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Comparing of the uranium concentration in tap water samples at Al-Manathera and Al-Herra Regions of Al-Najaf, Iraq

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Abstract

In this work, uranium concentrations and annual effective dose in tap water samples for Al-Manathera and Al-Herra Regions of Al-Najaf, Iraq were determined using a solid-state nuclear track detector (CR-39 detector). Furthermore, we determined the uranium isotopes (^{238}U, ^{235}U and ^{234}U) for all tap water samples under study. The tap water samples are collected nearly from all regions of Al-Manathera and Al-Herra for 22 regions. Thus, the total studied samples are 40. The results indicate that, the average values of uranium concentrations and the annual effective dose in Al-Manathera were larger than the average value at Al-Herra Regions. We concluded that the average value of the uranium concentrations and total average of the annual effective dose in tap waters samples under study were lower than the recommended value of ICRP (1.9 μg/l) and 1 mSv respectively. Therefore, most of the samples could be used without any healthy risk depending on the level of natural uranium concentrations.

Keywords: Uranium concentrations; Uranium isotopes; CR-39; Tap water; Al-Najaf

1. Introduction

Human beings are subjected to radioactivity when ingesting and inhaling radionuclides tagged with food, water and air. Uranium is one of the radioactive elements that occur naturally; it is widely available in the crust of earth [1] in three well known isotopes, namely. ^{238}U, ^{235}U and ^{234}U. ^{238}U and ^{235}U are the parent nuclides of two decay series, whereas ^{234}U is resulting from a decay of ^{238}U. Uranium exists in detectable concentrations in most natural waters either in dissolved or particulate form [2]. In hexavalent form, uranium is water-soluble, and in tetravalent form relatively insoluble [3]. Uranium natural sources include the minerals pitchblende, silicates vanadate, monazite and lignite sands and phosphates of uranium [4]. Uranium is toxic chemically radiologically, relying on concentration, exposure route, chemical nature, exposure period, solubility of uranium compound, and route of elimination from the body [5]. Uranium often classified as a contaminant particularly with drinking water. The most widely known radionuclides that present in drinking water are uranium, radium and radon. Uranium is a radioactive mineral which is

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occurring naturally can be found in particular kinds of rocks and soils. Water that moves through and over soil and rock compositions dissolves many compounds and minerals, including uranium and as such different quantities of it are existing in almost all the water sources. Drinking water that contains uranium can lead to adverse effects of human health. Because of biodegradability is not found in its nature, the heavy metals like uranium heap up in vital human organs and exert progressively growing toxic actions [6]. Particularly, long-run intake of uranium and some other heavy metals may make an increase in the risks of contracting kidney damage, cancer and cardiovascular diseases [7,8], whereas the experimental evidence indicate that the respiratory and reproductive systems are also subject to get affected by uranium exposure [9]. The systems of water which are vulnerable to this kind of contamination are required to go through an extreme monitoring for radioactive contamination to make sure that the drinking water is totally safe. The uranium estimation in water may also be a key for the hydro geochemical prospection for uranium to assess the health risks and also for mitigating processes. Taking into consideration the above mentioned factors, there was an attempt conducted to evaluate the uranium content in some samples of drinking water. Al-Manathera and Al-Herra regions of Najaf Governorate were selected to measure the concentrations of natural uranium in the samples of faucet water for several reasons, including the possibility of the effect of faucet water on the geological nature of these areas because of its presence near the natural uranium mine in Abu-Sakhir, its exposure to bombardment and environmental neglect more than the other cities, and the lack of radiation environmental studies around it, in addition to the fact that most of its areas are agricultural and chemical, and pesticides are used frequently compared with other areas in the province. The measurements of Uranium concentrations in water samples have been conducted worldwide in the recent past [10–13]. In this study, we have used SSNTDs type CR-39 detector for the uranium concentrations microanalysis of in tap water samples collected from some locations at Al-Manathera and Al-Herra, regions of Al-Najaf, Iraq. Also, the uranium isotopes (^{238}U, ^{235}U and ^{234}U) and the annual effective dose were calculated in all samples of tap water under study.

2. Area of study

The study focuses on an area located in the south west of Najaf city in Iraq as shown in Fig. 1. It is situated 18 km from Najaf and 22 km from west of Al-Kufa town. It is located within the southern part of Najaf sea. Al-Manathera city is bounded by 31.9089267°N north latitudes and 44.4868093°E east longitude, while Al-Herra city is bounded by 31.5300°N north latitudes and 44.2700°E east longitude. The area surface is semi plane of new depositional which contains a mixture of soft sands and clays along with vegetal organic materials resulted from remnants of grass, plants and trees.

3. Materials and methods

3.1. Sampling collection and sample sites

40 tap water samples were collected from twenty two major regions at Al-Manathera and Al-Herra area of Al-Najaf, Iraq in October–December 2016. Uranium concentrations of naturally occurring radionuclides in tap water samples were measured for Al-Manathera and Al-Herra regions which it shown in Fig. 2 and Table 1. The measurement of uranium concentrations in tap water samples were collected according to a systematic selection from different sites, two samples average from each point. The volume of samples texture for all samples was very similar. After collecting samples, each one was kept in a plastic cup and labeled according to its location. The collected samples were transferred to labeled closed plastic cup and sent to the laboratory of radiation detection and measurement in the physics department, Faculty of science, university of Kufa.

3.2. Experimental techniques

In this work, the methods adopted to measure the concentrations of uranium for the tap water samples is well known by the standard source methods. The Uranium standard solutions preparation was conducted by use uranium Octoxide U_3O_8 [14]. The concentrations of uranium in the standard solution were measured using special uranium dosimeter that can be shown in Fig. 3. The exposure time was seventy days for uranium standard solution. After 70 days, CR-39 solid state detectors were etched in a solution of (6.25 N) NaOH at a temperature of (60 °C) for (5 h), then the CR-39 tracks density were counted using an optical microscope. This procedure was applied to all the samples, including the standard samples [14].

The CR-39 tracks density (ρ) (track/cm^2 h) in the standard was calculated in accordance with the following relation [15]:

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