Study of background radiation and environmental radioactivity using high purity germanium detector

Shubhangi T.Mane[1],* Dibyadyuti Pramanik[2], T. B. Mane[3], A.K.Sharma[4] Maitreyee Nandy[5]

[1] *S.S.P.M.'S College of Engineering, Kankvali, Maharashtra state , INDIA*

[2.5]*Saha Institute of Nuclear Physics, Kolkata,,*

[3]*Shri S.H.Kelkar College of Arts Commerce &Science ,Devgad.*

[4]*Department of Physics, Shivaji University, Kolhapur,*

*****e*mail: mane.shubhangi@yahoo.co.in*

Introduction

Radioactive nuclei are present all over the earth, in soil, water and atmosphere. Most of them have natural origin, such as primordial radionuclide U-238, U-235, Th-232 and their decay chain up to one of the stable isotope of Pb. K-40 and Rb-87 are intense primordial radionuclide. Many other light and moderately heavy radionuclides of natural and cosmogenic origin are present in soil, water, atmosphere and in materials. The major equilibrium concentration of background radiation in the Earth's atmosphere contains gamma ray flux. The distribution of naturally occurring radioactive elements vary from place to place, depending on the types of rocks and soil. Therefore, the level of natural background ionizing radiations depends upon the geological and geographical conditions. Estimation of natural background radiation level has become an important part of national and international environmental radiation survey.

In this work we have attempted to assess the radionuclides present in soil samples from Maharashtra state using gamma spectrometric analysis [1,2]. We have recorded gamma radiation spectrum of four soil samples collected from Sindhudurg district of Maharashtra using High Purity Germanium detector (HPGe) and identified the radionuclide present in the soil samples. The results obtained are presented in the paper.

Experimental Details

The gamma spectrum of four different soil samples were collected from different places of Sindhudurg district of Maharashtra state, India and recorded using HPGe detector at Nuclear Physics Division, Saha Institute of Nuclear Physics, Kolkata. The HPGe detector is a versatile tool for the gamma ray spectrometry and spectroscopy. The Falcon-5000 coaxial Broad Energy, HPGe (BEGe) detector which uses pulse tube cooling technology, manufactured by CANBERRA was used. It measures a wide range of gamma energies (20keV-3MeV). Additionally, it has low noise, good efficiency and resolution at lower energy resulting from a reduction in the loss of signal, preserving at the same time, good efficiency for higher energies. The detector system is coupled with a radionuclide identifier and with a location identifier. For collimation application FALCON 5000 can be used in conjunction with a 8mm thick Falcol (98.0% W, 1.71% C, 0.29% H) collimator. The density of "falcol" is 11 g/cc In the present work, we have used this option to carry out measurements. Energy calibration of the detector has been carried out using standard Eu-152 calibration source.

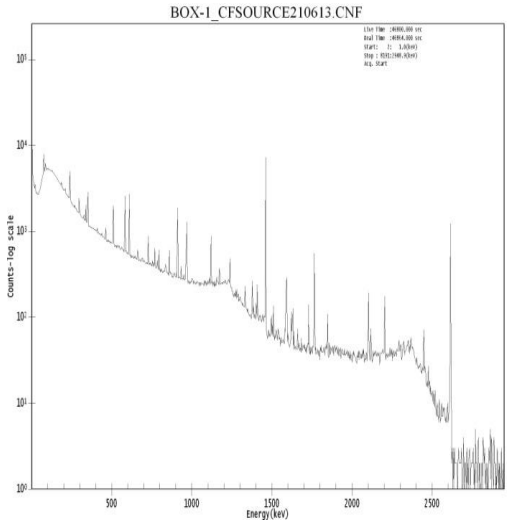
The soil samples were collected from a depth of 6 inches below the surface. The collected samples were dried in an oven at 100^0 C for 24 hours and then crushed and ground to fine powder and homogenized by passing through 250 µm test sieve. The samples were sealed, weighed and stored in an air-tight container for a period of 21 days for attainment of radioactive equilibrium. The samples were then analyzed for presence of gamma emitting radionuclide. In order to carry out this analysis, the room background gamma spectrum was first recorded. The spectra of the soil samples were recorded for a long counting time in such a way that the product of spectrum recording time and

weight of soil sample were kept constant. The analysis of spectra has been carried out by using the software ASCPC and NSCTSK software [3].

Results and Discussion

The recorded spectrum for the soil sample-1 is presented in figure 1. The background and soil sample spectra of each soil sample were normalized for the same counting time. The background spectrum was then subtracted from the spectra of each soil sample and it was used for the further analysis.

Fig. 1: Recorded spectrum of soil sample-1 with HPGe detector**.**



The resultant spectra were analyzed using the radionuclides analyzer software. Radionuclides contributing to different gamma rays spectral lines identified for soil sample 1 along with their total area counts are presented in table 1. We are carrying out further analysis for all the four samples for the activity of U-238 and Th-232 using the activities of their decay products in the decay chain. The K-40 activity from it's own activity (1460 keV).

Conclusion

Gamma spectroscopic analysis carried out so far indicates presence of Uranium, thorium and actinium series in the samples. Further analysis with regards to the presence of other radionuclides and concentration of different radionuclides in the samples are being carried out.

Table1: Identified radionuclides in soil sample1.

Sr No	Energy (keV)	Peak Counts	Tentative Nuclide
1	73.16	2.69E+4	Bi-211
2	75.19	2.63E+4	Pb-212
3	77.32	2.75E+4	Pb-212
4	209.38	1.39E+4	Ac-228
5	238.68	1.17E+4	Pb-212
6	295.19	7.93E+3	Pb-214
7	338.17	6.53E+3	Ac-228
8	351.78	6.25E+3	Pb-214
9	462.88	3.88E+3	Ac-228
10	609.13	3.15E+3	Bi-214
11	727.19	2.46E+3	Bi-212
12	911.06	2.36E+3	Ac-228
13	968.87	1.80E+3	Ac-228
14	1461.03	7.13E+3	K-40

Acknowledgement

We sincerely thank Prof. Maitreyee Saha Sarkar, Nuclear Physics Division, SINP, Kolkata for allowing us to work and providing guidance. We also thank Dr. Krishichyan, Nuclear Physics Division, SINP for providing technical help.

References

[1] A. K. Patra, J. Sudhakar, P. M. Ravi, J.P. James, A. G. Hegde, M. L. Joshi; Natural radioactivity in the geological matrices around Kaiga environment. J. Radioanal. Nucl. Chem. **270**, 307 (2006).

[2] G.Pinto, N.Karunakara, H. M. Somashekarappa, C. Rao, U. Prabhu, I. Yashodhara: Natural radioactivity in Udupi and Karkala Taluks of coastal Karnataka: Ind. Jour. Pure Appl. Phys. **48**, 527 (2011).

[3] R. K. Bhowmik (private communication)