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Studies on indoor radon and its progeny levels around Bangalore rural district and Bangalore city

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ABSTRACT

Indoor radon and its progeny levels were measured during 2005-2006 around Bangalore rural district and in Bangalore city using Solid State Nuclear Track Detector based dosimeters. More than 50 dwellings of different construction and types were chosen for the study in and around the city. The geometrical mean value of radon concentration level in indoor atmosphere of granite quarries varies from 55 Bq.m^{-3} to 300 Bq.m^{-3} with a median of 152.5 Bq.m^{-3} and its progeny varies from 0.24 to 19.6 mWL with a median of 8 mWL respectively. In Bangalore city the concentration level of radon varies from 18.4 Bq.m^{-3} to 104 Bq.m^{-3} with a median of 45 Bq.m^{-3} and its progeny varies from 1.62 to 11.24mWL with a median of 4.78 mWL respectively. Higher concentration of radon and its progeny were observed in granite quarries compared to Bangalore city due to the mining activity and types of the bedrock in granite quarries.

KEYWORDS

Radon;
Radon progeny;
Indoor;
SSNTDs;
Granite quarries.

INTRODUCTION

All organisms including human beings are always continuously exposed to radiation by natural sources. Among all the natural sources of radiation dose to man, inhalation of radon, thoron and their progenies contribute 50% of global effective dose[1-4]. The exposure to α - radiation emitted from radon and its daughter products gave health hazard not only to people working in uranium mines, but also to people living in normal houses, working places like thermal power plant, coal fields, granite areas and other related industries[5]. Exposure of persons to high concentrations of radon and its short lived progenies for a long period leads to pathological effects like the respiratory functional changes and occurrence of lung cancer[6-7]. Many authors have investigated radon and its progeny owing to the effect of natural radiation exposure on health, particularly in relationship with various type of cancer[8-17]. In 1988, the International Agency for Research on Cancer (IARC) identified radon is a lung concerning gas[18]. Nature has gifted several geological materials to mankind for building construction purposes. Granite is the one of the most important rock is used in building materials. The granite

rocks relatively higher contents of radionuclides[19]. The low-level concentration of radiation emitted from these materials contributes heavily to the exposure dose to the public living around the quarries and workers.

Many surveys have been performed to estimate the indoor radon concentrations. In view of the fact that the study on environmental radiation levels around granite quarries is important. The results would serve as base line data for the populated area near the granite quarries aiming at assessing the risk caused to the public by both indoor and outdoor exposure of the terrestrial radiation. Therefore data obtain from such study may be used locally to establish if and where controls are needed. The aim of the present study is to measure of concentrations of radon and their progenies and inhalation dose due to radon and its progenies.

Study area

The area of the present study is granite quarries around Bangalore rural district and Bangalore City in Karnataka, India. Bangalore is the capital city of Karnataka. It lies in the south-east quadrant at $12^0\ 8^1$ at latitude and $77^0\ 37^1$ in longitude. The geology of this part of southern India[20] forms predominantly a granitic terrain with numerous varieties of granite and granitic gneiss, charnockite, alkaline rocks etc. Within this vast granitic complex, deposits of quartzite, sandstone, and marble are found in significant quantities. The rocks are of peninsular gneiss and are widely distributed throughout this area. The emplacement of alkaline dykes has domed up the area. The rocks around Bangalore rural District are called closepet granites. These rocks are younger than peninsular granites. These rocks are concentration of pegmatite. The mining activity in this area covering a strange of more than 80 hillocks spread between Kanakapura, Ramanagara and Bidadi over 500 square kilometer. About 40 granite quarries are seen around this area out of which 28 quarries are selected. Nearly 4000 laborers are involved in stone crushing and loading activities. The soil in this area is red sandy loam with traces of yellow and black soil. The soil being porous, permits free internal and downward movement of water. Mixed red and black colored soil is formed the underlying parent rock, which is mostly granite. The houses are constructed with different types of materials, most of them are cement houses and a minor component comprising of huts. The materials used for building the cement houses consist of cement, reinforced concrete, burnt clay bricks, hollow blocks, Terracotta bricks and tiles. The floor finishes are made up of stones, concrete tiles, mosaic tiles, granite and marble slabs. The materials used for constructing huts are sand lime bricks, mortar, clay and asbestos sheets.

Methodology

Radon and its progeny levels in some dwellings of the study area were measured using Solid State Nuclear Track Detectors(SSNTDs). The double chamber dosimeter cup used for monitoring radon and its progeny. These dosimeters are suspended from the mid-point of the house at a height of 2 meters from ground level. At the end of the stipulated period of exposure, usually about 100 days, the dosimeters are retrieved and all the three SSNTDs are etched with 10% of NaOH solutions for 1hr at a bath temperature of about 60°C. The track density of alphas in the film was determined using a spark counter. Finally inhalation dose due to radon and its progeny in $mSv.y^{-1}$ can be calculated using the formula[2,21,22].

$$D(mSvy^{-1}) = (0.17+9F_R)\ C_R \times 7000 \times 10^{-6} \quad (1)$$

RESULTS AND DISCUSSIONS

Concentrations of radon and its daughter products were measured in different types of dwellings in Ramanagara, Bidadi and Kanakapura talucks of Bangalore rural district and Bangalore City. The results are summarized in TABLE 1. From the TABLE, it may be observed that, the concentration of ^{222}Rn in indoor atmosphere ranges from 18.4 to 300 $Bq.m^{-3}$, with a median of 120 $Bq.m^{-3}$. The concentration ^{222}Rn daughter products range from 0.24 to 19.6 mWL, with a median of 6.8mWL. The inhalation effective dose due to radon and its progeny varies from 0.49$mSvy^{-1}$ to 7.92$mSvy^{-1}$ with a media 3.17$mSvy^{-1}$. The important source of indoor radon is ^{226}Ra, present in soil beneath the ground and building materials. The building materials used are mostly bricks, cement, granite, tiles etc. the concentration of ^{226}Ra is relatively more in granites[2].

The maximum concentration of radon and its progeny were observed in Alanahally and Maralebekuppe villages. Pink granites attribute these villages and the

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TABLE 1 : Average indoor radon and its progeny concentration levels and equivalent effective dose around granite quarries and in Bangalore city

SI. no	Location	Type of house (Roof and Floor)	^{222}Rn conc. ($Bq.m^{-3}$)	^{222}Rn progeny Conc.(mWL)	Effective dose ($mSv.y^{-1}$)
		A. Kanakapura Taluck			
1	Maralebekuppe	Small tiled, F- Cement	205	13.50	5.41
		Mud house, F- Bare	300	10.73	7.92
		Mangalore tiled, F-Cement	180	15.60	4.75
		Hut, F- Bare	155	11.12	4.09
2	Alanahally	Small tiled, F- Bare	240	19.60	6.33
		Mud house, F- Bare	260	16.70	6.86
		Hut, F- Bare	170	9.77	4.49
		Concrete, F- Cement	190	6.80	5.01
3	Hosahally	Mangalore tiled, F- Cement	150	17.00	3.96
4	Terinadoddi	Mangalore tiled, F- Cement	113	3.89	2.98
5	Kodihally	Small tiled, F- Bare	180	8.60	4.75
6	Nayakaradoddi	Mangalore tiled, F- Cement	149	6.80	3.93
		Mangalore tiled, F- Cement	160	12.50	4.22
7	Ramanahally	Small tiled, F- Bare	175	8.20	4.62
8	Maharajakatte	Mangalore tiled, F- Cement	96	7.8	2.53
9	Puttadasanadoddi	Hut, F- Bare	70	0.3	1.85
10	Moolegondi	Hut, F- Bare	65	0.25	1.72
11	Kabballi	Hut, F- Bare	55	0.24	1.45
		B.Ramanagara Taluk			
12	L B Palya,	Concrete, F- Cement	110	0.86	2.90
13	K G Hosahally	Concrete, F- Cement	85	0.4	2.24
		Small tiled, F- Cement	125	3.34	3.30
		C. Bidadi Hobli			
14	Kallugopahally	Concrete, F- Cement	115	0.40	3.03
		D.Bangalore city			
15	Victoria Hospital	Concrete, F-Tile	63	6.75	1.66
		Concrete, F- Poly Vinyl (Air conditioned room)	40	4.15	1.06
16	HSR Layout	Concrete, F-Granite	104	11.24	2.74
17	Koramangala	Concrete, F- Mosaic	50	5.40	1.32
18	Vijaya nagara	Concrete, F-Mosaic	18.4	1.62	0.49
19	Rajajinagara	Concrete, F- Red oxide (II)	28.6	2.74	0.75
		Median	120	6.8	3.17
		Average	132	7.37	3.44

rocks are exposed to surface compared to the other regions. High concentration of radon and its progeny levels were observed where the granite rocks are very well exposure to surface. It may be due to higher diffusion from the soil into the dwellings. This is because to the bedrock or soil beneath a dwelling have high content of radium, then these gases can diffuse into the dwellings through the structure of bedrock along the different layers and the cracks resulting high concentration of radon and its progeny[23,24].

Lower concentration of radon and its progeny were observed in Kabballi, Moolegondi and Puttadasana doddi of Kanakapura taluck. The main reason for the lower concentration of radon and its progeny in these villages is the dwellings are huts of thatched roofs and walls having good ventilation. These huts are away from the quarries and mining activity was stopped at the time of measurement. This area surrounded by altered granites. These rocks containing low activity of ^{226}Ra. Indoor concentration is mainly depends on ventilation, rocks, types of building and material parameters

Slightly lower concentrations of radon and its progeny were observed in Hosahally, Terinadoddi, Kodihally, Nayakaradoddi, Ramanahally and Maharajakatte of Kanakapura taluck, L B Palya, K G Hosahally of Ramanagara taluck and Kallugopahally of Bidadi Hobli. This area surrounded by gray granites. These rocks have lower concentration of ^{226}Ra. The concrete houses having good ventilation and are away from the quarries. May be due to this they have slightly low concentration

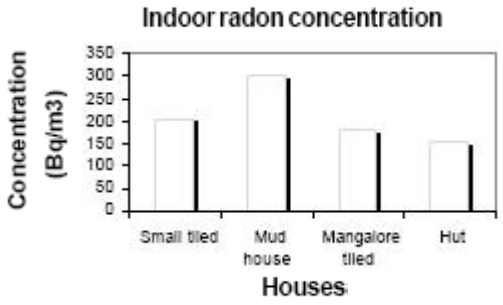

Figure 1: Indoor radon concentration in different types of dwellings of Maralebekuppe

compared to small tiled houses.

The variation of radon in different dwellings of Maralebekuppe is as shown in figure 1. It shows mud houses have higher concentrations of radon compare to concrete houses and huts. It is known that the major contribution to indoor radon and its progeny concentrations is due to local soil where the dwellings exist[25]. The higher concentration of radon progeny levels in dwellings of mud and mud planting walls can be expected as the mud is generally taken from the local soil. The huts are thatched roofs involves good ventilation and these shows less concentration of radon progenies.

In Bangalore City higher concentration of indoor ^{222}Rn and its progenies have been observed in HSR Layout, due to the reason that the floorings are made up of granites and the dwellings is poorly ventilated. In Victoria Hospital, the walls are also made up of granites. The flooring of the ground floor room is made up of tiles while that of the first floor room is made up of poly-vinyl materials. The first floor room is air-conditioned. In Victoria Hospital, higher concentration of indoor ^{222}Rn and its progeny is observed in ground floor room. This may be due to higher concentration of ^{226}Ra present in granites and tiles[26]. The A.C. room shows relatively lower concentration of radon and its progenies. This may be attributed to A.C., which enhances air exchange rate. The house in Vijayanagar shows low concentration of radon and its daughter products. This is because the house is newly constructed and has good ventilation. The concentration of radon and its daughter products in Koramangala is slightly high. This may be due to the reason that the house is quiet old and poorly ventilated, as the windows are always kept closed. The house in Rajajinagar has relatively lower concentration of radon and its daughter products, which may be because it is on the second floor and has red oxide floorings.

To estimate the population dose, conversion factor of 9mSv, equilibrium factor of 0.4 and occupation factor of 7000 hours is used[2]. The inhalation dose due to radon and its daughter products vary from 1.06 to 7.92 $mSvy^{-1}$ with an average of 3.66$mSvy^{-1}$. The houses having granite, tile floorings and walls having higher value of inhalation dose. However, new houses and dwellings with good ventilation show lower inhalation dose. Estimated average inhalation dose due to radon and its progeny varied from 1.06$mSvy^{-1}$ to 7.92$mSvy^{-1}$ median of 3.66$mSvy^{-1}$. Inhalation dose rate due to radon and its progenies gives geometrical mean value of 3.61$mSvy^{-1}$.

CONCLUSION

The maximum progeny concentrations of radon have been observed in the houses situated near the quarries where the mining activity was takes place. The concentration is mainly depends on the activity of radionuclides present in soil and rocks. The result shows that the impacts of radiation hazard due to mining activity (crushing and loading) on the laborers and public near the quarries are considerable. The concentrations of radon and its progeny levels are higher than global average.

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