2. KPA-11. The concentrations of uranium extracted from the samples are then analyzed by the KPA-11.

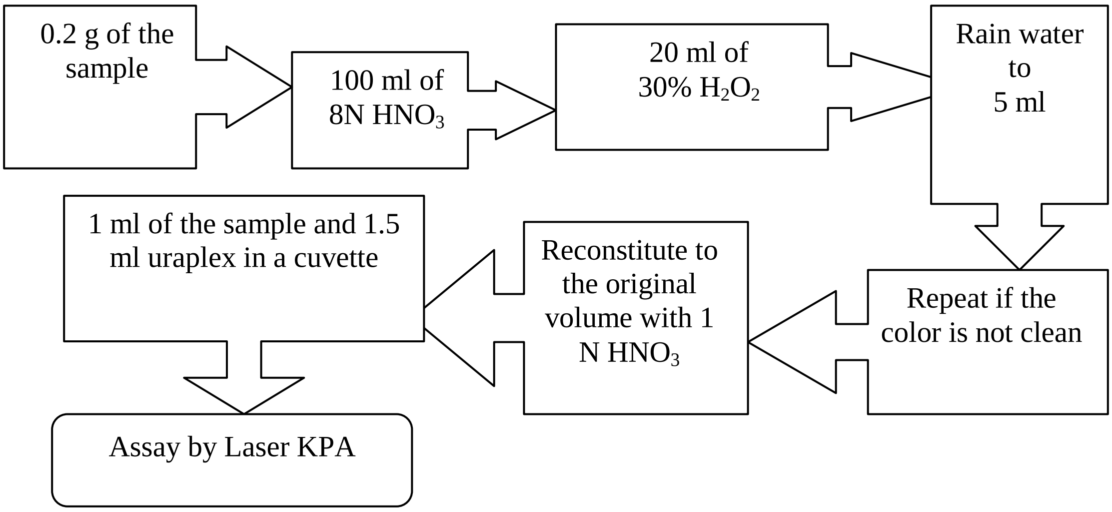

Fig. 2: Chart of radiochemical extraction of uranium [9].

The soil samples were prepared and measured using the procedure of the American Society for Testing and Materials (ASTM) as following:

Soil sample (0.2) grams was taken and added to (100) ml of HNO_3 concentration of 8 M and the sample is placed on the hotplate, with stirring that up to 5 ml. Then, 20 ml H_2O_2 concentration 30 % added to the sample with stirring where the sample is placed on the hotplate. The color of salts ranged from yellow to white. Deionized water (4) M was added to 1ml HNO_3 concentration 4M. Finally, the solution was analyzed in the KPA [2].

In this work, so low soil concentrations were prepared, less than 0.01ng/ml, in deionized water, detection limit was found to be 0.004 ng / mL. The system was calibrated for low and high domains (1, 10, 100 and 250 ng / mL) prior to measurements using quality control standards.

Table 3: Procedure of preparing uranium standard solutions [11] .

High range concentrations	
10 µg/l (10 ppb)	10 ml of 100 µg/l diluting with 0.82 M HNO_3 to 100 ml
5 µg/l (5 ppb)	5 ml of 100 µg/l diluting with 0.82 M HNO_3 to 100 ml
1 µg/l (1 ppb)	1 ml of 100 µg/l diluting with 0.82 M HNO_3 to 100 ml
0.5 µg/l (0.5 ppb)	0.5 ml of 100 µg/l diluting with 0.82 M HNO_3 to 100 ml
0.1 µg/l (0.1 ppb)	0.1 ml of 100 µg/l diluting with 0.82 M HNO_3 to 100 ml
0.05 µg/l (0.05 ppb)	0.5 ml of 10 µg/l diluting with 0.82 M HNO_3 to 100 ml
Low range concentrations	
1000 µg/l (1000 ppb)	0.1 ml of 1000 mg/l diluting with 0.82 M HNO_3 to 100 ml
500 µg/l (500 ppb)	50 ml of 1000 µg/l diluting with 0.82 M HNO_3 to 100 ml
200 µg/l (200 ppb)	20 ml of 1000 µg/l diluting with 0.82 M HNO_3 to 100 ml
100 µg/l (100 ppb)	10 ml of 1000 µg/l diluting with 0.82 M HNO_3 to 100 ml
50 µg/l (50 ppb)	5 ml of 1000 µg/l diluting with 0.82 M HNO_3 to 100 ml
20 µg/l (20ppb)	2 ml of 1000 µg/l diluting with 0.82 M HNO_3 to 100 ml

Linearity of the response to uranium

A daily background measurement and calibration were performed using four calibration standard solutions for each analytical range, ranging in concentration from the detection limit up to 1000 µg/l. Calibration were performed using six calibration standard solutions for high analytical range, ranging in concentration from the detection limit up to 5 mg/l. A blank sample of 0.82 M HNO_3 was used to determine the background and reagent uranium concentration. The blank's phosphorescence intensity was subtracted from all measurements. The low and high range calibration curve is displayed in Figs. 3 and 4 [5].

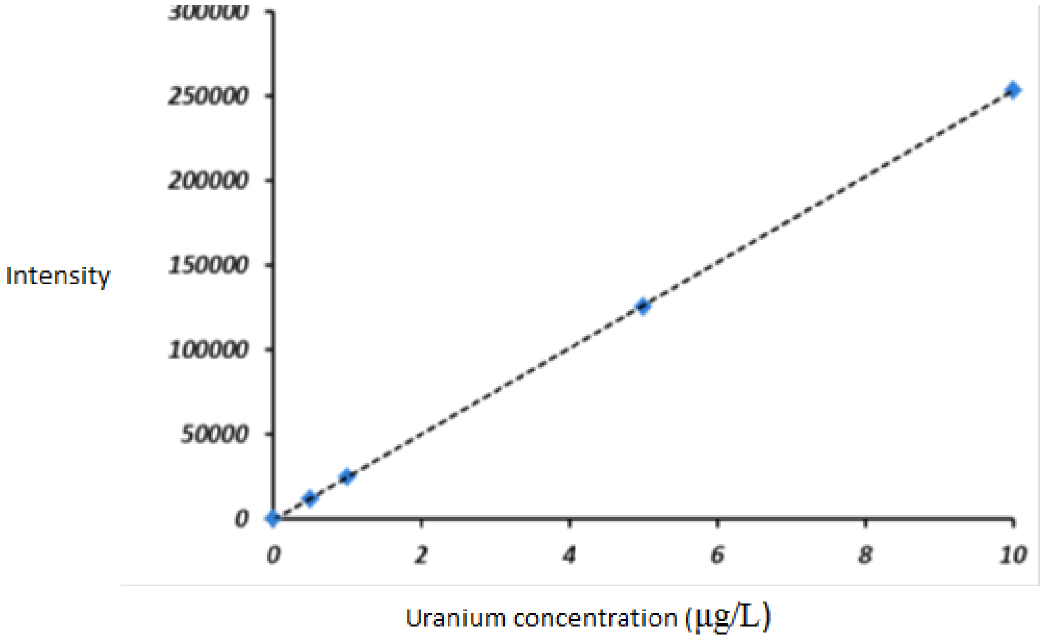

Fig. 3: Calibration curve of uranium concentration (µg/l).

Background, calibration and all sample measurements were performed using a reference solution of the same concentration as used with this original calibration.

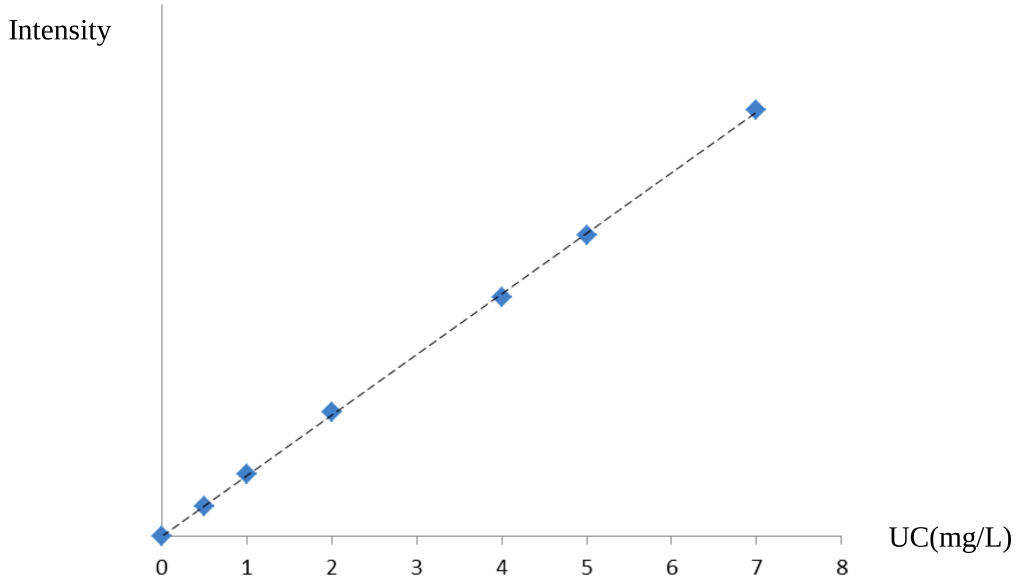

Fig. 4: Calibration curve of between uranium concentration (mg/l) and intensity [5].

Results and discussion

Tigris River was rich natural area for soil as well as of mix soil surrounding from every side of rivers clay and sediment. In this study, samples were collected from the most common soil in the Tigris River from Al- Karrada and Bab Al-Sharq in Baghdad. In addition, samples of rainwater were collected in Al-Rashad, Al-Obeidi, Al-Dora and Sadr City in Baghdad. The results show in the soil samples uranium concentrations of ^{238}U is 152.3 mBq /kg in sample S1, while the S2 sample was 164.8 mBq/kg. The concentrations of uranium: ^{235}U is 43 mBq / kg in sample S1and 47 mBq / kg in sample S2, the results of the rain samples show that the activity concentration of ^{238}U of 88 mBq/kg in sample R1, 67.6 mBq/kg in sample R2, 42.6 mBq / kg in sample R3 and Bq/kg 43.2 in sample R4. The results of the rain water sample obtained showed that the concentration of active activity of ^{235}U the samples 42.9 mBq/kg in sample R1, 30.9 mBq/kg in sample R2, 16.5 mBq/kg in sample R3 and 20.9 mBq/kg in sample R4. And final uranium concentration showed in Table 1 and Table 2 (UC values) in all water samples, the rain water all samples are more than ICRP recommended value of 1.9 µg / l. But all water samples can be compared with the value of WHO, which has a safe limit of 15 µg/l which is considered acceptable, and the soil all samples are low than approximately (3) mg per kg in the earth's.

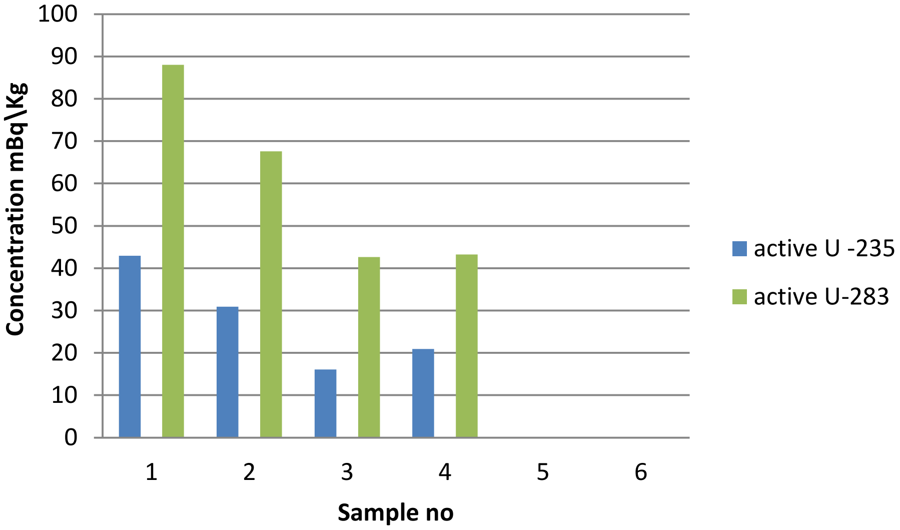

Fig. 5: Activates for ^{238}U and ^{235}U and samples for rain water.

Conclusions

In this study, a complete database to uranium concentration in soil of Tigris River and rainwater of Baghdad City was established using modern detection techniques which have very low detection limit. Uranium concentrations, intake of uranium in soil the Tigris river and Rainwater, The data presented in this study revealed current (KPA) uranium determinations in water. It is apparent that kinetic phosphorescence analyzer is currently capable of successfully sensitivity, and very high uncertainty up to the 0.01 µg/sample level. In addition, KPA has the potential to provide more accurate and precise measurements. KPA results indicated the tremendous ability to accurately and precisely measure microgram quantities of uranium in soil and rain water. According to the results, some remarkable conclusions can be listed;

1- The results show soil that this Tigris River is safe as for as the health hazards of uranium are concerned. And the soil all samples are low than approximately (3) mg per kg in the earth's [1].

2- The results show rain water in Al-Rashad, Al-Obeidi, Al-Dora and Sadr City in Baghdad are safe as for as the health hazards of uranium are concerned. The values of UC in all water samples are more than the recommended value of ICRP (1.9 μg/l), but most of the values are comparable or less to the safe limit of WHO (15 μg/l), United States EPA (30 μg/l) and UNSCEAR recommended safe limit (9 μg /l) [2].

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