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Data Article

Determination of natural radioactivity and radiological hazards of sediment sands in Tiruchirappalli district, Tamil Nadu, India

R. Hariprasath[a], M.T. Jose[b], I. Vijayalakshmi[b], A. Leo Rajesh[a,*]

[a] Department of Physics, St. Joseph's College, Tiruchirappalli, Tamil Nadu, India
[b] Radiological Safety Division, Indira Gandhi Centre for Atomic Research, Kalpakkam, Tamil Nadu, India

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ABSTRACT

In Tamil Nadu, India, sand from river beds are being used as a part of construction material. The radiological impact of natural radioactive materials present in river sands in Tiruchirappalli District are measured using gamma-ray spectroscopy. The average activity concentrations of ^{238}U, ^{232}Th and ^{40}K are measured to be 9.91 ± 4.74 Bq kg^{-1}, 18.30 ± 4.17 Bq kg^{-1} and 309.51 ± 23.23 Bq kg^{-1}, respectively. The average values of radiation hazards such as radium equivalent, hazard index, annual effective dose equivalent and annual gonadal dose equivalent are 55.29 ± 11.45 Bq kg^{-1}, 0.14 ± 0.02 and 0.19 ± 0.05 (Hex and Hin), 31.96 ± 5.85 μSv y^{-1} and 127.84 ± 23.4 μSv y^{-1} (outdoor and indoor) and 187.78 ± 30.60 μSv/y^{-1}, respectively. These values are compared with the international and Indian standard values and they lie below the recommended limits. Hence the sediment sand samples do not pose any significant radiological concern and could be used for construction purposes.

* Corresponding author. Tel.: +91 9444122070; fax: +91 4312701501.
E-mail address: aleorajesh@gmail.com (A.L. Rajesh).

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Specifications table.

Subject area	*Physical chemistry*
Sediment	*Sediment sand along the rivers*
Data category	*Spectral*
Dataacquisition format	*NaI (Tl) Gamma ray spectroscopic analysis (Nucleus PCAII – multichannel analyzer)*
Data type	*Analyzed*
Procedure	*Emission of radionuclides in sediments*
Data accessibility	*Data is with this article*

1. Rationale

Sediments from the rivers mostly consists of silicate and minerals with high cation exchange capacity. The radionuclides in the sediments are retained by the clay particles and as the sediments are used along with other building materials, they act as a medium of migration to transfer these radionuclides to the biological system. The present study is to assess the specific activity of primordial radionuclides (^{238}U, ^{232}Th and ^{40}K) and its radiological hazard indices in the sediments of Cauvery and Kollidam rivers in Tiruchirappalli district, Tamil Nadu, India, where the sediment sand is transported to other parts of the Tamil Nadu which is used along with other construction materials. The values obtained in the study area can be used as a baseline data for radioactivity.

2. Experimental procedure

The activity concentration of primordial radionuclides ^{238}U, ^{232}Th and ^{40}K in the sediment samples are measured using NaI(Tl) detector based gamma ray spectrometer. The size of the detector is 3″ x 3″ and the resolution is about 7.5% at 662 keV. The detector is shielded by 15 cm thickness of lead on all four sides and 10 cm thickness of lead on the top to reduce the back ground radiation in the lab. The schematic diagram of NaI(Tl) based gamma rays spectrometer is shown in Fig. 1.

While recording the spectrum, the samples are placed in the lead shield that has a shielding efficiency of 95%. The output of the detector is analyzed by PC based multichannel analyzer (Nucleus PCAII). Using standard reference materials of 250 ml containers procured from International Atomic Energy Agency (IAEA) for Uranium (1997.56 Bq), Thorium (1237.28 Bq) and KCl (5181.59 Bq) the gamma ray spectrometer was calibrated. All the samples were counted for 10,000 s and the spectra were observed for uranium, thorium daughter products and potassium. The system is also calibrated using three reference materials of 250 ml containers from IAEA (a known radioactivity of, soil 6; a uranium ore sample, RGU1 and a thorium sample, RGTh1).

3. Description of procedure

30 sediment samples (S1-S30) have been collected from both Cauvery and Kollidam rivers in Tiruchirappalli district. Each sample weight approximately 3 kg (wet sample). The samples are then dried in a hot air oven for about 120 °C for about 90 min to remove the moisture content in it and then sieved with a 1 mm mesh to remove stones, pebbles and other macro impurities. The homogenous sample is packed in a 250 ml PVC container of standard measurements (approximately 9 cm in height and 6.5 cm in diameter). It is then hermetically sealed to prevent the radioactive gases (^{222}Rn and ^{220}Rn) from the decay products of ^{238}U and ^{232}Th. The packed containers weighed about 400–500 g and left undisturbed for 4 weeks to attain a secular equilibrium between ^{228}Ra, ^{226}Ra and its daughter products. The exact net weight of samples was determined by a weighing balance before counting.

The activity concentrations of the primordial radionuclides were determined using the counting spectra of each sample. Natural radionuclides relevance for this work are mainly gamma ray emitting radionuclides in the decay series of ^{238}U and ^{232}Th and singly occurring radionuclides ^{40}K. The sample that had attained secular equilibrium was kept on the top of the NaI(Tl) detector and counted for a period of 10,000 s. From the gamma ray, 1.76 MeV of ^{214}Bi and 2.614 MeV of ^{208}Tl, the specific activity of ^{238}U and ^{232}Th were estimated as they are alpha emitters. The specific activity of ^{40}K was