# DETERMINATION OF URANIUM CONCENTRATION IN TEETH FEMALE SAMPLES USING FISSION TRACKS IN CR-39 FROM DIFFERENT COUNTRIES.

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**Abstract**

The present study was under taken to measure the uranium concentration in female teeth samples collected from different nationalities. The determination of uranium concentration in these samples has been done by using CR-39 track detector. The nuclear reaction is used as a source of nuclear fission fragments is (n,f) obtained by the bombardment of U-235 with thermal neutrons with flux ($5x10^3$ n/cm$^2$.s) was used from ( Am-Be) neutron source. The concentration values were calculated by a comparison with standard samples which prepared. The obtained results show that the concentration is ranging from (0.58± 0.7ppm) in Oman and Uae to (0.35 ± 0.03ppm) in Iraqi for male, the uranium concentration was the highest in Oman and Uae for female.

## Introduction

There are four ways in which radioactive contaminations can cause health hazards to the human being. The main routes of entry of the radionuclides in the body are (i) direct inhalation of air borne particulates, (ii) ingestion through mouth, (iii) entry through skin and (iv) direct radiation of skin. When inhaled into the lungs, a certain fraction of radioactive material enters into the bloodstream would depend upon factors such as the chemical and physical form of the radiomaterial, and the physiological of the person involved. Similarly, when radio nuclides are ingested, the amount it passing into the body fluids depends on the nature of radio material and on the physiological conditions of the person concerned.

There is a wide variation in the physiological characteristics of human beings. For the purpose of radiological protection. (International commission on radiological protection (ICRP), 1978) has defined a reference man. For instance reference man breathes about 23 m$^3$ of air per day and has the characteristic of a total water intake of 3 L 1/day. Reference man simply represents an average over that very wide spectrum of human characteristics. The fit of particular radionuclide inside the body depends on its chemical and physical form. Some elements distribute themselves fairly uniformly and so irradiate the whole body at the same rate. The majority of elements whoever, tend to concentrate in particular organs so that an intake of radioactivity may result in different dose rates to the various organs of the body. Such elements are iodine, which concentrates in the thyroid gland, and plutonium, which concentrates in the lungs or bones. The most sensitive organs are reproductive organs, kidneys, lungs, liver, etc, depending upon the nature and route of radionuclides through which they have entered into the body. Some of the most significant effects of radionuclides on the body are the induction of lung cancer, damage to genetic organs, damage to eyes and defects in the circulatory system [1].

## Radioactivity

There are two main sources of radiation are found in the environment, natural radioactivity source (which include terrestrial cosmic rays and cosmogenic) and man-made radioactivity sources (which include medical, fallout and nuclear power). [1-3]. Natural Uranium consists of $^{238}$U (99.275%), $^{235}$U (0.720%) and $^{234}$ U (0.005%) with half life ($4.49\times10^9$ year) [4], it's found in nature in different forms and the human body contains (90 µg) as average result from food chain, about 66% are found in bones and teeth, 16% in the liver, 8% in the kidneys and 10% in other tissues. The average annual intakes of uranium by adults are estimated to be (460 µg) from ingestion [2].

***Table (1)***
***Natural Radioactivity Series [3].***

| Series | First isotope | Half-life (years) | Last isotope |
|---|---|---|---|
| Uranium | $^{238}U$ | $4.49 \times 10^{9}$ | $^{206}Pb$ |
| Actinium | $^{235}U$ | $7.10 \times 10^{8}$ | $^{207}Pb$ |
| Thorium | $^{232}Th$ | $1.39 \times 10^{6}$ | $^{208}Pb$ |
| Neptunium | $^{237}Np$ | $2.14 \times 10^{6}$ | $^{209}Bi$ |

A natural radioactivity in earth crust belongs to the primordial radio nuclides, which are widely distributed through the earth's crust and have long half-lives. They can be divided in to those that occur singly such as potassium-40 and rubidium-87 whose half -lives ($1.3 \times 10^{9}$) and ($4.8 \times 10^{10}$) years respectively [2], and those which occur in series chains such as uranium -238 series, actinium series, thorium series and neptunium series. The importance of these chains comes according to their half life, abundance in nature and type of radiation emitted from them [4].

Over the last few decades man has "artificially" produced several hundred radionuclides, and the power of the atom used for a wide variety of purposes, medicine, weapon the production of energy detection of fires, illuminating watches and prospecting for minerals. All increase the radiation dose both to individual people and to man-kind as a whole.

Individual doses from man –made sources of radiation vary greatly most people received relatively small amount of artificial radiation, but few get many thousand times the amount they receive from natural sources.

The variability is generally greater for man -made sources than for natural ones. Most made sources, too, can be controlled more readily than most natural ones, through exposure to external irradiation to fall-out from past nuclear explosion [5].

Uranium naturally occurs as three different isotopes $^{234}U$, $^{235}U$ and $^{238}U$. Isotopes are atoms of the same element that have different numbers of neutrons but the same number of protons. This means that they behave in the same way chemically, but different isotopes release different amounts and kinds of radiation.

The chief radiological hazard from uranium 238 is alpha radiation. When inhaled or ingested, the most damaging form of ionizing radiation. However, as $^{238}U$ decays into its daughter products thorium and protactinium, both beta and gamma radiation are released, increasing the radiation burden further.

Knowledge of the level of natural uranium (U) in the human body is fundamental in order to estimate the potentially hazardous incorporation in accidentally exposed subjects. A constant monitoring of exposed workers needs reliable reference baseline values, which can be determined by measuring the U concentration in urine. ICPMS has proven to be a fast, reliable and highly sensitive technique for this purpose.

Non-uniformity in the distribution of U levels in various regions and differences in dietary habits account for the significant regional variations of U concentration in urine in non-exposed subjects. In this paper, the determination of daily uranium urinary excretion levels in a group of 12 non-exposed subjects from Northern Italy is presented and compared to data present in the published literature and to values obtained in a larger group of German volunteers. The urinary U output values observed in the Italian subset are generally higher than the corresponding levels measured in other groups. This could be the result of a higher intake of U from liquids, as assessed by the determination of U concentration in drinking waters.

**Solid State Nuclear Track Detector**

A solid state nuclear track detector (SSNTD) also known as an etched track detector or a dielectric track detector) is a sample of a solid material (photographic emulsion, crystal, glass or plastic) exposed to nuclear radiation (neutrons or charged particles), etched, and examined microscopically. The tracks of nuclear particles are etched faster than the bulk material, and the size and shape of these tracks yield information about the mass, charge, energy and direction of motion of the particles. The main advantages over other radiation detectors are the detailed information available

on individual particles, the persistence of the tracks allowing measurements to be made over long periods of time, and the simple, cheap and robust construction of the detector [6].

The basis of solid state nuclear track detection is that charged particles damage the detector within nanometers along the track in such a way that the track can be etched many times faster than the undamaged material. Etching, typically for several hours, enlarges the damage to conical pits of micrometer dimensions that can be observed with a microscope. For a given type of particle, the length of the track gives the energy of the particle. The charge can be determined from the etch rate of the track compared to that of the bulk. If the particles enter the surface at normal incidence, the pits are circular; otherwise the ellipticity and orientation of the elliptical pit mouth indicate the direction of incidence.

SSNTDs are commonly used to study cosmic rays, long-lived radioactive elements, radon concentration in houses, and the age of geological samples. A material commonly used in SSNTDS is polyallyl diglycol carbonate (PADC), also known as Tastrak, CR-39.

It is a clear, colorless, rigid plastic with the chemical formula $C_{12}H_{18}O_7$.Etching is usually performed in solutions of caustic alkalis such as sodium hydroxide, often at elevated temperatures for several hours [7].

**Experimental Details**

The countries which teeth samples were collected from (Oman, UAE, Egypt, India, Ethubia, Iraqi) as shown in Table (1).

The teeth samples were dried and then crushed and sieved (2 mm diameter). (0.5g) weight of the powdered teeth samples and the standard which prepared of different uranium concentration were pressed into a pellet of (1 cm) diameter and (1.5 mm) thickness.

**Irradiation Source**:

(Am–Be) neutron source with thermal neutrons flux ( $5x10^3$ n/ $cm^2$.s) at a distance (5 cm) in paraffine wax was used. It emits fast neutrons from the ($\alpha$, n) reaction such as:

$^{9}_{5}Be + ^{4}_{2}He \longrightarrow ^{12}_{6}C + ^{1}n + 5.76$ MeV …...…(1)

This source consists of a rod of (Am–Be) surrounded by a paraffin wax. The paraffin wax is usually used for moderating the fast neutrons to thermal neutrons. The neutron source with flux ( $5x10^3$ n/ $cm^2$.s ) was used to irradiated the sample.

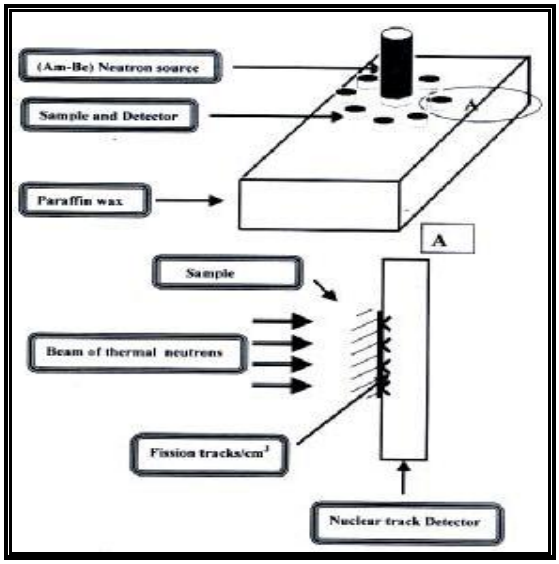


***Fig. (1) : The irradiation of the detectors and samples to the neutron source [9].***

**Enchant Solution**:

Sodium hydroxide solution with (6.25 N) normality has been used for the etching process, which prepared as:

$W = Weq \times N \times V$…….(3)

Where:

W = the weight of NaOH needed to prepare the given normality.

Weq = equivalent weight of NaOH = addition of the atomic weight of Na, O and H = 40.

N = normality = 6.25.

V = volume of distilled water = 250 ml.

The enchant compartment has a volume of about 250 ml contains the NaOH solution with 6.25 N. This apparatus is closed assembly, except for small vent at the top of the condenser tube, which prevents any change of etchant normality (concentration) during the experiment due to evaporation.

The etching was performed at $60^0$C while the etching time was 6.5 hr.

**Optical Microscope:**

The optical microscope is capable of giving magnifications of (40x) and eye piece (10x) to measure number of tracks, the calculation track density from equation:

Track density ($\rho$) = average of total pits / area of field view..... (2)

CR-39 nuclear track detector thickness (1000 μm) and area approximate to ($1\times1$ $cm^2$) were used. the relation between track density and uranium concentration (ppm) for standard teeth samples as shown in Fig.(1).

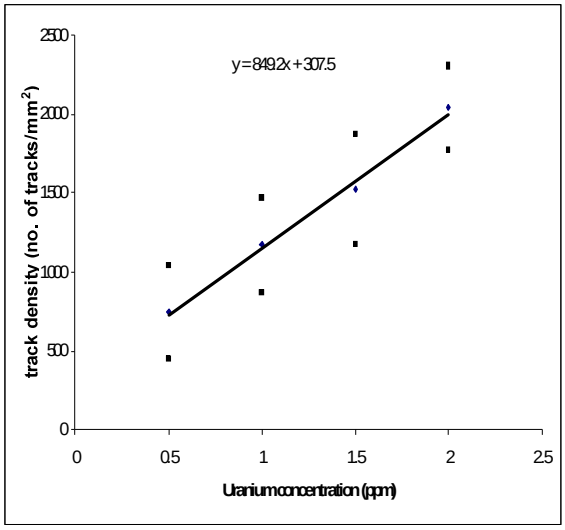


***Fig.(1) The relation between track density and uranium concentration (ppm) for standard teeth samples. .***

## Result and Discussion

The present study results were obtained from eight female teeth samples from different countries. The results include the measurements of the uranium concentration for female samples which where obtained using solid state track detector CR-39. As shown in Table (2).

***Table (2)***
***Uranium concentration in female teeth samples from different nationalities.***

| Nationality | Age year | ρ(tracks /$mm^2$)±σ | Uranium concentration ppm |
|---|---|---|---|
| Oman | 32 | 4980.4±610 | 0.58±0.07 |
| UAE | 32 | 4952.5±794.6 | 0.58±0.09 |
| Egypt | 54 | 4888.9±838.5 | 0.57±0.09 |
| India | 53 | 4257±631.2 | 0.50±0.07 |
| UAE | 35 | 3434.2±358.7 | 0.40±0.04 |
| UAE | 30 | 3288.1 ± 868. | 0.38±0.1 |
| Ethubia | 29 | 3171.9±495.1 | 0.37±0.05 |
| Iraqi | 18 | 2977.1±323.8 | 0.35±0.03 |

The uranium concentration in samples was found to be the maximum concentration (0.58 ppm) in Oman and Uae female of age 32years, incontrast the minimum uranium concentration was (0.35 ppm) in Iraqi female of age 18 years shown in Fig. (2).

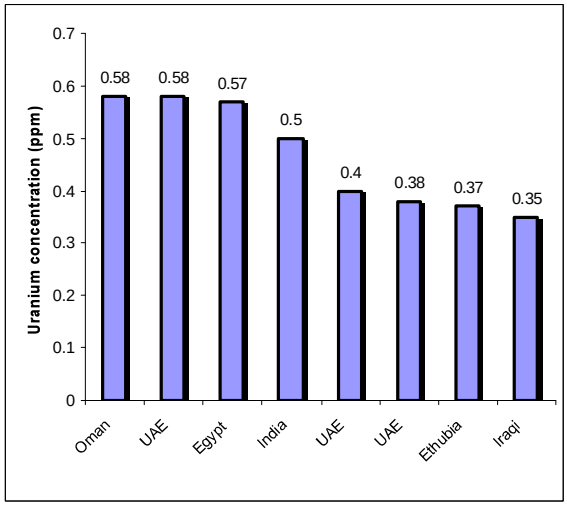


***Fig. (2) :Uranium concentration in female teeth samples.***

Uranium accumulates in bone, affects bone metabolism in laboratory animals, and when ingested in drinking water increases urinary excretion of calcium and phosphate, important components in the bone structure. However, little is known about bone effects of ingested natural uranium in humans. Studied 146 men and 142 women 26-83 years of age who for an average of 13 years had used drinking water originating from wells drilled in bedrock, in areas with naturally high uranium content. Biochemical indicators of bone formation were serum osteocalcin and amino-terminal propeptide of type I procollagen, and a marker for bone resorption was serum type I collagen carboxy-terminal telopeptide (CTx). The primary measure of uranium exposure was uranium concentration in drinking water, with additional information on uranium intake and uranium concentration in urine. The data were analyzed separately for men and women with robust regression (which suppresses contributions of potential influential observations) models with adjustment for age, smoking, and estrogen use. The median uranium concentration in drinking water was 27 μg/L (interquartile range, 6-116 μg/L). The median of daily uranium intake was 36 μg

(7-207 µg) and of cumulative intake 0.12 g (0.02-0.66 g). There was some suggestion that elevation of CTx ($\rho = 0.05$) as well as osteocalcin ($\rho = 0.19$) could be associated with increased uranium exposure (uranium in water and intakes) in men, but no similar relationship was found in women. Accordingly, bone may be a target of chemical toxicity of uranium in humans, and more detailed evaluation of bone effects of natural uranium is warranted. (10)

The age dependence of the natural concentration of uranium and thorium in the skeleton was investigated using human vertebrae bone collected from two Canadian locations. The concentration of both radioelement in digested ashed bone samples was determined using sector-field inductively coupled plasma mass spectrometry. The geometric means for uranium level in bones showed a significant statistical difference between the two locations studied. Similarly for thorium, a statistical difference was observed, although this difference was considered marginal. The thorium concentration differed only marginally with respect to age group, indicating that its behavior in the body could be age-independent. Conversely, the uranium level in bones was found to change for the age groups tested, an indication of age-specific deposition. The age profile for uranium was comparable to the calcium turn-over rate, indicating that uranium deposition is probably, in part, dictated by this metabolic process, showing the role of present uptake into the uranium concentration in bones for populations exposed to significant uranium intake. (11).

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**الخلاصة**

الهدف من البحث هو قياس تركيز اليورانيوم في نماذج اسنان النساء جمعت من دول مختلفه ثم قياس تركيز اليورانيوم في نماذج الاسنان بأستخدام تقنية عدآثار شظايا الانشطار في كاشف الاثر النووي CR-39 الناتجه عن قصف نوى اليورانيوم 235 بالنيوترونات الحراريه من المصدر النيوتروني Am-Be بفيض نيوتروني 500 $nc^{-2}s^{-1}$ وتم تحديد التراكيز بالحسابات المعتمده على المقارنه مع النماذج القياسيه والتي تم تحضيرها في المختبر والنتائج المستحصله تبين ان تراكيز اليورانيوم تتراوح ما بين (0.58ppm) في دولة الامارات وعمان الى (0.35 ppm) في دولة العراق.ومن النتائج تبين ان أعلى تركيز كان في دولة الامارت وعمان واقل تركيز في العراق.