Indian Journal of Pure & Applied Physics
Vol. 48, November 2010, pp. 817-819

Natural radioactivity levels in granite regions of Karnataka State

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Received 17 July 2010; revised 16 August 2010; accepted 1 October 2010

The activities of ^{226}Ra, ^{232}Th and ^{40}K and natural radiation levels have been measured at granite regions of Karnataka State, India using HPGe detector and scintillometer. In granite region ^{232}Th activity is high compared to ^{226}Ra. The data shows that the activities of ^{226}Ra, ^{232}Th and ^{40}K and ambient γ-radiation level were found to be high in comparison to global and Indian average[1].

Keywords: Radionuclides, Dose, HPGe detector, Scintillometer

1 Introduction

Radiation is a part of the world around us and unlike popular belief it does not occur only at the site of nuclear reactions. But no place on the earth is completely free from radiation. Ionizing radiation is harmful to human beings and mankind must be protected from unnecessary or excessive exposure[1]. The knowledge of distribution of radionuclides and radiation levels in the environment is important for assessing the effects of radiation exposure due to both terrestrial and extra terrestrial sources. People living in granite area or in mineralized sands receive more terrestrial radiation than the others, while people living or working at high altitude receive more cosmic radiation[1]. The irradiation of human body from external sources is mainly by gamma radiation from ^{40}K, ^{226}Ra and ^{232}Th series.

Many researchers have been actively involved in the field of environmental radioactivity and radiation levels in the last few decades in our country[2-4]. But in Karnataka state there is no significant work done except a survey[5]. This survey indicates that the granite rocks, which are used as building materials and gneiss rich in primordial radionuclides occupy major portion of Karnataka State[6]. In view of the fact that the measurement of γ-radiation level, activity of radionuclides in soil and rocks and estimation of equivalent effective dose due to these radionuclides in granite region is very essential to assessing the health risk due to radiation exposure.

The area of the present study is granite region of Karnataka State. It includes Chamundi granite of Mysore District; Ramanahally, Alanahally, Maralebekuppe, Maharajakatte and Kabballi of Bangalore rural District; Koratagere, Madhugiri Taluck of Tumkur District and Kote of Chitradurga District in Karnataka State, India.

2 Experimental Details

The gamma ray spectrometry method was used to estimate the activity of ^{226}Ra, ^{232}Th and ^{40}K in the soil and rocks. The activity of radionuclides[6] was calculated using the following Eq. 1:

$$\text{Activity}\left(\text{Bqkg}^{-1}\right) = \frac{(s \pm \sigma) \times 100 \times 1000 \times 100}{EWA} \quad \ldots (1)$$

where s is the net counts/s under the photo peak of intensity, σ is the standard deviation of s, E is the counting efficiency (%), A is the gamma abundance (%) of the radionuclides and W is the mass of the sample (kg).

The dose rate in air due to radionuclides was calculated by using the following equation[1]:

$$D\left(n\text{Gyh}^{-1}\right) = 0.462A_{\text{Ra}} + 0.604A_{\text{Th}} + 0.0417A_{\text{K}} \quad \ldots (2)$$

where A_{Ra}, A_{Th} and A_{K} are the activity concentrations of radium, thorium and potassium.

Ambient gamma radiation levels were measured by using scintillometer. The exposure rate (μRh^{-1}) was converted into dose rate[7] (nGyh^{-1}) using conversion factor of $1\mu Rh^{-1} = 8.7\ n\text{Gyh}^{-1}$.

Table 1 — Activity concentration of radionuclides in soil and rock samples, estimated and measured absorbed gamma radiation dose

Location	Sample	Average activity of radionuclides (Bq kg^{-1})			Gamma absorbed dose rates (nGyh^{-1})	
		^{226}Ra	^{232}Th	^{40}K	Calculated*	Measured
Chamundi granite	Soil	60.0±1.4	45.0±1.2	257.0±5.8	101	134
	Rock	64.0±1.3	76.0±1.5	1096.0±11.2		
Ramanahally	Soil	45.3±1.2	119.6±1	920.0±9.8	147	186
	Rock	62.7±1.4	144.0±2.3	1100.0±10.2		
Alanahally	Soil	46.3±1.2	121.4±1.9	553.0±6.7	135	178
	Rock	70.0±1.3	145.0±2.5	757.0±7.4		
Maralebekuppe	Soil	50.0±1.1	92.2.0±2.0	1031.0±10.6	285	316
	Rock	165.0±1.9	530.0±3.0	1250.0±12.4		
Maharajakatte	Soil	36.4±1.0	54.6±1.2	850.0±9.2	130	194
	Rock	42.0±1.0	189.2±2.6	1012.0±10.3		
Kabballi	Soil	28.4±1.0	30.9±1.0	461.0±7.2	54	85
	Rock	32.4±1.0	36.9±1.0	485.0±7.0		
Siddaganga hills	Soil	41.0±1.3	26.0±1.0	386.0±6.8	70	95
	Rock	75.0±1.5	60.0±1.2	400.0±6.8		
Koratagere	Soil	35.0±1.2	44.0±1.1	589.0±5.8	91	128
	Rock	75.0±1.4	70.0±1.5	916.0±9.8		
Madhugiri	Soil	36.0±1.1	40.0±1.2	1100.0±9.8	102	132
	Rock	59.0±1.2	65.0±1.2	1190.0±9.9		
Chitradurga Kote	Soil	60.0±1.2	46.0±1.1	880.0±8.8	106	155
	Rock	69.0±1.3	67.0±1.3	1120.0±9.4		
Minimum		28.4±1.0	26.0±1.0	257.0±5.8	54	85.0
Maximum		165.0±1.9	530.0±3.0	1250.0±12.4	285	326
Geometrical mean		52.9±1.3	73.8±1.8	750.1±9.8	110.7	150.4

*Total gamma dose calculated from the activities of ^{226}Ra, ^{232}Th & ^{40}K. This does not include cosmic ray component

3 Results and Discussion

The activity of radionuclides in soils and rocks at granite regions of Karnataka State, absorbed dose due to these radionuclides and ambient gamma radiation dose are presented in Table 1.

The maximum activity of radionuclides were found in granite rocks of Maralebekuppe and Alanahally of Bangalore rural District. These regions are attributed by pink granite. These rocks are younger than altered and gray granite rocks. The gamma absorbed dose mainly depends on activity of radionuclides present in soils and rocks. Hence higher gamma radiation dose was observed in these regions when compared to other regions[8].

In Chamundi granite of Mysore, Koratagere and Madhugiri of Tumkur District, slightly less concentrations of radionuclides were observed compared to Maralebekuppe and Alanahally of Bangalore rural District. The types of rocks in these regions are gray granites. The gray granite consists of low concentrations of ^{226}Ra, ^{232}Th and ^{40}K compared to pink granites. Thus, slightly less absorbed gamma dose and measured gamma radiation dose have been observed in these regions.

The lower activity of radionuclides were observed in Maharajakatte and Kabballi of Bangalore rural district. The types of rocks in this region are altered granites and dolerites. These rocks overlap the pink granites. Thus lower activity of radionuclides and less gamma absorbed dose were observed.

The maximum activity of ^{40}K was observed in Maralebekuppe and Ramanahally village of Bangalore district, Madhugiri of Tumkur district and Kote of Chitradurga district. The potassium bearing minerals in granites are feldspar, orthoclase, muscovite, biotite and mica. The abundance of potassium to some extent is proportional to silica content of the rocks. Since silica content of granite is high, we observe higher value of ^{40}K. The average values of ^{226}Ra, ^{232}Th and ^{40}K concentration reported for normal background areas of Indian soil are 15, 18.36 and 369.6 Bq.kg^{-1} and the corresponding world average are 30, 45, 420 Bq.kg^{-1}, respectively[9-12].

4 Conclusions

It is established that the exposure of human population to natural radiation sources is more significant than that due to artificial sources. The average activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K in soil and rocks samples are found to be high in comparision to Indian and global average[1,7]. Gamma radiation levels in granite region were found to be relatively high compared to the surroundings and normal background regions across the world. But they

were low in comparision to high background areas (Kerala, Brazil and Italy). The measured values of ambient gamma radiation are comparable with the estimated gamma radiation dose due to radionuclides.

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