INVESTIGATION OF INTAKE OF URANIUM IN DRINKING WATER AROUND CHICKMAGALURE, INDIA.

Manjunatha S.[1] **and P Venkataramaiah** [2]

[1]Department of Physics, The Oxford College of Engineering, Bommanahalli, Hosur Road Bangalore-560068, INDIA.

[2]Department of PG Studies, University of Mysore-570009, INDIA

Email: manjunatha_s@yahoo.com

ABSTRACT

An important route of human intake of uranium and other radionuclides, especially when the general population is considered is by ingestion through drinking water. The present study conducted around Chickmagalure, Karnataka, India. The concentration of uranium in natural waters is generally found to be very low, often being of the order of few parts per billion (ppb). Laser Flourimetry has been used to estimate the uranium concentration in drinking water. Uranium concentrations are found to vary from 0.2 to 27.9 ppb (g.l^{-1}) with a geometric mean of 3.7 ppb. The daily intake of uranium by the local population of the study region varies from about 0.8 to 111.6 g.d^{-1}.

KEYWORDS: Uranium, Radionuclides, Laser Flourimetry

I. INTRODUCTION

Uranium is present in all type of rocks, soil and water. Uranium present is either in uranous (U^{4+}) or uranyl (U^{6+}) form. Uranium occurs most commonly as oxides, hydroxides, phosphates, carbonates, sulphates, arsenates, vanades and silicates [4]. These are derived from the decomposition of uranium minerals like uraninite, pegmatite and pitchblende veins [9,10].

Uranium concentration in water depends on host aquifer rock, the presence of oxygen and complexing agents, chemicals in the aquifer, chemical reactions with ions in solution and the nature of contact between the uranium minerals and the water. The uranium content of natural water may vary from traces to 600 ppb (g.l^{-1}) or more [6]. In the ground and surface water it is found to be about 0.2 ppb. Normally concentration of uranium in air is much less than in food and water. Uranium enters the body through drinking water, which contains trace quantities of uranium. According to one estimate food contributed about 15% of the ingested uranium while drinking water contributed the remaining 85% to the human population in U.S.A [3]. Many authors reported the concentration of uranium in drinking water using Laser Flourimetry technique [5,12,13].

II. EXPERIMENTAL PROCEDURE

Most of the natural waters contain a few ppb of dissolved uranium [4]. Although spectrometers are available and used for the determination of uranium, their accuracy at levels of uranium found in natural waters is low. In the present investigation, Laser Flourimetry has been used to estimate the uranium concentration in drinking water and its detection limit of uranium in water is of the order of a few ppb. It's most serious drawback however is the quenching of uranium fluorescence by many interfering elements like pH, hardness, turbidity etc. It uses a nitrogen laser as the primary excitation source. The measurement is based on the fluorescence of uranium salt under ultra violet excitation. Uranyl salts emit fluorescence that spans the spectral region from 490 to 540 nm with three characteristic peaks. A fluorescing agent, namely Fluran is used to convert the various Uranyl species present in water into a single form, which has a high and uniform spectral yield. The instrument was calibrated using standard solution in the range of 0.5 to 10 ppb before analysis of normal samples

The drinking water collected and processed as mentioned in Ghoda et al. The sample of water to be tested was filled in a quartz cuvette (cell). The pH of the water sample was adjusted to about and 0.5 ml of Fluran was added to the sample in the cell and mixed thoroughly. The Fluorimeter reading was noted. The same procedure was repeated with the water sample under investigation. The concentration of uranium in the sample is calculated [5,12].

III. RESULT AND DISCUSSION

An important route of human intake of uranium and other radionuclides, especially when the general population is considered by ingestion through drinking water. The results are given in Table- 1. Uranium concentrations are found to vary from 0.2 to 27.9 ppb with a geometric mean of 3.7 ppb. These values are well within the WHO standard of 30 ppb for drinking water [19].

Lake water was found to be having higher concentration of dissolved uranium than other water bodies. This is probably due to accumulation of suspended particulate, large aquifer contact and water run off from fields under active cultivation where fertilisers (phosphate) have been used [6]. The pH of lake waters were also found to be higher (8.0 – 8.4) than other water sources. The higher pH may be one of the additional reasons for higher dissolved uranium content. With an oxidising environment at higher pH value (>7) solubility of uranium is known to be favored if it is converted to uranyl form (U^{6+}) [11]. The highest uranium value (27.9 0.7 ppb and pH 8.4) was measured at the Magadi, which is very close to the rocky mountain of Uraniferous Quartz Pebble Conglomerate (U-QPC) [10].

Underground water was found to contain higher uranium content than municipal supply water. The values for Kalasapura and Devagondanahalli villages were of moderate order at 11.6 and 7.8 ppb respectively. These villages are close to the U-QPC region. On the other hand low values of 0.43 and 0.2 ppb were found in Karthekere and Mirle, which are also close to the U-QPC region [9]. While lower contents of the primordial radionuclides where found in the surface soils of Lakya and Lakshmipura, the water of these villages showed higher uranium content. Nearly 55% of study locations showed uranium content of water to be less than 4 ppb.

Table 1. Concentration of Uranium in Water

Sl. No.	Location	Source of Water	pH	U Conc. (ppb)
1.	Birur (8)	Bore well	7.0	5.5 ± 0.10
2.	Birur (4) #	Lake	7.1	2.0 ± 0.04
3.	Chickmagalur, (7)#	Bore well	7.2	2.4 ± 0.08
4.	Chickmagalur	Lake	8.5	3.6 ± 0.22
5.	Chickmagalur (4) #	Lake	7.5	1.3 ± 0.02
6.	Chickmagalur ZP (4)	Bore well	7.3	5.7 ± 0.15
7.	Chickmagalur Mudigere Road (5)	Bore well	7.1	3.8 ± 0.10
8.	Devagondanahalli village (9)	Lake	8.1	6.2 ± 0.16
9.	Devagondanahalli village	Bore well	7.3	7.8 ± 0.25
10.	Kadur (10)	Bore well	6.8	3.2 ± 0.05
11.	Kadur (8)#	River	7.9	3.9 ± 0.10
12.	Kadur Bus stand (6)	Bore well	7.3	0.62 ± 0.10
13.	Kalasapura village (6)	Bore well	7.2	11.6 ± 0.08
14.	Karthekere village (8)	Bore well	7.5	0.43 ± 0.02
15.	Magadi Kymara (7)	Bore well	7.7	2.3 ± 0.08
16.	Lakshmipura (6)	Bore well	7.1	6.8 ± 0.23
17.	Lakya (12)	Bore well	6.9	13.5 ± 0.50
18.	Magadi (6)	Lake	8.4	27.9 ± 0.7
19.	Mirle (8)	Bore well	7.2	0.2 ± 0.03
20.	Mundre (10)	Lake	8.0	17.5 ± 0.45
21.	Mundre (6)	Bore well	7.0	4.9 ± 0.10
22.	Sakrepatna (6)	Bore well	7.2	0.8 ± 0.09
23.	Sakrepatna (7)	Well	7.1	1.7 ± 0.11
24.	Shivapura (5)	Well	7.8	16.3 ± 0.19
25	Uddeboranahalli (11)	Bore well	7.4	0.3 ± 0.02
			Overall pH range 6.9 – 8.5	**0.2–27.9**

ð Municipal Supply, Parenthesis indicates number of samples.

The concentrations of uranium in water measured in this area may be compared with values reported from other places in India as well as outside (Table- 2). The present study shows a general agreement between uranium levels observed in and around Chickmagalur and the values reported in literature from elsewhere.

Table 2. Concentration of Uranium in Waters from Different Environs

Region	Uranium in water ($\mu g.l^{-1}$) Range	Mean	Analysis Method/ Instrumentation	Reference no.
Indian Scenario				
Chickmagalur, India	0.2 – 27.9	3.7	Laser Flourimetry	Present Study
Mysore, Karnataka	BDL – 67.8	–	-do-	12
Bhatinda, Punjab	11.7 – 113.7	–	Fission Track	8
Amritsar, Punjab	17.9 – 20.2	–	-do-	8
Kanpur, U.P.	2.6 – 9.9	–	-do-	13
Allahabad, U.P.	0.9 – 3.8	–	-do-	13
Jhansi, U.P.	0.9 – 6.5	–	-do-	13
Southwest coast	0.4 – 2.7	–	-do-	1
Ganga River, Himalayas	0.9 – 33.4	–	-do-	15
Jadugud a, Bihar	0.4 – 5.0	0.7	Radiochemical	7
India (Overall)	0.6 – 19.2	–	–	2

World Scenario				
China	0.04 – 5.3	–	γ Spectrometry	13
Finland	0.3 – 4.2	–	γ Spectrometry	16,18
Newyork, USA#	0.02-0.04	0.03	-	6
Newyork, USA@	0.001-0.003	0.003	-	6
USA	0.03 – 7.0	–	–	6
USA*	0.03 - 1948	–	–	6

]ð: Tap water (Town Supply). @: Deionised water. *: Underground water.

IV. INTAKE OF URANIUM THROUGH WATER

The principal route of intake of radionuclides by the general population is through ingestion of food and water. There too the water route is more significant than through ingestion of food. Knowing the concentration of the radionuclides in the waters of a region and the rate of consumption of water the intake by the population can be calculated. The average daily intake of water by Indians is about 4 liters [9,19]. The daily intake of uranium by the local population of the study region varies from about 0.8 to 111.6 $g.d^{-1}$. The mean intake works out to 15.6 $g.d^{-1}$ or 5.69 $mg.y^{-1}$.

V. CONCLUSION

Higher levels of uranium were found in surface water (Lake Water) as well as in ground water. In general the uranium concentrations could be graded as Lakes > Wells > Bore wells > Municipal supplies. The higher concentration of uranium in Lake Water is due to large aquifer contact and runoff water from fields under active cultivation. The intake of uranium and other radionuclides by the population of the study region is of the same order as the population of other similar regions.

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Dr.Manjuantha S. is a professor in the Department of Physics,Oxford college of Engineering, Bangalore. He hasve 23 years of teaching experience with 12 publication in National and International journals. His area of research are in Nuclear and Environmental Physics.