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ORIGINAL ARTICLE

Studies on Gross Alpha Activity in Ground Water Samples of Mandya District, Karnataka State, India

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ABSTRACT

Groundwater contains trace amounts of uranium (^{238}U and ^{235}U), thorium (^{232}Th) and their decay products depending on the geophysical parameters and geochemical composition of the soil, rock and water which are transported through groundwater. Gross alpha activity in selected water samples of Mandya district was carried out using a ZnS(Ag) scintillation alpha counting system. The gross alpha activity in water varies from 3.8 to 92.7 mBql^{-1} from the overall data of the study area. The samples are classified into seven taluks and the average value varies from 16.7 to 36.5 mBql^{-1} with an average of 36.3 mBql^{-1} and standard deviation of 6.5 mBql^{-1}. All the samples are well below the guideline level recommended by WHO. The highest alpha activity of 92.7 mBql^{-1} is observed in a sample of Malavalli Taluk due to the fact that ground water originates from the granite and rock strata.

Key words: *Gross alpha activity, Alpha counting system, Radiation, Dose*

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INTRODUCTION

The high energy terrestrial and extraterrestrial radiations are harmful to the human beings when exposed at higher levels. The primordial radionuclides such as uranium, thorium and their daughter products are the main source of radiations from earth. Singly occurring radionulides (^{3}H, ^{7}Be, ^{14}C, ^{40}K, ^{50}V) also contribute to the terrestrial radiation dose. There are about 70 naturally occurring nuclides which are radioactive. (UNSCEAR 2000) report says natural radiation sources contribute about 87% of the radiation dose received by human being. Secondary radionuclides derived from radioactive decay of the primordial radioactive elements are found in soil, air and water. These sources have added new dimensions to health physics (ICRP 1996; IAEA. 2011). Thus the measurement of these elements in soil, air and water has been the interest of many researchers all over the world. The radionuclides enter our body through ingestion and inhalation and causes health risks to humans (WHO. 2004). In this paper an effort has been made to measure the gross alpha activity in drinking water of Mandya district, Karnataka state, India. Uranium is found in salic, granite, sedimentary shale rocks in the form of oxides (uraninite and pitchblende), hydroxides, phosphates, arsenates, vanadates, silicates and sulphates. Uranium is also found in fertilizers and in ocean. Intake of uranium through food is 4 g/day, where bone receives highest dose (0.3 m rem/year) (Kumar, *et al.,* 2016). Uranium decays by both alpha and gamma emissions to form radium which is a

radioactive metal found in all rock, soil, water, plants and animals. Its isotopes are ^{223}Ra, ^{224}Ra, ^{226}Ra and ^{228}Ra. Radium is released to groundwater through recoil mechanism from mineral surfaces that build up radium igneous rocks. As groundwater moves through these rocks radium isotopes are dissolved and transported with the water. Radium is chemically similar to calcium and is absorbed by plants from the soil and then passed on through the food chain to human beings. Measurement of these isotopes in natural water is of great interest in radioprotection as they tend to accumulate mostly in the bones (80%) when ingested and average annual effective dose equivalent to bone from radium is 70 Sv (UNSCEAR. 2000; NCRP 1984). Radium decays by emission of alpha radiation to form radon which is also radioactive element in gaseous form. Thoron (^{220}Rn), radon (^{222}Rn) and actinion (^{219}Rn) are its isotopes (Singh, et al., 2008; NRC. 1999). Measurement of gross alpha activity is one of the simpler radiation monitoring technique used in many scientific and industrial applications. This can be done by evaporating the sample to dryness on a planchet and counting the alpha activity using a ZnS(Ag) scintillation counter. Several researchers have studied the gross alpha activities across the world (USEPA. 2003; Pintilie, *et al.,* 2016). The radiological examination of water requires a rapid measurement technique. The various technique to measure gross alpha activity, includes alpha counting using a surface barrier detector and gamma-ray spectrometry using a NaI(Tl) scintillation detector, HPGe detector, liquid scintillation counter, proportional counter, co-precipitation method, alpha/beta discrimination liquid scintillation counting etc (USEPA. 2003). Many regulatory agencies like Bureau of Indian Standard (BIS), World Health Organization (WHO) and Environmental Protection Agency (EPA), which have set a guideline value as 100, 500 and 555 mBql^{-1} respectively for the gross alpha activity in drinking water (WHO.2004; Jobbágy, *et al.,* 2011; Jha, *et al*., 2013).

STUDY AREA

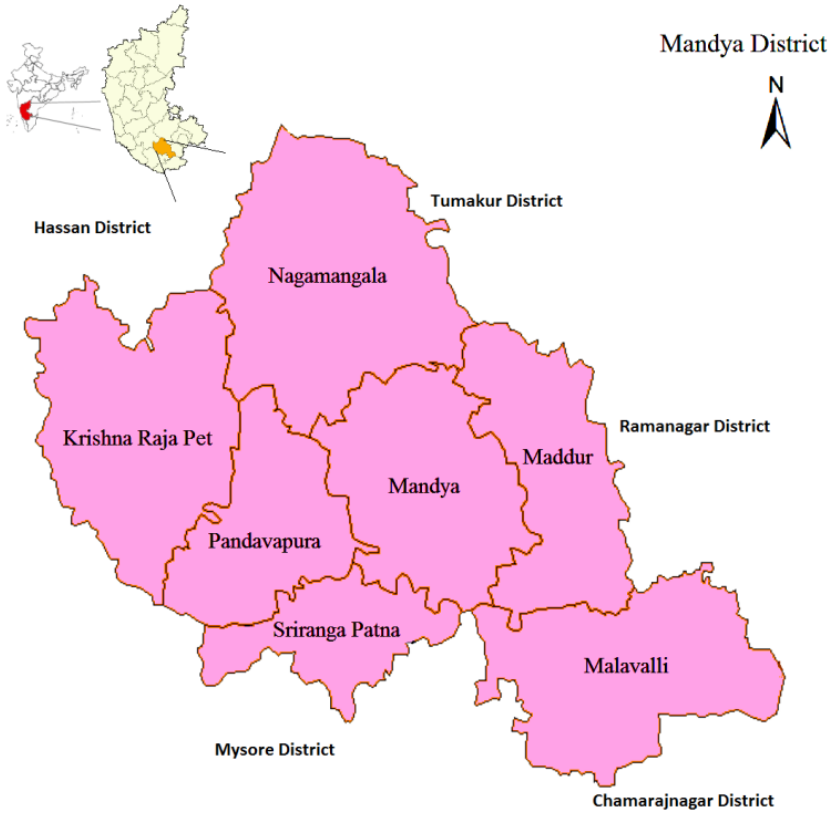

Fig. 1: Study area Mandya District

The water samples were collected from different parts of Mandya district Karnataka state, India. The district lies between 76°19' and 77° 20'E, 12°13' and 13°04'N and is surrounded by Hassan, Tumkur, and Ramanagar districts. The total area of Mandya district is about 4960 square kilometers. The types of rocks identified in this region are the Dharwad schists, Peninsular gneisses and Granites. Gneiss rocks are found in bands of typical exposure in quarries at Chinakurali. Bellibetta and Hadnur schists belts are dharwad schists belts continued form Tumkur district. Red sandy loam soil, Red clay loam soil, Medium black soil, and Lateritic soil are the types of soils in the district. Red sandy loams are the altered products of gneisses. Red clayey loams are the altered products of schists. These two types of soil are found in K.R. Pet, Nagamangala, Sriranga Patna and Mandya taluks of the districts. A clayey loam are clayey in structure and are gravellic and is found in Pandavapura, Srirangapatna, Maddur, Malavalli and Mandya taluks of the district. The map of the study area is shown in figure 1.

METHODS OF MEASUREMENTS

Scintillation counter with silver activated zinc-sulphide phosphor is more specific for counting alpha particles. In the present study, the alpha counting system (ACS 4004, manufactured by Electronic Corporation of India Limited) is used to measure the alpha activity with ZnS (Ag) phosphor screen as scintillators. Zns (Ag) phosphor screen is coupled optically to a photo multiplier which is then fed to an EHT unit and preamplifier. Water samples were filtered through whatmann filter paper 42 and to the filtrate add 5g of MnO_2 then stirred for an hour. This mixture is heated to get clear solution and then it is treated with concentrated HCl and after dryness 30ml concentrated HNO_3 is added, to convert the mixture into nitric acid medium and heated to evaporate organic content present in water. About 5 liter of the water sample was collected in clean polypropylene bottles from each location in the study area. The collected water samples were acidified with dilute nitric acid to pH 2 and were slowly evaporated at a temperature of 60° C to a volume of 50 ml in a furnace. The residue of the sample was then dried on a metallic planchet by transferring it drop by drop and the sample was allowed to cool to the room temperature. The planchet then counted in an alpha counting system for 5000 s for. Gross Alpha activity (A) is estimated using the following equation (Zorer, *et al.,* 2009; Bonotto, *et al.,* 2009).

$$A\,(Bql^{l}) = \frac{C_s - C_b}{E.F.V}$$

Where,

C_s is the average count rate of the sample (cps)
C_b is the average background count rate (cps)
E is the alpha counter efficiency (%)
V is the volume of the sample (liter)
F is self-absorption factor

RESULTS AND DISCUSSION

Gross alpha activity in selected water samples of Mandya district was carried out using a ZnS(Ag) scintillation alpha counting system. The result of the estimated gross alpha activity in ground water samples is shown in Table 1. The gross alpha activity in water varies from 3.8 to 92.7 $mBql^{-1}$ from the overall data of the study area. The samples are classified into seven taluks and the average values varies from 16.7 to 36.5 $mBql^{-1}$ with an average of 36.3 $mBql^{-1}$ and standard deviation of 6.5 $mBql^{-1}$. The highest alpha activity of 92.7 $mBql^{-1}$ is observed in a sample of Malavalli Taluk due to the fact that ground water originate from the granite and rock strata. Pink granite contains highest concentration of rare earth elements, which is found in this region that responsible for the high alpha activity in water samples. In few samples of KR Pet taluk higher level of gross alpha

activity is observed. These samples were belong to region where depth of water level is very low. Lower level of gross alpha activity is observed in the samples collected near Cauvery river of Srirangapatna Taluk. Regulatory agencies like Bureau of Indian Standard (BIS), World Health Organization (WHO) and Environmental Protection Agency (EPA), which have set a guideline value for the gross alpha activity in drinking water as 100, 500 and 555 $mBql^{-1}$ respectively. The gross alpha activity measured in the Mandya district is low compared to the guideline values and it may be safe for the drinking purpose from radiological point of view. The histogram of gross alpha activity in water in the study area is shown in Fig. 2.

Table 1: Gross alpha activity in water samples at different locations of Mandya district

Taluk	Area (km^2)	Population (Million)	Number of Samples	Gross alpha activity $mBql^{-1}$	
				Range	Average
K.R. Pet	904	0.26	12	4.4 to 86.7	36.5
Maddur	613	0.30	12	7.5 to 63.2	25.4
Malavalli	808	0.28	15	4.6 to 92.7	32.1
Mandya	699	0.42	10	5.8 to 64.5	27.6
Nagamangala	1045	0.19	10	7.1 to 55.3	23.4
Pandavapura	535	0.18	12	8.2 to 56.4	22.3
Srirangapatna	342	0.18	09	3.8 to 41.4	16.7
Average					26.3
Standard deviation					6.5

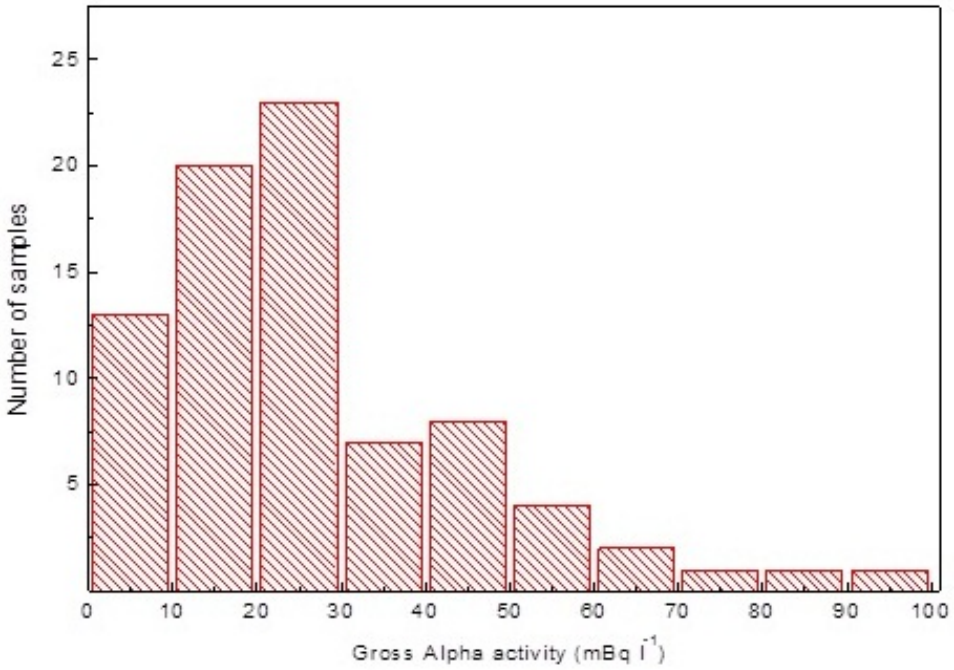

Fig. 2: Histogram of gross alpha activity in Mandya Dist

CONCLUSION

The gross alpha activity in water varies from 3.8 to 92.7 $mBql^{-1}$ from the overall data of the study area. The samples are classified into seven taluks and the average value varies from 16.7 to 36.5 $mBql^{-1}$ with an average of 36.3 $mBql^{-1}$ and standard deviation of 6.5 $mBql^{-1}$. All the samples are well below the guideline level recommended by WHO. The highest alpha activity of 92.7 $mBql^{-1}$ is observed in a sample of Malavalli Taluk due to the fact that ground water originates from the granite and rock strata.

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