Measuring the concentration of uranium for adults teeth in adjacent areas of Tigris river in Baghdad city using nuclear track detector CR-39

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Abstract

In this study, the fission track registration technique with the CR-39 detector are using to determination the uranium concentrations for seventeen samples of teeth distributed in four districts in Baghdad City .Five samples taken from both Al-Durra District and Al-Jadiriyia District, Four samples taken from Al-Karrda (Alaatar street) Taken four samples and three samples taken from Al-Zuafrania and by 0.5gm in weight and 1.5 mm in thickness. The uranium concentrations in teeth samples measured by using fission tracks registration in (CR-39) track detector that caused by the bombardment of (U) with thermal neutrons from (^{241} Am-Be) neutron source that has flux of (5×10^3 n cm^{-2} s^{-1}). The concentrations values were calculated by a comparison with standard samples. The results showed that the maximum value of uranium is (0.071 ppm) equal to (0.686Bq) in Al-Zuafaraniya district and the minimum is (0.035 ppm) equal to (0.31Bq) in Al-Jadiriah district.

Key words
Uranium concentration, nuclear track detector, CR-39.

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قياس تركيز اليورانيوم لأسنان البالغين (الذكور-الإناث) للمناطق المحاذية لنهردجلة في محافظة بغداد باستخدام كاشف الاثر النووي (CR-39)

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الخلاصة

في هذه الدراسة تم استخدام تقنية تسجيل اثار شظايا الانشطار مع كاشف الاثر النووي CR-39 لتحديد تراكيز اليورانيوم في سبعة عشر عينة اسنان موزعة في اربعة احياء في مدينة بغداد وهي احياء الدورة بواقع 5 عينات والجادرية بواقع 5 عينات والكرادة داخل (شارع العطار) بواقع 4 عينات والزعفرانية بواقع 3 عينات وبوزن 0.5غم وسمك 1.5ملم. تم تحديد تركيز اليورانيوم في عينات الأسنان عن طريق تسجيل أثار شظايا الانشطار في كاشف الأثر النووي (CR-39) الناتجة من قصف نوى اليورانيوم بالنيوترونات الحرارية من المصدر النيوتروني (^{241}Am-Be) بفيض نيوتروني حراري 5×10^3ncm^{-2}s^{-1}. تم تحديد التراكيز بالحسابات المعتمدة على المقارنة مع العينات القياسية ، ومن خلال النتائج المستحصلة وجد ان اعلى قيمة لليورانيوم هو 0.071ppm والذي يعادل 0.868Bq في حي الزعفرانية وان أدنى قيمة هو 0.025ppm والذي يعادل 0.31Bq في حي الكرادة.

Introduction

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 ^oC) and boiling point (4131 ^oC), 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 U238 99.276%, U235 0.718% and U234 0.0056%[2].[3].

Recently many attempts have been made to develop the alpha sensitive plastic film (ASPF) family of the solid state nuclear detector (*SSNTDs*) for this purpose[4]. *CR*-39 is one of the solid state nuclear detectors which can response to alpha particle with high efficiency. The authors have successfully applied this method for purpose of uranium exploration[5] .

Nuclear track detector is one of the most popular detectors used to study the nature of damage product by heavily ionization radiation such as alpha particle or fission fragment, the technique of measuring the number of particle by observing their track in certain organic or inorganic materials has been used for the study of phenomena in such diverse fields as geology, astrophysics, and nuclear physics. The technique based on the damage created in a solid along the path of heavily ionizing particle as it is a very simple technique, it can be implemented easily in field of studies, since it does not require electronic system [6] [7] [8].

Materials and Methods

1- Collection of teeth samples

Seventeen samples of teeth distributed in Four districts in Baghdad City (Al Durra , Al Jadiriah , Al Karrada and Al Zaafaraniya) were taken from location of study, the samples weight (0.5 gm) and (1.5 mm) in thickness and (1 mm) in radius were cleaned, dried for using a hydraulic machine. Then in an oven at 60 ^oC for 15 hours [9].

2- Irradiation of the detectors.

The pellets (teeth samples) were covered with *CR*-39 detector and put in a plate of paraffin wax at a distance of (5*cm*) from the neutron source *Am-Be*, with flux of thermal neutron (5×10^3 n cm^{-2} s^{-1}), as shown in Fig.1 [10].

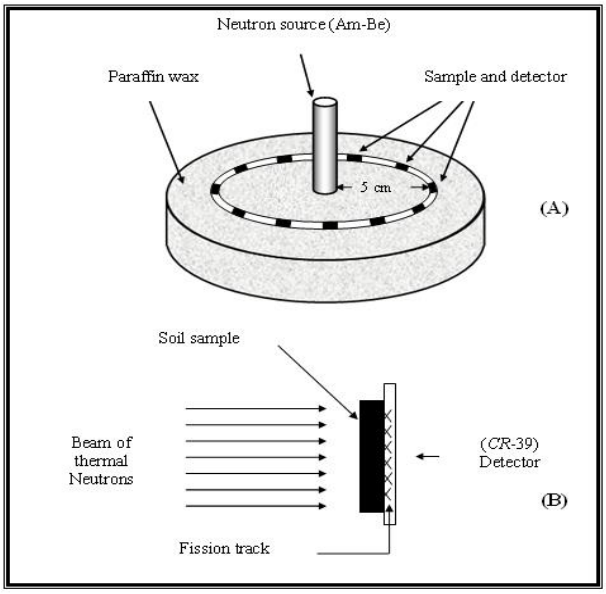

Fig.1: (CR-39) detector for teeth sample [9].

3-Chemical etching and microscopic scanning

After the irradiation time 7days [10], the *CR*-39 detectors were removed and etched in a 6.25 *N* aqueous solution of *NaOH* maintained at 60 ^oC for 15 *hr*, which was the normal employed etching time [10]. The detectors were rinsed with distilled water and dried in air. The tracks recorded in *CR*-39 detectors were counted by using optical microscope at a magnification of 400x. The density of the tracks ρ in the detectors was calculated according to the following relation:

$$\rho_x = \frac{N_{ave}}{A}$$

where

ρ: Track density[2] Track / mm^2.

N: Average of total tracks.

A: Area of field view.

4- Uranium concentration

Fission track technique was used for determination uranium concentration in the teeth samples by making a comparison between track densities registered on the detectors of the sample and that of the standard sample. The uranium content in the unknown samples was determined by using the formula [11]**;**

$$\frac{C_X}{\rho_X} = \frac{C_S}{\rho_S}$$

where

C_S, C_X: Uranium concentration (*ppm*) for standard and sample respectively.

ρ_S, ρ_X: track density (*track/*mm^2) for standard and unknown sample respectively.

And $C_X = C_S \frac{\rho_X}{\rho_S}$

Fig.2 shows this relation between track density and uranium concentration, when (*slope* = ρ_S / C_S)

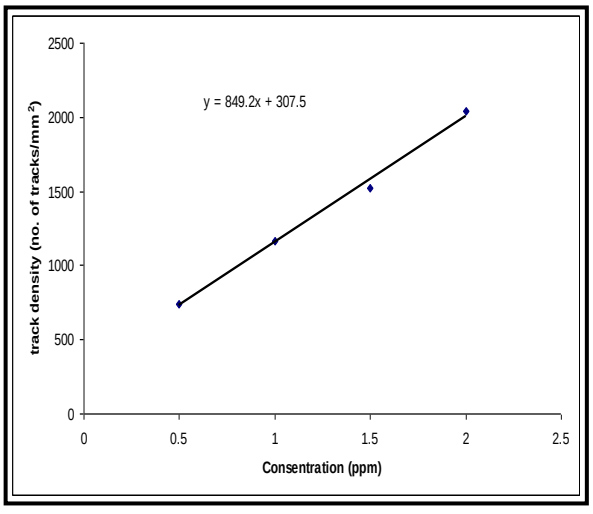

Fig.2: The relation between track density and uranium concentration.

Results and discussion

Table1(a,b,c and d) present the tracks density, uranium concentrations, and the rates for different study areas in irradiated samples that measured by *CR* – 39 detector. The samples collected from 17 location distributed in 4 districts in different sites in Baghdad city.

Table 1: Uranium concentration in teeth samples

(a) Uranium concentration in Al-Durra District

Sex &Age	Track Density (track/mm2)	Uranium Concentration ppm
Female 29	38	0.0369
Female 26	38.59	0.0361
Male 35	42.34	0.0399
Female 30	37.50	0.0362
Male 37	41.56	0.0389
Aveage	39.598	0.0376*12.4=0.46624Bq

(b) Uranium concentration in Al-Jadiryia District

Sex &Age	Track Density (track/mm2)	Uranium Concentration ppm
Male 40	42.34	0.0395
Female 44	39.06	0.0366
Male 33	34.48	0.0379
Male 27	27.51	0.0250
Female 34	47.56	0.0451
Ave	38.19	0.0360*12.4=0.4464Bq

(c)Uranium concentration in Al-Zuafrania District

Sex &Age	Track Density (track/mm2)	Uranium Concentration ppm
Male 46	58.4	0.076
Male 34	42.8	0.062
Male 28	56.1	0.075
Ave	52.43	0.071*12.4=0.8804Bq

Table 1: Uranium concentration in teeth samples (d) Uranium concentration in Al-Karrada District

Sex &Age	Track Density (track/mm2)	Uranium Concentration ppm
Female 27	39.3	0.037
Female 35	47.5	0.044
Male 41	32.1	0.035
Male 26	28.1	0.027
Ave	36.75	0.0357*12.4=0.44268Bq

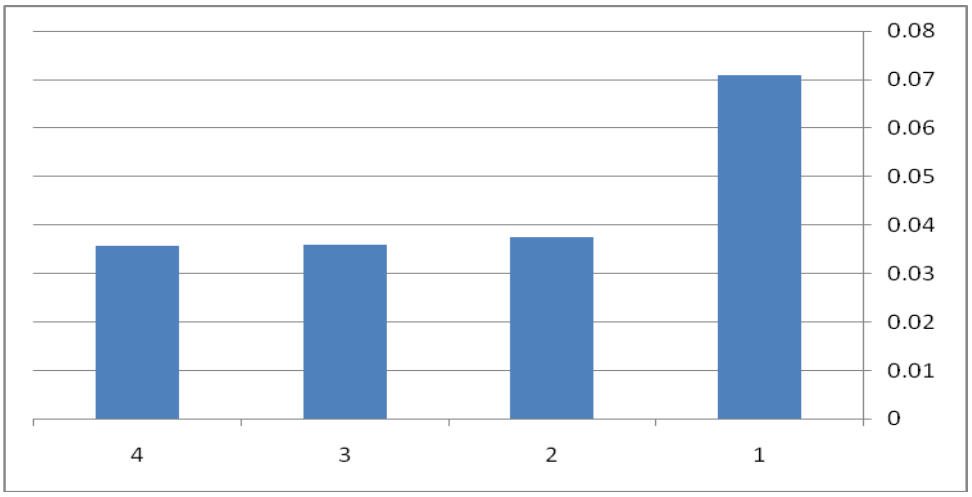

Fig. 3: Compare Between (max& min) of Uranium concentration in teeth samples.

Fig.3 shows that the average maximum value of uranium was (0.071 *ppm*) in Al-Zuafrania district and the minimum was (0.025 *ppm*) in Al-Jadria district.

The uranium level in each samples varies from (0.0361 to 0.0399 ppm) in Al-Durra district , (0.0451 to 0.025 *ppm*) in Al-Jadria district, (0.076 to 0.062 *ppm*) in

Al-Zuafrania district, (0.044 to 0.027 *ppm*) in Al-Karrad distric (Al-Atar Street),

Fig.3 shows the compare between the uranium concentration in Teeth samples for maximum and minimum concentration in the tow districts, the uranium concentration in Al-Zuafrania district is relatively higher than the other districts this is due to difference rezones,we note that there is contrast of uranium concentration and this disparity back to the variation in the ages and races, we note also the high concentration back to male, this is because males more exposed to radiation because of the work and as well as for reconstruction as males the accumulated dose have exposure more than females.

In conclusion, we found that the uranium levels in the teeth in this field of study within the acceptable values (0.05 ppm) in the acceptable American system [13].

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