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Research Article

Measuring the Uranium Concentration for Adults Teeth in Al-Fluja 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 13 samples of teeth distributed in Al-Fluja City 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 0.12 ppm and the minimum is 0.58 ppm.

Keywords: *Uranium concentration, nuclear track detector, CR-39*

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 ^{o}C) and boiling point (4131 ^{o}C), has a tensile strength similar to most steels and it is chemically very reactive (Eisem bud M. and Gesel T.I, 1997). Natural uranium consists of three isotopes. Their concentrations by mass are U^{238} 99.276%, U^{235} 0.718% and U^{234} 0.0056% (IAEA, 1990; Asia H. Al-Mashhadani, 2015).

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 (Eman Ibraheem, 2003). *CR*-39 is one of the solid state nuclear detectors which can response to alpha particle with high efficiency (Aleea Abdul Razaq, 2009). The authors have successfully applied this method for purpose of uranium exploration.

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 (Durrani, S. A. 1982) as it is a very simple technique, it can be implemented easily in field of studies, since it does not require electronic system (Durrani S. A. &. Bull R. K, 1987).

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Materials and Methods

1-Collection of teeth samples

(13) Samples of teeth distributed in Al-Fluja city were taken from the location of study, the samples weight (0.5 gm) and (1.5 mm) in thickness and (1 mm) in radius were cleaned, dried using a hydraulic machine. Then samples were dried in an oven at 60 ^{o}C for 15 hours (Khan, A. J., 1989).

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) (Singh S., *et al*, 2001).

3- Chemical etching and microscopic scanning

After the irradiation time 7days (Singh S., *et al*, 2001), the *CR*-39 detectors were removed and etched in a 6.25 *N* aqueous solution of *NaOH* maintained at 60 *℃* for 15 *hr*, which was the normal employed etching time (Singh S., *et al*, 2001).

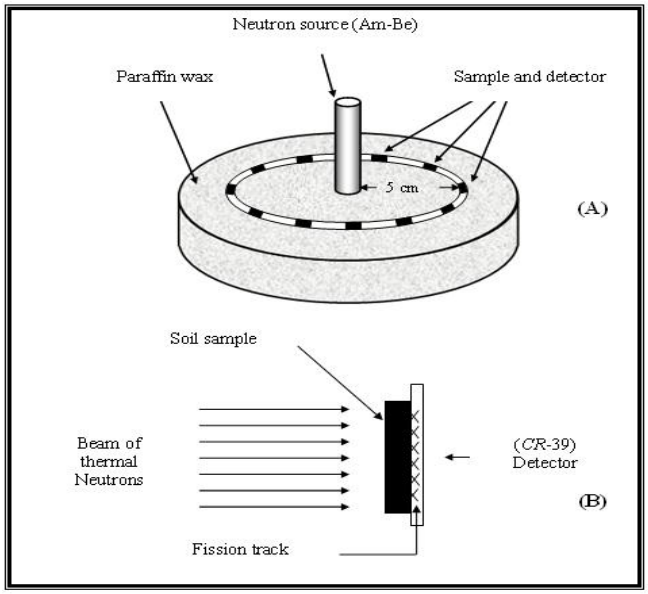

Fig 1: *CR*-39 detector for teeth sample

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_x in the detectors was calculated according to the following relation:

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

where

ρ_x: Track density Track / mm^2.

N_{ave}: 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 (Berger M., 1973);

$$\frac{C_x}{\rho_x} = \frac{C_s}{\rho_s}$$

where

C_s, Cx: Uranium concentration (*ppm*) for standard and sample respectively.

P_s, ρ_x: track density (*track/mm²*) for standard and unknown sample respectively.

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

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

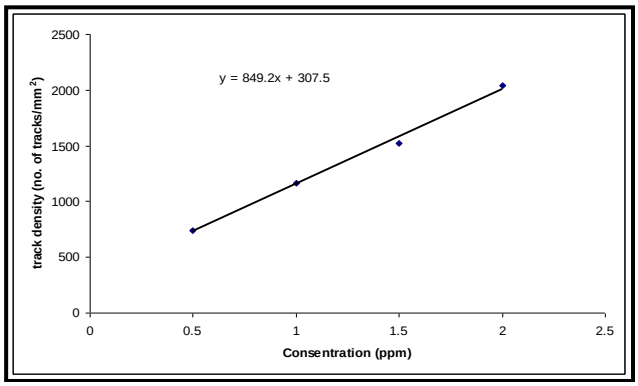

Fig.2 The relation between track density and uranium concentration

Results and discussion

Table1 presents the tracks density, uranium concentrations, and the rates for the different study areas samples that measured by *CR* – 39 detectors. The samples collected from Al-Fluja location distributed in random.

Table1: Uranium concentration for teeth samples

Sex &Age	Track Density (track/mm2)	Uranium Concentration Ppm
Male 48	72.1	0.12
Male 46	65.8	0.092
Female 46	42.68	0.058
Male 45	65.5	0.09
Female 44	41.56	0.058
Male 40	58.4	0.081
Male 39	56.1	0.078
Female 36	40.6	0.0561
Female36	40.9	0.0567
Male 34	42.56	0.059
Female 34	40.1	0.0561
Male 33	42.1	0.058
Male 31	40.6	0.0561
Ave		0.070

Figs 3and 4, show the average maximum value of uranium was (0.070) distr samples for maximum and minimum concentration where 0.12 and 0.0561ppm.

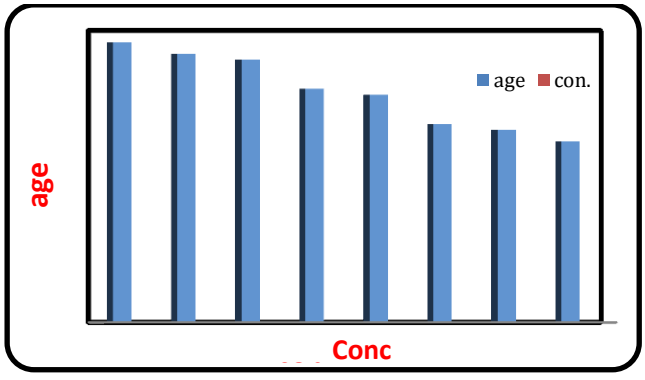

Fig. 3 Uranium concentration in male teeth

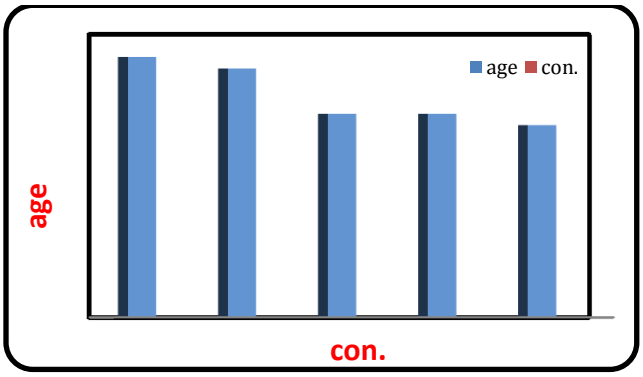

Fig.4: Uranium concentration in female teeth

This disparity back the variation in the ages and races, The high uranium concentration for male, due to 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 (Fleischer R.L. *et al*, 1975; Henryk B., Firyal B. ,2004).

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