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Radium Studies in Sand Samples Collected from Sea Coast of Tirur, Kerala, India Using LR-115 Plastic Track Detectors

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Abstract: Radium is naturally occurring solid radioactive element in the earths surface and it is chemically similar to calcium and is absorbed from soil by plants and passed up the food chain to humans. High intake or body exposure to radium causes serious health hazards and may result in bone cancer. Track etch technique has been used with LR-115 type II plastic track detector to measure the effective radium content of sand samples collected from the sea coast (Unniyal beach) of Tirur of Malappuram district of Kerala state (India). The value of effective radium content ranges from 45.6 to 226.1 Bq/Kg with an average of 111.9 Bq/Kg. The content of radium observed in the samples of this region is insignificant regarding health related concern.

Keywords: Kerala; sand sample; LR-115 type II plastic track detector; track etch technique; radium.

1. Introduction

During the last decade, there has been an increasing interest in the study of radium activity in various building materials. Since radium is a highly radioactive chemical element and it is the most important source of radioactivity in the coastal areas. Radium is a solid radioactive element under ordinary conditions of temperature and pressure [1]. Radium is chemically analogous to calcium, and is absorbed from soil by plants and passed up the food chain to humans. Microscopic quantities of radium in the environment can lead to some accumulation of radium in bone tissue whereby it degrades bone marrow and can mutate bone cells. Ingestion or body exposure to radium causes serious health effects which included sores, anemia, bone cancer and other disorders [2]. ^{226}Ra is a product of ^{238}U decay series. Emitted energy from the decay of radium causes vexed on the skin and produces many other detrimental effects. Radium is a naturally occurring radioactive metal moreover it is present in soil, sand, rock, water, plants and animals. Sand is used as a construction material in buildings. Higher values of radium in sand contribute significantly in the enhancement of indoor radon in dwellings [2]. It has been estimated that each square kilometer of the earth surface (to a depth of 40 cm) contains 1 gram of radium [3]. Radium is one million times more radioactive than the same mass of uranium. Its decay occurs in at least seven stages, the following main products were called radium emanation recognized as radon. Radon is a heavy gas and the later products are solids. These products are themselves radioactive in nature.

Proper knowledge of radioactive contents

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in construction materials is important since it allows calculating the exposure of the population to radiation from natural sources. In the light of the above facts the measurement of radium content in coastal and uranium rich areas is great importance for environmental and safety assessment. In the present study, track etch technique has been used with LR-115 type II plastic track detector to measure the effective radium content of sand samples collected from the sea coast (Unniyal beach) of Tirur of Malappuram district of Kerala state (India). The study area lies between 8˚30'26.64"N and 76˚58'19.2"E.

2. Materials and methods

Beach sands have been occurring in polyethylene bags by using grab sampling method along the coast with an average width ranging from 0.5 to 1 km. Some samples were collected from out water and some from 1 feet depth.

2.1. Measurements of effective radium content

"Sealed can technique" has been used [4, 5]. The collected samples were dried in an oven about 12 hrs at 150˚C, to remove moisture. Dried sample 0.10 Kg was placed at the bottom of the plastic can. The geometry of the can is 7cm diameter and 7.5 cm height and closed for a period of one month in order to get equilibrium. Once the radioactive equilibrium is over, the detector is fixed inside the lid of the can with the help of transparent adhesive tape, in such a way as to allow the coated side of the detector to face the soil sample. The size of the LR-115 type II plastic track detector is 1.5 × 1.5 cm. The cans sealed tightly for 90 days. Thus the coated side of the detectors were exposed independently to the alpha particles from the decay of radon in diffusion process in the empty part of the Can and from Po ^{218} and Po ^{214} deposited on the inner walls of the Can [5]. After the exposure period the detectors were etched in 2.5 N NaOH solution at 60˚C for a period of 1 hour and 30 minutes in a constant temperature water bath used for visualization of tracks. The detectors were washed and dried for ten minutes. The etching process removes a bulk thickness of 4μm remaining a residual detector thickness of 8μm [6]. The tracks was observed and counted by using microscope with a magnification of 400×.

Once the radioactive equilibrium is over after closing the can the activity concentration of radon begins to increase with time T [2]. According to the relation

$$C_{Rn} = C_{Ra}\left(1 - e^{-\lambda Rn T}\right) \quad (1)$$

Where, C_{Ra} is the effective radium content of the sample, λ is the decay constant for Radon.

The track detector efficiency depends on the radius and height of the used Can [2].

The radium concentration was calculated by using this formula

$$C_{Ra} = \frac{\rho h A}{KTeM} \quad (2)$$

where, ρ is track density (track /cm^2), h is distance between the detectors and top of the sample in cm, A is surface area of the sample in cm^2, K is the sensitivity factor (0.02 tracks cm^{-2} d^{-1} per Bq m^{-3}). T_e is the effective exposure time:

$$T_e = \left[T - \lambda_{Rn}^{-1}\left(1 - e^{-\lambda Rn T}\right)\right] \quad (3)$$

3. Results and discussion

Table 1, represents the values of effective radium content of sand samples collected from sea coast Tirur (Unniyal beach) of Malappuram district of Kerala state (India). The value of radium concentration ranges from 45.6 to 226.1 Bq/Kg with an average of

111.9 Bq/Kg and a standard deviation 44.4. These values are higher than the values found by [1, 9] while are lower than those reported in the sand of Chhatrapur beach, Orissa and Brazilian beach [2, 8]. As the sand is the basic ingredient used in construction materials in India. By mixing it with cement, sand is commonly used as a building material for fired clay and fly ash bricks for the construction of walls and also as a plastering material. It is also used in the manufacturing of concrete.

The deposit comprise of pure white quartz sands, dirty white silt, silty sand, grey to dark grey sands, redtery sands made up of fine to medium grained sands with ilimonate, monazite, rutile, zircon, leycoxene (brown ilmenite), sillimanite and garnet. The radioactive component of Kerala beach sand is monazite, which contains thorium (8-10%, highest in the World) and its radioactive daughter products [7]. The study was carried out for residents of Kerala. The residents are exposed to a naturally occurring radiation dose ten times higher than the worldwide average [10]. There are similar natural radiation area in southern China, Iran and Brazil, but the Kerala coast in southern India is believed to be the only high radioactivity region with a high population density [10]. It is clear from the table that all samples having radium content less than 370 Bq /Kg are advisable to be used in construction of dwellings [11]. Thus, results reveal that the area is safe as far the health hazard effects are concerned.

4. Conclusion

The values of effective radium content was found to be in the range of 45.6 to 226.1 Bq/Kg of samples which is less than the permissible value of 370 Bq/Kg are advisable to be used in construction of dwellings. Thus, results reveal that the radioactive levels of these areas are below the level specified by OECD. It is observed that the area is safe as far the health hazard effects are concerned.

Table 1. Effective radium content in different sand samples collected from sea coast of Tirur, Kerala, India

S. no.	Sample code	Effective Radium content C_{Ra} (Bq / Kg)
1.	Beach-15	45.6
2.	Beach-16	54.8
3.	Beach-8	75.7
4.	Beach-17	82.1
5.	Beach-14	84.0
6.	Beach-3	89.3
7.	Beach-11	94.0
8.	Beach-12	101.3
9.	Beach-2	102.1
10.	Beach-7	103.0
11.	Beach-1	109.4
12.	Beach-4	110.3
13.	Beach-6	113.0
14.	Beach-5	120.3
15.	Beach-19	134.2
16.	Beach-13	135.1
17.	Beach-18	139.6
18.	Beach-9	206.0
19.	Beach-10	226.1
Average Value		111.9
Standard deviation		44.4
Rel. std. %		39.7

Table 2. Radium content of building materials from India and other countries

Material	Country	Average activity content of ^{226}Ra (Bq Kg^{-1})
Brick	Norway	104.0
	U K	52.0
	USSR	55.5
	W. Germany	59.0
	Finland	778.0
	India	48.1
Cement	Norway	30.0
	U K	22.0
	USSR	25.9
	W. Germany	25.9
	Finland	44.4
	India	86.0
Granite	USSR	14.8
	W. Germany	104.0
	U K	89.0
	India	30.0
Sand (Gravel)	U K	7.4
	Finland	37.0
Present study	India	111.9

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