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Analysis of natural Radionuclides in soil samples of Naushera area of Rajouri in Jammu Division

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Abstract: *Naturally occurring radioactive materials are widely spread in the earth's environment, being distributed in soil, rocks, water, air, plants and even within the human body. All of these sources have contributed to an increase in the levels of environmental radioactivity and population radiation doses. This paper presents the activity level due to the presence of^{226}Ra,^{232}Th and^{40}K in soil samples of Naushera area in Rajouri District. The measured activity of ^{226}Ra, ^{232}Th and ^{40}K in collected soil samples ofNausheraregion was found to vary from 13±10 to 55±10 Bq kg^{-1}, 14±9 to 101±13 Bq kg^{-1} and 150±81 to 1310±154 Bq kg^{-1}, respectively. The radium equivalent activity in collected soil samples was found to vary from 47 to 211 Bq kg^{-1}. The total absorbed gamma dose rate in this area was found to vary from 22 to 93 nGyh^{-1}. The distribution of these radionuclides in the soil of study area is discussed in details.*
Key Words: *Radionuclides, soil samples, ^{226}Ra, ^{232}Th and ^{40}K*

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I. Introduction

Soil is the upper part of the earth's crust and is formed as a result of rock deformation by physical and chemical processes, which include weathering decomposition, organic matter addition and water movement. It not only consists of organic and inor-ganic compounds but also includes radionuclides such as uranium, thorium, radium, potassium, etc., which constitute a background radiation. The back-ground radiation represents a considerable fraction of the total radiation exposure to the individual. The levels of natural background radiation dose rates vary from 1.4 to 2.4 mSv y^{-1} depending on the concentration of primordial radionuclides in the soil and the latitude and longitude of the place. The distribution of natural radionuclides and its radiological effects is most important factor for affecting the human living environment. In high background radiation areas, it may cause both external and internal effects. Moreover, the natural radionuclides are used for tracing tools for geologic-al processes because they show all type of geochemical behaviour in the environment. It plays an important role in the radiation protection measurement, geoscientific research and guidelines for use and management of these materials. Therefore, the knowledge of radionuclide distribution and radiation levels in the environment is important for assessing the effects of radiation exposure due to the presence of natural radionuclides. The objective of the present study is to measure the natural radio-activity levels and radium equivalent activities, absorbed dose rate dose in soil samples.

II. Study Area

The study area lies in the Naushera region in Jammu and Kashmir UT. This part of Rajouri has a fragile ecosystem. It has been observed that a large number of changes are found in this area in a year due to some cross border disturbances along with some areas of tectonic dislocations viz. fault and thrust zone and occurrence of natural disaster in the area. This hypothesis also suggests that organic composition of soil and rocks get modified. Due to this reason, the mineralogy of parent material influences the background radioactivity. The soil present in this area is generally dark brown in colour and rich in organic matter. The soil is highly drainage and affected by rain fall, soil erosion, cloud burst, earthquakes and landslides. During this process, the rocks are already under stress and are prone to the further dislocation.

Experimental techniques

Soil samples were collected from 6 locations in Nausheraarea(NAU 1-6). The collected soil samples were stored in polyethylene bags for transport and storage. All soil samples were air-dried naturally in the laboratory at room temperature for2 weeks and the organic materials, stones, plants, pebbles, debris and plant roots were removed before sieving. Then, the samples were dried in an electric furnace at 110•C and sieved through a sieve with mesh size of 150 mm. Each dried sample of 500g was packed in a Marinelli beaker of 500 ml capacity to allow uniform distribution of^{222}Rn and its decay products. These sample containers were stored for a period of 1 month before gamma-ray spectrometric analysis, so as to allow the establishment of secular equilibrium between ^{226}Ra and its decay products. The prepared soil samples were placed in a shielded gamma-ray spectrometry unit for a counting time of 3h. The measurement of natural radionuclides in soil samples was carried out using an NaI(Tl) gamma radiation detector of size 6363 mm with a multichannel analyser. The activity of ^{40}K was evaluated from the 1460-keV photo peak,the activity of ^{226}Ra from the 1764-keV gamma-ray line of ^{214}Bi and that of ^{232}Th from the 2610-keV gamma-ray line of ^{208} Tl. This spectral analysis was performed with the aid of computer software SPTR-ATC (AT-1315). The peak energies of the gamma-ray spectra were measured in reference to the 661-keV photo peaks of ^{137}Cs. The activity concentrations of these soil samples were calculated from the intensity of each line in the spectrum, taking into account the mass, geometry of the samples, counting time and efficiency of the detector.

III. Result And Discussion

Table-1 shows the activity concentrations of natural radionuclides in 6 soil samples. The measured activity of ^{226}Ra, ^{232}Th and ^{40}K in collected soil samples of Naushera area was found to vary from 13±10 to 55±10 Bqkg^{-1}, 14±9 to 101±13 Bqkg^{-1}and 150±81 to 1310±154 Bqkg^{-1}, respectively. The highest value of ^{226}Ra and ^{232}Th was found to be 55±10and 101±13 Bqkg^{-1}.The high value of potassium has been found in the sample NAU-5. The elevated value of ^{40}K is due toreason that the concentration of naturally occur-

Table 1. Activity concentration of natural radionuclides in collected soil samples in Naushera Area of Rajouri

S.No	^{226}Ra (Bq kg^{21})	^{232}Th (Bq kg^{21})	^{40}K (Bq kg^{21})	(Bq kg^{21}) Ra_{eq}	(nGyh^{21}) dose rate Absorbed
NAU-1	13+10	14+9	187+136	47	22
NAU-2	20+10	15+8	300+150	67	32
NAU-3	42+10	101+13	150+81	211	93
NAU-4	38+5	26+3	760+91	134	65
NAU-5	41+6	15+4	1310+154	163	83
NAU-6	55+10	17+10	612+130	111	54

ring radionuclides in soil depends on the rock type from which the soil is formed and the leaching of bad rocks and soil. Chemically, potassium is highly soluble in water. The concentration of ^{40}K in this region is decreased by leaching process and is also diluted when the organic matter and soil water con-tents increase. This suggests that the concentration of radionuclides in soil is increased by adsorption with soil particles and their precipitation on soil. Losses of radionuclides from the plant root zone by infiltration into deeper soil layers are generally neglected in estImating the radionuclide accumulation in soils. These losses are significant where soil permeability is high and the adsorption of radionuclides to soil particles is low. Moreover, the behaviour of radionuclides in soil is affected by different biochemical processes, when organic matter decomposition changes soil property from an oxidising to a reducing medium. The high values of ^{226}Ra and ^{232}Th in soil samples may be due to the presence of uranium and thorium mineralisation in the area. The geological structure of the area also increases the level of radionuclides. The radionuclides are found to be significantly distributed from one to another place in study area. Here, the surface geochemistry plays an important role for the accumulation of radionuclides. These variations were caused by different chemical and physical properties of radio-nuclides in soil and rocks.

The high value of potassium has been found in the sample NAU-5. The elevated value of ^{40}K is due topresence of felsic rocks, especially kaolinisedintru-sive. Once released through the weathering offeldspar minerals, potassium is very soluble and occurs as the simple cation K^+ over the entire stability field of natural water. Although potassium is an abundant element, its mobility is limited by three processes: (1) it is readily incorporated into clay-mineral lattices because of its large size, (2) it is adsorbed more strongly than Na^+ on the surfaces of clay minerals and organic matter and (3) it is an important element in the biosphere and is readily taken up by growing plants.

Radium equivalent activity

The radionuclide concentrations have been defined in terms of radium equivalent activity (Ra_{eq}) in bec-querel per kilogram to compare the specific activity of materials containing different amounts of ^{226}Ra, ^{232}Th and ^{40}K and calculated by following relation:

$$Ra_{eq} = A_{Ra} + 1.43A_{Th} + 0.077A_K$$

where A_{Ra}, A_{Th} and A_K are the activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K in becquerel per kilogram, respectively. Radium equivalent activity (Ra_{eq}) for collected soil samples varies from 47 to 211 Bq kg^{-1} with an average of 115 Bq kg^{-1} (Table 1). These values are ,370 Bq kg^{-1}, which is acceptable for safe use.

IV. Conclusions

The measured activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K in this study were found to be lower than the upper range of the world average mean value. It is observed that the background radiation varies over a range of concentrations and exposure rates from a variety of causes. The magnitude of variation can be significant over a short distance and also can vary in one place to another place. In this study, it was found that all the parameters for radiation hazards and dose are much lower than recommended value. Understanding the characteristics of background and the wide range of background values encountered in the field is beneficial when designing and conducting surveys. It has been observed that the background radiation levels in the study area due to radionuclides are similar to the normal background radiation area. The results of this study can be used as a baseline data in the study area for observation of any possible change in the future.

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