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Identification of Radio Nuclides in Soil Samples from selected Locations in Kerala, India

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Abstract

Environmental radioactivity is an unavoidable phenomenon and is definitely harmful to all living organisms. It is non uniformly distributed in earth's crust and Kerala is considered as one of the high back ground radiation areas. The present study is initiated with the objective of detecting various radio nuclides present in the soil from five different places in the districts of Thrissur and Malappuram in Kerala, using Scintillation detector Nay(Tl), connected to multi channel analyzer. The samples were analyzed using gamma ray spectroscopic method and the photo peaks from the spectrum indicates the presence of lead (^{212}Pb, ^{214}Pb), actinium (^{228}Ac), bismuth(^{214}Bi) and potassium (^{40}K).

Keywords: Environmental radio activity, soil sample.

Introduction

Human beings are continuously exposed to natural radiation coming from cosmic ray sources and terrestrial sources such as ^{238}U and ^{232}Th series, and singly occurring ^{40}K. The radio nuclides in the two series have short half lives, they are still important because they are continuously produced by their long lived parents through many decay modes. It is non uniformly distributed on earth's crust. Some areas of world are known as High Back Ground Radiation Areas where radiation levels are more than the other parts of world due to the presence of radio active minerals present in natural sources such as rock, soil, minerals. The well documented data regarding high natural background radiations are obtained in places like Guarapari in Brazil, Yangjiang in Chin, Chavara and Manavalakurichi in India, and Ramsar in Iran. There has been an increasing interest in understanding the natural radiation levels present in natural sources and building materials since the last few year. It is necessary for evaluating the risk due to low level radiations exposed to public with the increased concern over radiation safety.

Material and Methods

The samples were selected from the regions near Thrissur and Malappuram which are located near the northern zone of kerala. The sample type and regions are listed: i. Beach Sand Sample - Kottapuram Kota (Thrissur), ii. The Laterite Soil -Kottappuram (Thrissur), iii. Soil Sample-Ponnani (Malappuram), iv. Soil Sample-Puthu ponnani (Malappuram), v. Soil Sample-.Kodungalloor (Thrissur).

Collected samples were from about one meter beneath the ground. Archaeological studies by State Archaeological Department is now going on at Kottapuram Kota, Thrissur (Pattanam excavation) for estimating the age of historical monuments found at that site. The samples collected were dried in an oven at a temperature of about 100°C for five hours to remove the moisture content in it. Dried samples were then finely powdered in a mortar. Finely powdered samples are packed in a polythene bags and were sealed using Araldite to prevent the escape of radon from the sample[1]. All samples were stored for about four weeks before gamma analysis is performed. This is to allow ^{226}Ra and its short lived progenies to reach secular equilibrium[2]. ^{226}Ra is an intermediate member of the decay series whose half life is shorter than its parent nuclide.

Natural radio activity in the selected samples were studied using scintillation detector (NaI(Tl)) and it is more often used for gamma ray spectroscopy[3] . The detector system consists of a single crystal of thallium activated sodium iodide NaI(Tl) and a photo multiplier tube, amplifier and a multichannel analyser. Collected samples were subjected to analysis with the help of PHAST PC- 8K software. The detector is shielded using lead blocks to minimise the background radiation effects. The samples were counted for a period of 18000s.

The spectrum was analysed by gamma ray spectroscopic method. Each gamma ray photon has descrete energy, and this energy is characteristic of source isotope. We can determine the source of radiation by measuring the energies of gamma ray photon. For Gamma rays of natural terrestrial origin and for matter comprising rock, water and air, compton scattering is dominant interaction process[4]. The main gamma energy peak recorded in a detector is called photo peak which results in full absorption of the gamma photon energy in the crystal. Any source whose peaks are known can be used to do energy calibration. From the calibration graph, the gamma ray energies of radionuclides present in the samples are found out. These energy values are compared with the standard values of the

radionuclide series given in the table 1 to identify unknown radionuclides.

Table-1
^{238}U and ^{232}Th Series and Primordial Gamma lines[5]

Series	Nuclide	Energy (keV)
^{238}U (^{226}Ra)	^{234}Th	63.24
	^{214}Pb	77.11
	^{226}Ra	186.21
	^{214}Pb	351.93
	^{214}Bi	1120.29
	^{214}Bi	1847.42
^{232}Th	^{212}Pb	238.63
	^{228}Ac	440.44
	^{208}TI	510.7
	^{228}Ac	651.51
	^{228}Ac	674.16
	^{228}Ac	968.97
	^{228}Ac	1430.95
^{40}K	^{40}K	1460.39

Results and Discussion

The energy calibration of the counting system helps the identification of unknown radionuclides. The energy calibration is done by analyzing sources emitting photons of known energy and plotting the channel number where the full energy peaks occur against the energy spent by the photons in the detector. The following table lists the sources used for calibration.

Table-2
Sources used for the energy calibration of spectrometer

Source	Energy(E) in keV
^{133}Ba	356
^{22}Na	511
^{137}Cs	662
^{60}Co	1173
^{22}Na	1274
^{60}Co	1332

With the calibration, we found the energy values corresponding to the channel number of the identified photo peaks in the spectrum of the samples analyzed. From the found energy values, the nuclides which are responsible for emitting these gamma lines were identified as given in the reference table-1, which gives various gamma lines in the Uranium and Thorium series.

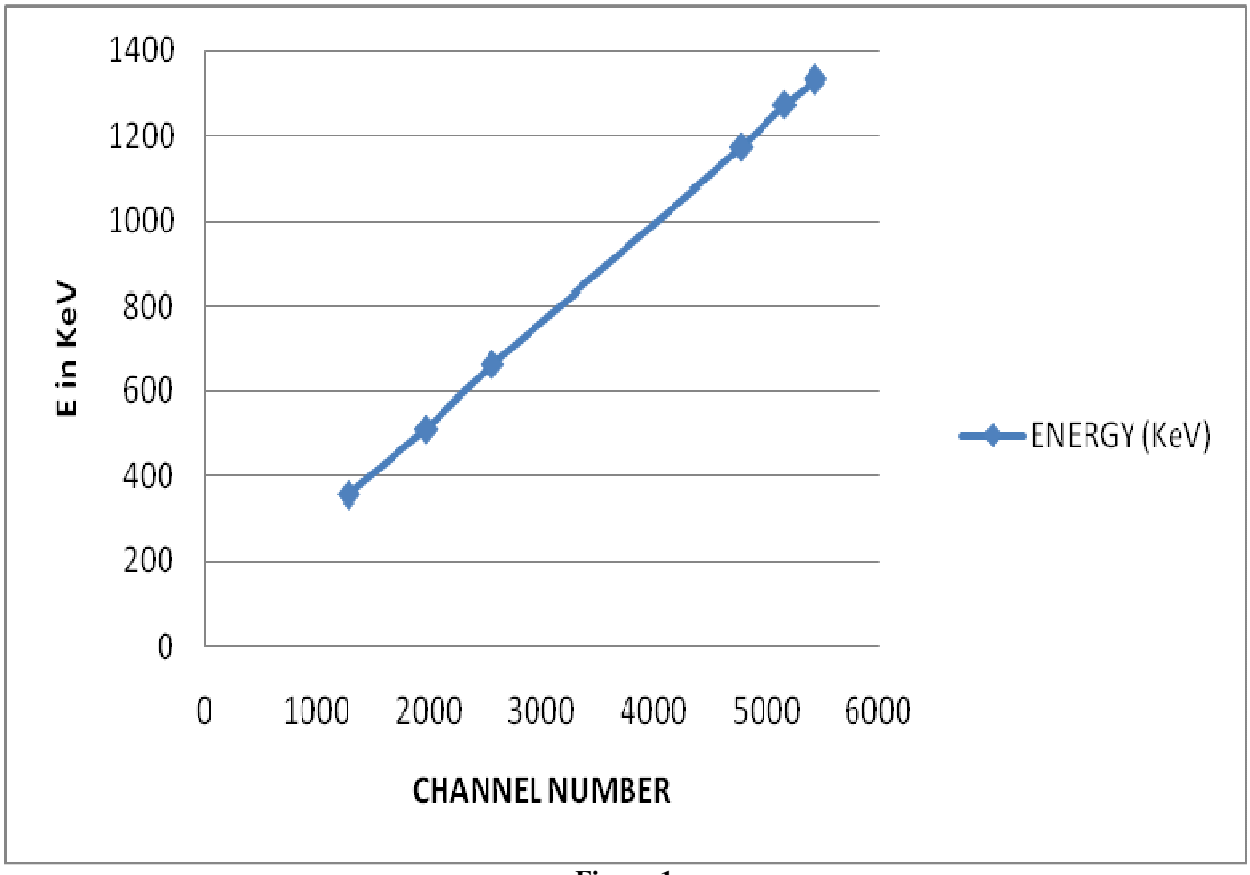

Figure-1
Calibration graph shows relation between channel number and energy

Table- 3
Radio nuclides present in the Beach Sand Sample -Kottapuram Kota(Thrissur) and their parents

Channel	Energy (keV)	True Energy (keV)	Nuclide	Source
807	242.98	238.63	^{212}Pb	^{232}Th
1244	346.42	351.93	^{214}Pb	^{226}Ra
2558	657.44	651.51	^{228}Ac	^{232}Th
3892	973.19	968.97	^{228}Ac	^{232}Th
5896	1447.53	1460.39	^{40}K	^{40}K

Table -4
Radio nuclides present in the Laterite Soil –Kottappuram (Thrissur) and their parents

Channel	Energy (keV)	True Energy (keV)	Nuclide	Source
870	255	250	^{212}Pb	^{232}Th
2634	675	651.51	^{228}Ac	^{232}Th
4609	1150	1120.29	^{214}Bi	^{238}U(^{226}Ra)
5943	1430	1460.39	^{40}K	^{40}K

Table -5
Radio nuclides present in the Soil Sample-Ponnani (Malappuram) and their parents

Channel	Energy (keV)	True Energy (keV)	Nuclide	Source
842	250	238.63	^{212}Pb	^{232}Th
2599	660	651.51	^{228}Ac	^{232}Th
3744	930	968.97	^{228}Ac	^{232}Th
6013	1450	1460.39	^{40}K	^{40}K

Table- 6
Radio nuclides present in the Soil Sample Puthuponnani (Malappuram) and their parents

Channel	Energy (keV)	True Energy (keV)	Nuclide	Source
883	260.77	238.63	^{212}Pb	^{232}Th
1273	352.74	351.93	^{214}Pb	^{238}U(^{226}R)
1381	378.2	351.93	^{214}Pb	^{238}U(^{226}R)
2476	636.43	651.51	^{228}Ac	^{232}Th

Table -7
Radio nuclides present in the Soil sample-Kodungalloor (Thrissur) and their parents

Channel	Energy (keV)	True Energy (keV)	Nuclide	Source
884	261.01	238.63	^{212}Pb	^{232}Th
2609	667.81	674.16	^{228}Ac	^{232}Th
3764	940.18	968.97	^{228}Ac	^{232}Th
5185	1275.29	1120.29	^{214}Bi	^{238}U(^{226}R)
5920	1448.63	1460.39	^{40}K	^{40}K

Conclusion

A detailed study generally involves the identification of the elements and the determination of the activity concentrations of the radionuclides in various samples. This study can be considered as the first step towards a detailed study of the radionuclides in the soil. The spectra of five soil samples spectrum were analysed using Gamma ray spectroscopic method and the corresponding radio nuclides were identified. It is seen that ^{212} Pb and ^{228}Ac are common in all samples. The presence of ^{214}Bi is seen in Thrissur samples especially in Kottappuram and Kodungalloor[40]. K is found in all samples except that from Puthuponnani. The presence of daughter nuclides of ^{238}U, ^{232}Th series and ^{40}K identified in the samples

of soil show an important significance. The main reason is that the natural radioactivity and its variation in the sources are due to their geological origin.

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