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Study on Natural Gamma Radiation Hazards in and around Hassan District, Karnataka State, India.

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A B S T R A C T

The natural background gamma radiation levels were measured in dwellings of urban Hassan city & its surrounding Taluks, Karnataka state, using environmental radiation Dosimeter ER-709. The recorded gamma dose rate in indoor atmosphere was found to vary from 87 $nGy.h^{-1}$to 487 $nGy.h^{-1}$ with a mean value of 288.6±102 $nGy.h^{-1}$. In outdoor atmosphere it was found to vary from 78.3 $nGy.h^{-1}$to 461$nGy.h^{-1}$ with an average value of 260.4±88 $nGy.h^{-1}$. It was observed that the dose rates are higher in Channarayapatna Taluk and in Hassan City and lower in the place of Halebeedu and Belur. The absorbed dose at different mines and granite factories were found to vary from 304.5 $nGy.h^{-1}$to 583 $nGy.h^{-1}$with an average value of 434.6 $nGy.h^{-1}$. The Annual effective dose due to natural background gamma radiation exposure in the Hassan city and its surrounding Taluks is calculated and found to be 0.67 $mSv.y^{-1}$ & 2.90 $mSv.y^{-1}$with mean value of 1.735±0.56 $mSv.y^{-1}$. This is higher than the global average.

Introduction:

All organisms including human beings on this earth irrespective of his place of stay and occupation is getting some dose of high energetic radiation, which exits all around us this is called natural background radiation.

The major contribution to the average annual dose received by mankind still comes from natural radiation. Natural background radiation contributes significantly to the effective dose received by the general population [1-2]. The radiation levels in the environment are important for assessing the effects of the radiation exposures due to terrestrial and extra-terrestrial sources. Terrestrial radiation is due to radionuclide present in varying amounts in soil, rocks, building materials, water and atmosphere[3]. Significant portion of the background radiation arises from radionuclides such as ^{40}K, ^{238}U, ^{232}Th and radon, Thoron and their progeny present in indoor and outdoor atmosphere[4]. Out of the total radiation exposure nearly 97.7% is from natural sources and only 2.3% is from manmade sources of radiation such as radioactive waste releases from nuclear reactor operations and accident, fallout from weapon tests, exposure due to radioactive waste dispose and other industries, medical & agricultural uses of radioisotopes[5-7].

The external gamma radiation irradiates whole body including bones and gonads and significantly produces the genetic hazards and cancer. Radiations are harmful to human beings and hence mankind must be protected from unnecessary exposures. People have been exposed to natural ionizing radiation of both terrestrial and extra-terrestrial origin in indoor and outdoor environment[8-9]. The detail comprehensive assessments of these doses are reported in the reports by UNSCEAR (2008, 2010, and 2011) and ICRP[10-11]. Both these committee have considered the state of scientific knowledge and have derived their best estimates of the mean annual dose to individual in the general population. Doses via inhalation result from the presence of dust particles in air containing radionuclides of ^{238}U and ^{232}Th decay chains. The ICRP has developed a detailed lung model to calculate the effective dose for exposure to air born radionuclides [(11)]. It is nevertheless, still a simplification of actual respiratory anatomy and physiological behavior. Several investigations all over the world have reported ambient gamma radiation exposures in different geological regions[12-17]. Because of the wide variations in natural background exposure even within limited regions more efforts are required to determine the detailed distribution of population within dose intervals for the various components of exposure. Therefore results of the total gamma radiation exposure in indoor and outdoor atmosphere are presented in this paper. The measurements were carried out in the year 2012 in the Hassan District.

The Study Area:

The geology of the study area is Hassan district in Karnataka state which lies between $12^0\ 13^1$ and $13^0\ 33^1$ north latitudes and $75^0\ 33^1$ and $76^0 38^1$ east longitude. Hassan district is considered as Field Museum of Geology since it consists of varieties of rocks as well as minerals. The common rock types in and around Hassan are Gneisses, Granites, Gabbroid, ultramafic igneous rocks, Dolerites, Diorites, steatite and associated pegmatite rocks. The common minerals available in this district are asbestos, magnetite, Kaolin, Chromite, Garnets, micas, and Kyanite etc.

Methodology:

The external gamma dose rates in air were measured in different locations of the study area using portable GM tube based Environmental radiation dosemeter (ER709 manufactured by NUCLEONIX SYSTEMS, PVT LTD) Hyderabad, India, is exclusively designed to serve as low level survey meter in indoor and Outdoor atmosphere. The detailed methodology is given elsewhere[9]. Once operated, the dosemeter gives a radiation dose rate value after few minutes. The measurements were made at a height of one meter from the ground. The mean value was recorded and calculated for each place. The exposure rate ($\mu R.h^{-1}$) is converted into dose rate ($nGy.h^{-1}$)[7] using a conversion factor of $\mu R.h^{-1}$ = 8.7 $nGy.h^{-1}$ and equivalent effective dose in $mSv.y^{-1}$ is calculated by the conversion co efficient $0.7Gy^{-1}$ for adults and occupation factor, of 0.8 and 0.2 for indoor and outdoor respectively.

Results and Discussion:

The results of the measurement and average indoor and outdoor gamma absorbed dose and equivalent effective dose in different dwellings and at different locations around Hassan district are summarized in Table–1.The total equivalent effective dose to the publics of Hassan district are varies from 0.67 $mSv.y^{-1}$ to 2.90 $mSv.y^{-1}$ with a mean value of 1.735±0.56 $mSv.y^{-1}$. The ratio of indoor and outdoor gamma radiation equivalent effective dose from the study varies from 1.44 to 8.89 with a median of 4.7. This ratio can be used as an indicator of relative occurrence of gamma radiation level. This ratio is different at different place.

Indoor:

The indoor gamma absorbed dose varies from 87 $nGy.h^{-1}$ to 487 $nGy.h^{-1}$ with a median of 288.6±102 $nGy.h^{-1}$.The higher value of indoor gamma absorbed dose is observed at Channarayapatna. This is due to the area surrounded by granite rocks contains higher activity of radionuclides, in addition the building material and geology of the area also enhances the absorbed dose[11]. The lower value of indoor gamma absorbed dose is observed in famous Halebeedu Shiva temple and in Belur Channakeshava temple, which are built by chlorite steatite schist (soap stone) rocks which contain less concentration of radionuclides.

Outdoor:

The outdoor gamma absorbed dose varies from78.3 $nGy.h^{-1}$to 461 $nGy.h^{-1}$ with a median of 260.4±18 $nGy.h^{-1}$. The higher value of gamma absorbed dose is also observed at Channarayapatna. The higher value may be due to the pegmatite and other granite rocks present in this area. These rocks contain higher activity of radionuclides[9]. The lower value of gamma absorbed dose was also observed at Halebeedu. This may be due to slightly lower radionuclides present in the earth's crust.

The average gamma absorbed dose and equivalent effective dose at different mines and granite factories in Hassan districts are summarized in Table 2. The outdoor gamma absorbed dose varies between 304.5 $nGy.h^{-1}$to 583 $nGy.h^{-1}$ with a mean value of 434.6±83 $nGy.h^{-1}$. The higher value of gamma absorbed dose is observed at Rajanasiriyur granite quarry (ultrabasic rocks or green granite) near Halebeedu which contains relatively higher activity radionuclides. The higher value is also observed at one location of Tagadur chromite mines. This may be due to titanium ferrous magnetite available at that area which has higher concentration of radionuclides. The lower value of gamma absorbed dose was observed at another location of Tagadur chromite mine where only chromite (or) chromium trioxide is available at that area this has lower activity of radionuclides. The outdoor equivalent effective dose to the publics at different mines and granite factories in Hassan district are varies from 0.37 $mSv.y^{-1}$ to 0.71 $mSv.y^{-1}$ with a mean value of 0.53±0.1 $mSv.y^{-1}$.

Conclusion:

The findings of this study established that gamma radiation levels in the dwellings constructed in and around rocky area and local soil type and at different mines and granite factories were found to be relatively high compared to the surroundings and normal background regions across the world. A detailed study on the radiation dose to the public's and workers around the granite industries and mining area is required.

Table: 1. Average indoor and outdoor gamma absorbed dose and equivalent effective dose at different parts of the Hassan district.

Sl. No.	Place	Exposure rate ($\mu R.h^{-1}$)		Absorbed dose ($nGy.h^{-1}$)		Equivalent effective dose ($mSv.y^{-1}$)		Total dose ($mSvy^{-1}$)	Ratio Indoor/ Outdoor
		Indoor AM±SD	Outdoor AM±SD	Indoor	Outdoor	Indoor	Outdoor		
	BELUR								
1	Channakeshava temple	13±5	36 ±13	113	313	0.55	0.38	0.93	1.44
2	Near Police station	35±7	18±8	304	156	1.49	0.19	1.68	7.78
3	Central part of the city	36±5	20±5	313	174	1.53	0.21	1.74	7.21
	HALEBEEDU								
4	Govt. First grade College	14±6	19±5	122	165	0.59	0.2	0.8	2.94
5	Halebeedu Shiva Temple	10±4	23±4	87	200	0.42	0.24	0.67	1.74
6	Central part of the city	20±3	9±4	174	78.3	0.85	0.09	0.95	8.89
	HASSAN CITY								
7	Northern extension	27±8	18±4	235	156	1.15	0.19	1.34	6
8	Master control facility	38±5	47±4	330	409	1.62	0.5	2.12	3.24
9	Near Malnad Engg. college	40±5	28±6	348	243	1.7	0.29	2	5.73
10	Hassan new bus stand	41±4	34±5	357	296	1.75	0.36	2.11	4.83
11	Tannerahalla	29±4	21±8	252	183	1.23	0.22	1.46	5.52
12	Kuvempunagara	44±6	41±7	383	356	1.87	0.43	2.31	4.3
13	Mines & geology Dept.	48±10	38±6	417	330	2.04	0.4	2.45	5.05
	ARASIKERE								
14	Municipal office	37 ±7	32±5	322	278	1.57	0.34	1.92	4.63
15	Near Bus stand	26±10	29±5	226	252	1.1	0.3	1.41	3.59
16	Jain Swethambara temple	35±11	33±6	304	287	1.49	0.35	1.84	4.24
17	Prathibha college area	37±8	25±5	322	217	1.57	0.26	1.84	4.94
18	Municipal quarters	41±6	19±6	357	165	1.75	0.2	1.95	8.62
	HOLENARASIPURA								
19	Near Bus stand	30 ±8	28±6	261	243	1.28	0.29	1.57	4.3
20	General hospital	35±8	42±8	304	365	1.49	0.44	1.94	3.3
21	Pete beedi	19±6	33±9	165	287	0.81	0.35	1.16	2.3
22	Govt. PU college for girls	27±9	30±9	235	261	1.15	0.32	1.47	3.6
23	Near Channambika circle	34±9	25±6	296	217	1.45	0.26	1.71	5.46
	CHANNARAYAPATTNA								
24	Near Bus stand	50±10	43±7	435	374	2.13	0.45	2.59	4.66
25	B M Road Kote area	56±5	48±6	487	417	2.38	0.51	2.90	4.17
26	Navodaya College	52±4	46±4	452	400	2.22	0.49	2.71	4.53
27	Raghavendra mutt	22±6	24±4	191	209	0.93	0.25	1.19	3.67
	Mean	**33.18±12**	**30±10**	**288±10**	**260.4±88**	**1.41±0.5**	**0.31±0.1**	**1.735±0.5**	**4.7**
	Maximum	**56±5**	**48±6**	**487**	**417**	**2.38**	**0.51**	**2.9**	**8.89**
	Minimum	**10±4**	**9±4**	**87**	**78.3**	**0.42**	**0.09**	**0.671**	**1.44**

Table: 2. The average gamma absorbed dose and equivalent effective dose at different mines and granite factories in Hassan district.

Sl. No.	Place	Exposure rate ($\mu R.h^{-1}$)	Absorbed dose ($nGy.h^{-1}$)	Equivalent effective dose ($mSv.y^{-1}$)
		Outdoor	**Outdoor**	**Outdoor**
1	Rajanasiriyur Quarry Near Halebeedu	67±15	583	0.71
2	Katihally (MML) Hassan	45±10	391.5	0.48
3	Bageshpura (MML) Clay mines(Near Arasikere)	55±11	478.5	0.58
4	Nuggenahally chromite mines office	48±8	417.6	0.51
5	Tagadur chromite mines Location-1	35±5	304.5	0.37
6	Tagadur chromite mines Location-2	60±10	522	0.64
7	Kothari Marbles (Hassan)	48±9	417.6	0.51
8	Industrial area Asian granite (Hassan)	42±6	365.4	0.44
	Mean	**50±9**	**434.6±83**	**0.53±0.1**
	Maximum	**67±15**	**583**	**0.71**
	Minimum	**35±5**	**304.5**	**0.37**

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