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Study of gamma exposure rate in Mysore and Chamaraj Nagar district, Karnataka, India

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Background:: Humans beings are continuously exposed to ionizing radiation from natural sources. The main contributors to natural radiation are high-energy cosmic radiation and radioactive nuclides that originates in the earth's crust. Exposure to high levels of radiation can cause serious health effects. In this study an attempt has been made to monitor the levels of environmental background radiation (gamma) in temples, historical monuments, schools and colleges, hostels, wedding halls and theaters in Mysore and Chamaraj Nagar districts and assess the possible effects on environment and human health. ***Materials and Methods:*** Environmental radiation dosimeter is used to measure the outdoor and indoor radiation absorbed dose levels. The measurements were made 1 m above the ground level. ***Results:*** Inside the temples it varies from 122.7 to 231.4 $nGy.h^{-1}$ with a median of 130.1 $nGy.h^{-1}$ outside the temples it varies from 141.8 to 340.2 $nGy.h^{-1}$ with a median of 216.2 $nGy.h^{-1}$. In different types of buildings in indoor atmosphere it varies from 112.2 to 197.5 $nGy.h^{-1}$ with a median of 127.0 $nGy.h^{-1}$ and in outdoor atmosphere it varies from 140.9 to 298.4 $nGy.h^{-1}$ with a median of 216.2 $nGy.h^{-1}$. ***Conclusion:*** The indoor absorbed dose rate is higher than outdoors in all types of constructions. Indoor and outdoor environment of the temples has higher levels of radiation than the historical monuments and other public and private building in Mysore and Chamaraj Nagar districts. Use of additional granite materials inside or outside the building will enhance the absorbed radiation dose levels. The values observed in the study area are comparable with other values observed in different parts of the world. **Iran. J. Radiat. Res., 2008; 6 (2): 59-63**

Keywords: *Gamma radiation, dosimeter, Mysore.*

INTRODUCTION

Human beings are continuously exposed to ionizing radiation from natural sources. The main contributors to natural radiation are high energy cosmic radiation and radioactive nuclides that originates in the earth's crust, and are present everywhere in the environment, including the human body. A significant portion of the background radiation arises from the radioactive nuclides ^{40}K, ^{238}U, ^{232}Th, ^{222}Rn, ^{220}Rn and their progeny present in indoor and outdoor atmosphere (1). In addition to exposure to natural radiation, most individuals often expose themselves to greater doses of radiation that are contributed from all anthropogenic sources combined. Out of the total radiation exposure nearly 97.7% is from natural sources and only the remaining 2.3% is from man made sources of radiation (2). Receiving amount of radiation varies considerably depending on the location, elevation, rock types, soil content, weather condition and building. In fact, radioactivity can be in the air we breathe, soil on which we walk, dwellings in which we live and even within our bodies (3). A worldwide review (4) of the concentrations of ^{40}K, ^{238}U and ^{232}Th in soil gave median values of 400, 35 and 30 Bq Kg^{-1}, respectively. Exposure to high levels of radiation can cause serious health effects. The degree of effects depends on intensity of the dose, the length of exposure, and the type of body cells exposed. The value received by an

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individual depends on altitude, latitude, type of building and the building construction material. The presence of natural radionuclides in building materials may lead to an increment of both external and internal radiation exposure of the inhabitants of dwellings built with such materials [(5)]. External exposure inside dwellings arises from gamma-emitter radionuclides existing in the walls, floor and ceiling of the building [(6)]. Most of the building materials contain naturally occurring radioactive elements, the most important of which are potassium ^{40}K and the members of two natural radioactive series, which can be represented by the isotopes of thorium ^{232}Th and uranium ^{238}U. The presence of these radioisotopes in the materials causes external exposure to the people who live in the building. In addition, the disintegration of uranium ^{238}U increases the concentration of radon gas ^{222}Rn and of its daughters in the house [(7)]. Radiation exposures from building materials to people can occur either from indoor radon or from external gamma radiation. Both the concentration of indoor radon and the level of gamma radiation from the building materials depend primarily on the total radium concentration in the materials. Thus, limiting the radium concentration in the building material, limits the amount of potential exposure to building occupants from both indoor radon and gamma radiation.

The gamma-ray dose rate is governed by the total radioactivity distributed in soil over an area of a few hundred square meters to a few tens of cm depth from the ground surface [(8)]. The induction of cancer appears to be the most important effect of low-dose ionizing radiation such as, natural background radiation, to occur in an exposed population [(9)]. The major site of solid cancers induced by whole-body radiation exposure is breast in women, skin, thyroid, lung, leukemia and some digestive organs [(9, 10)]. Therefore, keeping in view the natural risk, it is necessary to know the dose limits of public exposure [(11)] and to measure the natural environmental radiation level outdoor and inside the dwellings, which make use many a types of constructional materials.

In this study an attempt has been made to monitor the levels of environmental background radiation (gamma) in temples, historical monuments, schools and colleges, hostels, wedding halls and theaters in Mysore and Chamaraj Nagar districts and assess the possible effects on environment and human health.

MATERIALS AND METHODS

Study area

The study area lies between 12° 15' N and 12° 25' N latitude and between 76° 35' and 76° 45' E longitude. The study area cover about 800 sq km, including Mysore, Hunsur, K.R. Nagar, H.D. Kote and T. Narasipura taluks of Mysore district; Srirangapatanna of Mandya district and Chamaraja Nagar districts of Karnataka states in India. It is part of a gently sloping plain in the Indian peninsular shield with isolated hills made of intrusive. The archean rocks of south India are best developed in Mysore and are made up of schists, gneisses and granites. The rocks known as the Peninsular Gneisses are widely distributed in Mysore. They consist mainly of gneisses, granites and granodiorites of varying composition, texture and structure. Chamundi granite is anorogenic boss occurring in Mysore with an isochron age of 790 ± 60 million years. The emplacement of alkaline dykes has domed up the area southeast of Mysore. It is predominantly pink granite with a minor component of grey granite. Hunsur (west of Mysore) is covered by granite gneiss and gneissic granites with various hornblendic rocks, pyroxenites, dunites containing chromit andmagnesite. The metamorphic siliceous schists run from Bilikere (west of Mysore) in south and southwest direction from nearly 40-48 km. The Sargur schist belt extends from Yelwal (west of Mysore) to very near to the Kerala border. Pegmatitic intrusions into the Precambrian gneisses and schists have also been found near Krishna Raja Sagar.

Red sandy loams are mainly found in the entire Mysore district. The colour of the soil changes from place to place and is dependent on the presence of hydrated oxides of iron. These soils permit free internal and downward movements of water. Mixed red and yellow coloured soils are generally formed from the underlying parent rock, which is mostly granitic. These soils are highly sticky. Black soils are found in some parts of Mysore.

Instrumentation

Environmental radiation dosimeter ER type manufactured by Nucleonix System is used to measure the natural background or environmental radiation. It is exclusively designed to serve as a low-level survey meter. It is an ideal choice for environmental radiation monitoring and also for geological prospecting of radioactive minerals. The instrument is calibrated to read exposure rate in two ranges with measuring sensitivity of 0.1μR h^{-1} and 1μR h^{-1} and exposure with measuring sensitivity of 1μR. All measurements were made 1 m above the ground level. The arithmetic mean of the readings was taken as representative figure for each location. The exposure rate in μR h^{-1} was converted into absorbed dose rate nGy.h^{-1} using the conversion factor of 1μR/h = 8.7 nGy.h^{-1}, which stems from the definition of Roentgen [12].

RESULTS AND DISCUSSION

The results of the survey on gamma radiation absorbed dose rate in the ancient temples are summarized in table 1 at each location minimum of ten readings were taken and averaged. The gamma absorbed dose rate in the temples is varying from 122.7 to 231.4 nGy.h^{-1} for outdoor and 141.8 to 340.2 nGy.h^{-1} for indoor. In all the cases, absorbed dose rate inside the temples were higher than the outdoor atmosphere. Higher levels of absorbed dose rate inside temples are mainly depends on radon concentration, concentration of natural radionuclides (^{226}Ra, ^{232}Th and ^{40}K) present in soil and building materials and ventilation rate. The use of gneissic granite for the

Table 1. Gamma radiation exposure in ancient temples of Mysore and Chamaraj Nagar Districts.

	Temples	Place/ Location	Absorbed dose rate in air (nGy.h^{-1})		Ratio: indoors to outdoors
			Outdoors	Indoors	
1	Chamundeshwari	Mysore	167.0	237.5	1.4
2	Nanjundeshwara	Nanjangud	231.4	278.4	1.2
3	Kirthinarayanaswamy	Talakad	129.6	189.7	1.5
4	Maraleshwaraswamy	Talakad	126.1	141.8	1.1
5	Veerabhadraswamy	Talakad	128.8	185.3	1.4
6	Vydhyanatheshwara	Talakad	123.5	220.1	1.9
7	Mallikarjuna	Mudkuthorae	170.5	340.2	2.0
8	Mahadeshwara	T. Narasipura	130.5	212.3	1.6
9	Maradigudda	Kollegal	175.7	321.9	1.8
10	Somanatheshwara	Somnathpura	122.7	181.8	1.5
	Minimum		122.7	141.8	1.1
	Maximum		231.4	340.2	2.0
	Median		130.1	216.2	1.5
	Geometric mean		147.3	223.2	1.5
	Standard deviation		35.4	64.2	0.3

construction of walls and floor in all the investigated temples has increased the indoor absorbed dose rate. Gamma radiation levels inside and outside the temples located in and around sand dunes of Talkad are low compared to other temples and their locations. However, the levels of absorbed dose rate was high at indoor than outdoor atmosphere of these temples in Talkad. The activity of radionuclides in building materials is more than the activity of radionuclides in soil except sand [1]. The indoor and outdoor absorbed dose rate is high in Nanjundeshwara temple. In this temple, white granite slabs are used for the flooring in addition to use of gneissic granite to construct walls. The doses of radiations outdoors are normally found to be associated with soil covered area. The higher radiation levels are attributed to regions having granetic rocks and structure of granites. The temples, namely Chamundeshwari, Mallikarjuna and Maradigudda are constructed at the top of the hills and are located in the regions having granetic rocks. In Mallikarjuna temple, indoor dose rate was 340.2 nGy.h^{-1}, which is the highest. The highest radiation levels are found inside the temple, which are usually massive granitic structure. Higher level of radiation outside the temple may be attributed to the presence of higherconcentrations of uranium and thorium in the soil or rock structures. The gamma radiation exposure in different buildings of Mysore and Chamaraj Nagar Districts is shown in table 2. Compared to temples, indoor and outdoor absorbed radiation dose levels in historical monuments, schools and colleges, hostels, wedding halls and theaters were low. The levels of radiation are higher inside the building than outside it. The minimum and maximum for indoor absorbed dose rate measured inside various building was 140.9 and 298.4 nGy.h^{-1} respectively. Residential building materials, principally concrete, can contain small amounts of radium, which generates radon gas that can migrate into residences. Furthermore, radon daughters trapped in concrete emit gamma radiation that can cause exposures to building occupants. Gamma absorbed dose rate inside and outside the wedding halls. Outdoor and indoor absorbed dose rates in other buildings, such as Mysore palace, Jagamohan palace, St. Philomena's church, Premier studio,

Table 2. Gamma radiation exposure in different buildings of Mysore and Chamaraj Nagar Districts.

		Absorbed dose rate in air (nGy.h^{-1})		**Ratio: indoors to outdoors**
		Outdoors	**Indoors**	
1	Historical monuments			
	Mysore palace	133.1	177.5	1.3
	Jagamohan palace	156.6	196.6	1.3
	Crawford hall	134.9	161.8	1.2
	Premier studio	112.2	141.8	1.3
	St. Philomena's church	125.3	174.0	1.4
2	Schools/colleges	118.3	145.3	1.2
3	Hostels	127.0	140.9	1.1
4	Wedding halls	197.5	298.4	1.5
5	Theaters	124.4	148.8	1.2
	Minimum	112.2	140.9	1.1
	Maximum	197.5	298.4	1.5
	Median	127.0	161.8	1.3
	Geometric mean	134.7	171.2	1.3
	Standard deviation	26.0	49.6	0.1

schools and colleges, hostels and theaters did not show any significant variation. However, the radiation levels in Mysore palace, Jagamohan palace and St. Philomena's church were slightly higher than the schools and colleges, hostel and theaters. Historical monuments lacked adequate ventilation and accumulated higher levels of radiation in indoor environment. Slightly higher level of radiation is observed in theaters when compared to schools and colleges, and hostel buildings. This may be because of lack of ventilation in theaters. Larger ventilators provided in the Crawford Hall building and Premier studio might have reduced the levels of gamma radiation in the air. The level of radiation observed outside the buildings in Mysore and Chamaraj Nagar districts is however not very much different from observation elsewhere. Similar observations have been made in measurement carried out in other parts of the country as well as the world and the values observed in the study area are comparable with other values observed in different parts of the world [(4)].

CONCLUSION

The indoor absorbed dose rate is higher than outdoors in all types of constructions. Indoor and outdoor environment of the temples has higher levels of radiation than the historical monuments and other public and private building in Mysore and Chamaraj Nagar districts. The absorbed gamma dose rates recording in the temple, historical monuments, 141.8 to 340.2 $nGy.h^{-1}$ with a median of 216.2 $nGy.h^{-1}$. In different types of buildings in indoor atmosphere it varies from 112.2 to 197.5 $nGy.h^{-1}$ with a median of 127.0 $nGy.h^{-1}$ and in outdoor atmosphere it varies from 140.9 to 298.4 $nGy.h^{-1}$ with a median of 216.2 $nGy.h^{-1}$. These values observed in the study area are comparable with other values observed in different parts of the world. Further detailed study is requires estimating natural background radiation.

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