Study of Environmental gamma radiation level in and around Thirthahalli taluk Karnataka, India

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Adstract

Environmental gamma radiation dose rate in and around Thirthahalli taluk is measured using portable gamma radiation survey meter. Measurements were made in 29 various locations situated in and around Thirthahalli taluk. The measured gamma dose rate ranges from 34.8 nGy/h to 408.9 nGy/h. Relatively higher dose rates were recorded in those areas where granitic outcrops are prominent and also in the places having regional geology as granites. No seasonal variations in the gamma dose rate were noticed during the study.

Indoor gamma dose measurements were also carried out systematically in various houses situated in the study area having different types of flooring tiles. The higher dose rate was recorded in the houses having granitic flooring and lower dose rate in the houses having white marbles flooring.

Keywords-Environmental gamma radiation, Gamma survey meter, Regional geology, Granites, Indoor and outdoor gamma dose rate.

1. Introduction

Thirthahalli is a taluk headquarters of Shimoga district, Karnataka state lies in southern part of India. Its plateau is about 602.88 m above mean sea level with a latitude of 13° 14' N and longitude 75° 14'E. It is characterized by the malnad region having heavy rain fall and rich vegetation (15). Tunga River is the main source of water for the people in this region.

The study area belongs to Shimoga belt and has ancient rock formations. The geological features indicates migmatites and gniesses as the major deposition in the study area, Quartz and chlorite schist forms the second major deposit found in east and north eastern part of study area. Few patches of acid volcanics and granites are noticed in eastern part and Metabasesalt formation in south western part of the study area.

The environmental radiation is mainly due to radio nuclides U^{238}, Th232 and K^{40} present in the earth's crust, Radon and Thoron gases present in the atmosphere due to emanation from earth's crust, cosmic radiation and radio nuclides present in the environment due to atmospheric fall out [(4), (2)]. About 97.7% of the radiation exposure is from these natural sources [3].

The occurrence of radio nuclides varies from place to place on the globe depending on regional geology and geography ([1], [2]). Hence it is essential to characterize the environmental matrices with respect to their radioactivity content to assess the radiation dose to population. As a preliminary study in this direction the environmental gamma radiation measurement has been carried out in this area. This type of work has not been carried out so far in this part of the country and hence happens to be first of its kind.

1.1 Experimental methods

a. Outdoor measurements:

The outdoor gamma dose rate measurements were taken in air at one meter above ground level in different locations using portable gamma radiation survey meter RDS31. It is a G M tube based survey meter with a digital display and has a sensitivity of 1μR/h. The instrument is procured from Electronic Enterprises India private limited (EEIPL), Hyderabad a knowhow from Bhabha Atomic Research Centre (BARC) Mumbai. The instrument was precalibrated by Mirion technologies, as per the recommendations of the radiation and nuclear safety authority of Finland and later by the EEIPL laboratory, Hyderabad.

The measurements were carried out in and around Thirithahalli taluk covering a radial distance of about 20 km keeping Thirthahalli city as centre. The places chosen for measurement covers all varieties of geological depositions present in the study area as shown in the geological map as shown in fig1. In each place, undisturbed locations were identified for measurement. In every location 20 to 40 readings were recorded at various points. Similar procedure is adopted for other locations in the same place, to know the statistical variation in the gamma radiation exposure rate. The readings were recorded both in summer and winter seasons. The geometric mean of all these readings were taken, that gives representative value of gamma radiation dose of a given place. Similar type of measurement was made in some granitic quarries present in the study area. The exposure rate in μR/h was converted in to dose rate in nGy/h using the conversion factor of 1μR/h =8.7nGy/h ([5], [6]).

b. Indoor measurements:

To know the indoor gamma radiation dose rate, various houses were selected having different types of flooring materials. The intension of this study is to identity the dependence of gamma radiation dose with respect to type of building material. The measurements were made for a period of 3 to 6 hours in a house. For this purpose, the G M survey meter was directly coupled to a computer system and using CSW31 software, the readings were noted. The detector was configured to record the data for every 10 minutes. The geometric mean of all such readings was taken as a representative data for that house

1.2 Theory and calculations

UNSCEAR 1988 recommended indoor and outdoor occupancy factor of 0.8 and 0.2 respectively. This occupancy factor is the proportion of the total time during which an individual is exposed to a radiation field [10].

To compute the indoor and outdoor annual doses due to gamma radiation, following equations were used ([5], [7], [8]).

Annual dose for outdoor=Dose rate × 0.2 × 8760hr/yr which is expressed in nGy and then expressed in mSv.

Annual dose for Indoor=Dose rate × 0.8 × 8760hr/yr which is expressed in nGy and then expressed in mSv.

1.3 Results and calculations

The gamma dose rate measured for 29 places in and around Thirthahalli taluk, is presented in table-1. Relatively higher dose rate was found in the places where granitic outcrops are prominent. Out of nine places measured, that covers the regional geology as granites, showed higher gamma dose rate range 62.48-308.42nGy/h and in three different places measured having regional geology comprising of Acid volcanics showed gamma dose rate range from 62.48-73.03nGy/h.

Similarly out of six measurements in quartz and chlorite schist region showed the range 43.65-78.89nGy/h, for metabasalt region measured in three places showed the range of 61.32-69.63nGy/h and in Migmatites region measured for nine places recorded gamma dose rate 44.01-85.98nG/h. The observed gamma dose rate in places with different regional geology is presented in fig 2.

The indoor gamma radiation dose rate measured in selected houses situated in Thirthahalli city is shown in table-2. The highest gamma dose rate of 130.7nG/h was found in houses having granitic flooring and lowest gamma dose rate of 65.83nGy/h for white marbles .This is shown compared in the fig 3.

The overall indoor gamma dose rate measured is slightly high compared to the outdoor gamma dose rate. This may be attributed to the less washout of radon and its progeny in the indoor environment compared to the outdoor environment by various environmental factors. However the work is in progress to determine the concentration of primordial radio nuclides present in these building materials. The criterions like the radon escape, ventilation aspects, etc has not been taken into consideration in the present study.

1.4 Conclusion

It can be concluded that, the places having the regional geology comprising of granites show slightly higher radiation dose rate which is similar to the observations made elsewhere [12]. However, the measured outdoor gamma dose rate in the present study is comparable with the all India average and world average as shown in table 3. Further, the indoor gamma dose rate depends on the type of building material. The houses that are built with granitic flooring shows higher gamma dose rate.

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Table 1

The Outdoor Gamma Dose Rate

Regional geology	location	Total number of readings taken	Gamma dose rate (nGy/h)			Annual effective dose due to gamma radiation (mSv)
			Range	Geometric mean	Geometric standard deviation	
Granite	Melina patruvalli	102	113.1-156.6	137.7	1.11	0.24
	Kikkeri	106	69.6-87	82.12	1.08	0.14
	Garaga	104	113.1-139.2	130.5	1.08	0.22
	Beguvalli	113	113.1-130.5	125.7	1.05	0.22
	Keegadi	102	52.2-95.7	75.46	1.28	0.13
	kangalkoppa	107	69.6-87	80.76	1.14	0.14
	Kelanarasi	108	104.4-17	132.12	1.19	0.23
	M.kuruvalli quarry1	98	69.6-147.9	180.19	1.23	0.31
	M.kuruvalli quarry2	112	78.3-165.3	122.611	1.24	0.21
	k.kuruvalli quarry	110	95.7-208.8	133.16	1.23	0.23
	Thirthahalli hill	100	147.9-408.9	308.42	1.45	0.54
	Siddeshwara hill	106	104.4-304.5	237.35	1.31	0.4
Acid volcanics	Halaga	110	60.9-78.3	70.53	1.04	0.12
	Singanabidri	113	52.2-69.6	62.48	1.12	0.1
	Hegalatti	118	60.9-78.3	73.03	1.10	0.127
Quartz	Kannagi	116	69.6-87	78.89	1.09	0.13
	Yadavalli	102	52.2-60.9	58.17	1.07	0.1
	Thudur	105	52.2-104.4	68.44	1.28	0.11
	Alase	117	43.5-69.6	59.38	1.21	0.1
	Attigudde	102	34.8-52.2	43.65	1.13	0.07
	Kalkurchi	112	69.6-87	74.17	1.13	0.129
Metabasalt	bellihalli	110	34.8-78.3	69.63	1.21	0.121
	Agumbe	107	34.8-69.6	61.32	1.24	0.107

	Hosur	115	60.9-69.6	65.3	1.06	0.11
Migmatites	Malalur	120	34.8-52.2	44.01	1.16	0.07
	Kestur	122	43.5-69.6	61.63	1.15	0.107
	Belur	107	34.8-130.5	85.98	1.46	0.15
	Salur	118	43.5-95.7	76.15	1.28	0.13
	Bobli	121	43.5-87	72.76	1.24	0.12
	Kimmane	125	60.9-87	71.53	1.16	0.125
	Nonbur	118	60.9-87	73.43	1.14	0.128
	Thyrandur	112	52.2-69.6	70.83	1.14	0.124
	Kavaleduga	118	60.9-87	72.69	1.21	0.127

Table 2

The Indoor Gamma Dose Rate

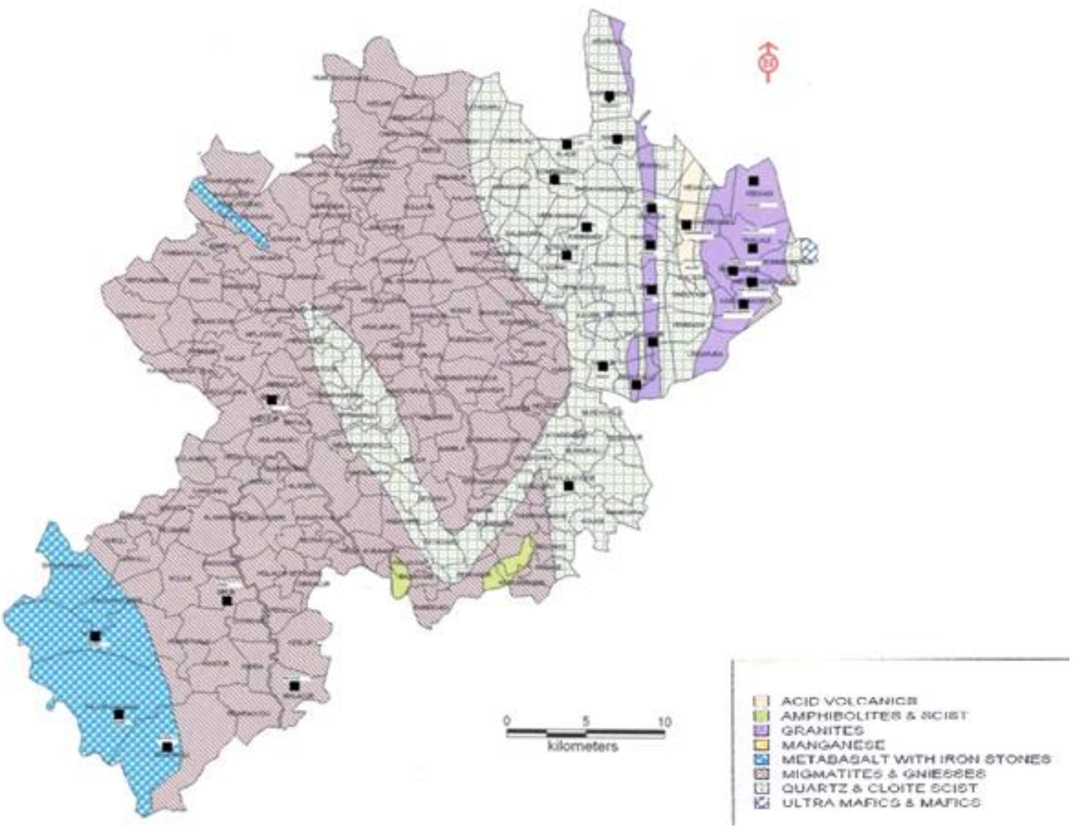
Flooring type	**Number of samples studied**	**Total number of readings taken**	**Gamma dose rate (nGy/h)**			**annual effective dose due to gamma radiation (mSv)**
			Range	**geometric mean**	**geometric standard deviation**	
Granite	6	389	52.2-226.2	130.7	1.57	0.91
Red oxide	2	110	52.2-87	76.12	1.14	0.53
Andhra marble	4	123	52.2-104.4	80.13	1.12	0.56
Vitrified tiles	2	67	87-139.2	95.98	1.07	0.67
White marbles	3	104	43.5-87	65.83	1.15	0.46
Mosaic	4	161	52.2-113.1	90.26	1.14	0.61

Table 3

Comparison of Gamma Absorbed Dose in Air with Other Environs

Gamma absorbed dose in nGy/h		**Region**	**Reference**
Present work	**Literature values**		
43.65-308.42	77.4-146.2	Shimoga	Anandaram 1998
	50-250	Mysore	Nagaaiah 1996
	30.87.8	Goa	Avadhani et al 1998
	43.5-3480	Ullal beach*	Radhakrishnan et al 1993
	44-2012	Kalpakkam beach*	Iyengar et al 1994
	130.5-10579.5	Chavara Kerala*	Ramachandran et al 1994
	75	Karnataka Average	Nambi et al 1987
	89	All India Average	Nambi et al 1987
	28-45	World average	UNSCEAR 1988
	19.3-24.3	Nigeria	A.A Sadiq et al 2012

* Areas of high background radiation



The regions where the gamma radiation measurements were made

Courtesy: NRDMS Centre, Shimoga

Fig: 1 GEOLOGICAL MAP OF THIRTHAHALLI TALUK

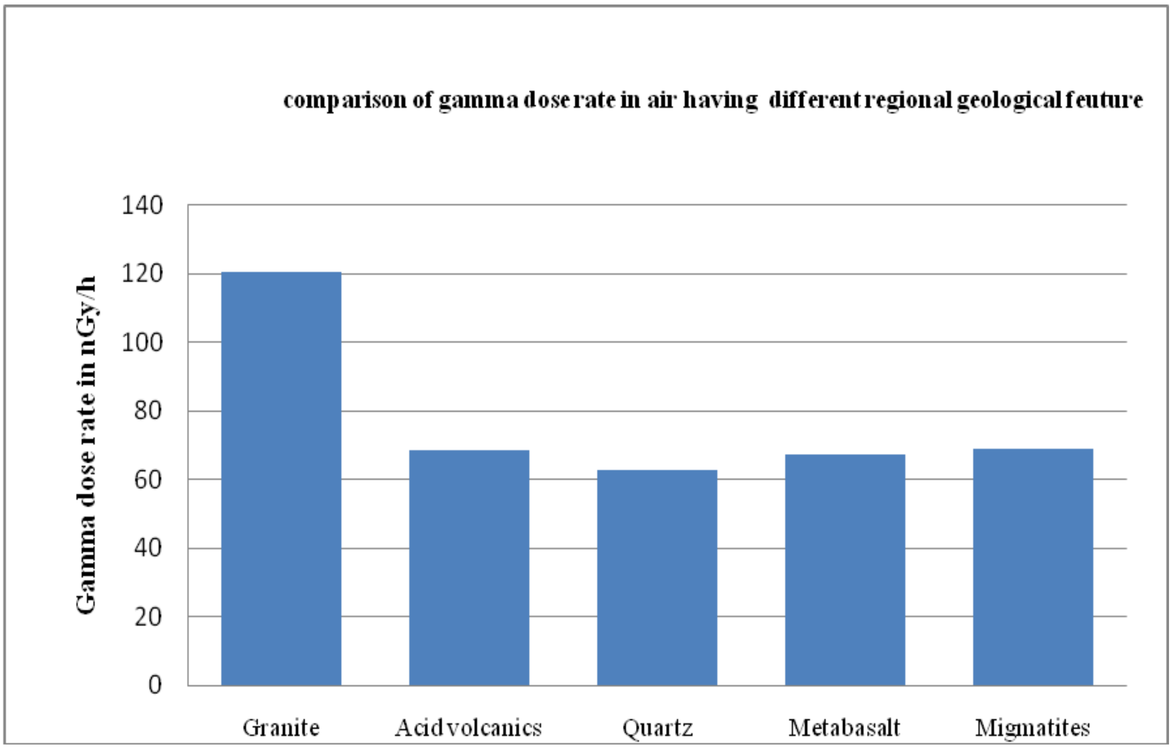


Fig 2: A plot of outdoor gamma dose rate with respect to regional geology.

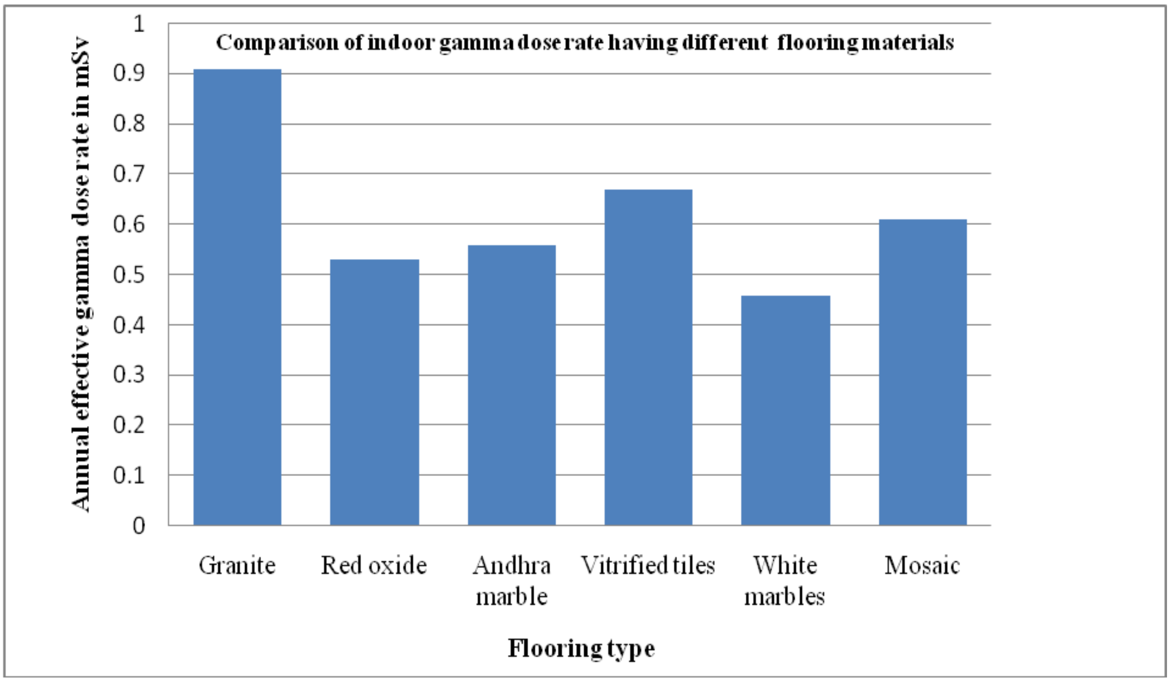


Fig 3: A plot of indoor gamma dose rate with respect to flooring material used

References:

[1]Bruno Sensoni (1982) "*Natural high background areas at Fichtelgebrge*", In Natural Radiation environment proc. Of 2^{nd} spec. Symp., Bombay (Edited by Vohra K G, Mishra U C, Pillai K C and Sadashivan S), Wiley Eastern Ltd.,New Delhi, India -PP 78-84.

[2]M. Eisenbud (1987) *"Environmental radioactivity",* III Edition, Academic press, New York.

[3]Narayana K K, Krishnan D and Subbaramu M C (1991*) "Population exposure of ionizing radiation in India" ISRP* (k)-BR-3.

[4]B.N Anandaram (1998) *"Study of environmental radioactivity in and around Shimoga"* Ph.D thesis Mysore University.

[5]B.N Anandaram, SManjunatha and P Venkataramaiah(1995) *"Study of environmental gamma radiation level in and around Shimoga Karnataka, India".* Proc.Nat. sym.phys. 11

[6]K M Nagaraju, M S Chandrashekar, K S Pruthvi Rani, L Paramesh(2013) Radiat Prot Environ [serial online] 2012 [cited 2013 Jul 17];35:73-6. *"Measurement of gamma natural background radiation in Chamaraja Nagar district, Karnataka state, India".*

[7]A A Sadiq, E.H.Agba (2012)"*Indoor and outdoor ambient radiation levels in keffi, Nigeria",* Facta Universities Series: workings and living Environmental protection Vol.9, no1, 2012, pp.19-26.

[8]Nnamdi N Jibiri and Sunday T U obarhuna (2013*)."Indoor and Outdoor gamma dose rate exposure levels in major commercial Building material distribution outlets and their radiological implications its occupants in Ibaden Nigeria "* Journal of Natural sciences research ISSN 2224-3186(paper) ISSN 2225-0921 (online) Vol-3 No.3,2013.

[9]Nambi K S V,Bapat V N,David M,Sundaram V K,Sunta C M and Soman D (1987) *"Country-wide environmental radiation monitoring using Thermoluminescence dosimeters"*, Radiation protection dosimetry, vol. 18, No.1, pp 31-37.

[10] United Nations Scientific Committee on the effects of atomic radiation (UNSCEAR) (1988) "*Sources, effects and risks of ionizing radiation".*

[11] Iyengar (1994) *"Natural radiation aspects in the high background areas Kalpakkam",* Proc. Of 3rd National Symposium on environment, pp 48-55.

[12] Ramachandran T P,Boban T G and Jayadevan S (1994) *"Radiation measurements in a high background radiation area in Kerala"*, proc. Of 4th National symposium on environment,pp 43-47.

[13] Nagaiah N (1996) *"Study of environmental radiations around Mysore"*, PhD thesis Mysore university.

[14] Avadhani D N,Mahesh H M,Karunaka N,Narayana Y,Balakrishna K M and Siddappa K (1998) *"Radiation level and radionuclide distribution in the environment of Goa",*Proc.ofNSRP-12,pp 253-255.

[15]"*Shimoga district at* a glance 2011-12" A statistical view of Shimoga district, published by district statistical office Shimoga.

[16] Radhakrishna A P, somashekarappa H M,Narayana Y and Siddappa K(1993)"*A new natural background radiation area on the southwest coast of India".*Health phys.65(4) 390-395