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Radioactivity of Some Soil Samples from Kuba, Butura Ward, Bokkos Local Government Area, Plateau State, Nigeria

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ABSTRACT

The activity concentration of naturally occurring radionuclide ^{40}K, ^{226}Ra and ^{232}Th were measured in some soil samples from Kuba village, Bokkos Local Government Area, Plateau State, Nigeria using gamma ray spectroscopy. The soil activity ranges from 246.40± 11.32, 129.40± 6.44 and 57.92± 22 $Bq.kg^{-1}$ respectively 116.70± 9.24 to 397.2± 13.32$Bq.Kg^{-1}$ for ^{40}K, 35.87± 1.02 to 88.09±1.14 $Bq.kg^{-1}$ for ^{226}Ra, and 103.60± 5.23 to 162.10± 7.11 $.Kg^{-1}$ for ^{232}Th with mean values of 246.40±11.32, 57.92±1.22 and 246.40±11.32 $Bq.kg^{-1}$ respectively. The concentrations of these radionuclides are compared with the world average. The radium equivalent activity calculated from the analyzed soil samples ranges from 200.2536 to 291.9765 $Bq.Kg^{-1}$ with the mean value of 261.0386 $Bq.Kg^{-1}$. The mean values ^{40}K and Radium Equivalent are low compare to the world average but the mean values for, ^{226}Ra and ^{232}Th are above the permissible value, therefore pose a significant threat to inhabitants or workers dealing with transportation of soil and there is no good safety index for all building made from these materials and the inhabitants due to high activity concentration of ^{232}Th and ^{226}Ra.

KEYWORDS: *Radionuclides, Radium Equivalent Dose, ^{40}K, ^{226}Ra and ^{232}Th*

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INTRODUCTION

Natural background radioactivity and the associated external exposure due to gamma radiation depend primarily on the geological and geographical conditions and appear at different levels in the soils of each region in the world. The knowledge of this natural radioactivity distribution in the environment is essential in various fields of science. The high geochemical mobility of radionuclides in the environment allows them to move easily and to contaminate much of the environment with which humans come in contact therefore it is important to know the distribution of source –rock materials containing elevated levels of radionuclides processes that concentrate the radionuclides.

The meaning of the word soil varies in different fields depending upon its relevance. Farmers consider it as the part of the earth's surface containing decayed and organic materials in sufficient quantity to grow plants and crops. The Geologist see it as the left over from underlying parent rock that support root growth. To the engineer, soil include all earth materials overlying the rock crust and contain particles of minerals, gases and liquids. According to the soil science society of America (SSSA) soil is a living system that represents a finite resource vital to life on earth. It forms the thin skin of unconsolidated mineral and organic matter on the earth's surface, and develops slowly from various parent materials and is modified by time, climate, macro-and microorganisms, vegetation and topography.

Soil contain organic, inorganic compounds and also radionuclides. The naturally occurring radionuclides present in soil include ^{226}Ra, ^{226}Ra ^{232}Th and ^{40}K. The gamma radiation emitted from these naturally occurring radioisotopes called terrestrials background radiation, represents the main source of irradiation to the populace and contribute to the total absorbed dose via inhalation, ingestion and external irradiation calculate by beck suggested that 50-80 percentage of

the total gamma flux at the earth surface arises from ^{40}K, ^{238}U and ^{232}Th series in topsoil.

Kuba Village, in Bokkos Local Government Area, Plateau State, Nigeria is one of the oldest tin mining area in Plateau State. Due to the mining activity over acentury, the bricks laying and plastering soil samples were measured to assess the magnitude of the radionuclides content.

THE STUDY AREA

This study was conducted in and around Kuba community where local bricks are made for building and Plastering sand are collected for finishing of most of residential houses in of Butura Ward, in Bokkos Local Government Area of Plateau State, Nigeria. The samples were collected along Kuba-Bagodu road, Kuba-Kafuta road and Kuba-Kafuta road

MATERIALS AND METHODS

In order to measure natural radioactivity in soil, ten surface samples were collected from from three different sites. After removing the stone and organic materials, the sample were dried in an oven at about 1500C for 1-2h to remove the moisture content and then crushed to pass through a 150 mesh sieve to homogenize it. The representative powered samples were filled in a polyethylene circular disc of 55-m diameter and 13 mm height. finally, every sample was stored for four weeks to reach the equilibrium state between radon and its decay products, since radium measurements are usually based on the activities of radon daughters ^{214}Bi, ^{214}Pb and then the gamma ray spectrum was accumulated for up to 900min. the method is discuss in earlier publication. Each sample was subjected to a gamma ray spectrometer with HP Ge setup and multichannel analyzer. The applied low-level gamma –ray spectrometer consists basically of high purity germanium detector with its electronic circuit. The detector is coaxial closed end closed facing window geometry with vertical dipstick (500-800microns) the HPGe GEM is P-Type with the following specifications.

Resolution (FWHM) at 122keV, ^{57Co} is 1100eV and at 1.33 MeV, ^{60}Co is 2.00 K e V peak-to Compton Ratio, ^{60} Co is 46, relative's efficiency at 1. 33 Me V, ^{60} Co is 20% operation bias voltage is $_{+2000}$ V dc.

The detector is shielded in a chamber of four layers starting with Plexiglas (10mm thick) copper (30mm thick) lead (100mm thick) and finally cadmium (3mm thick) this shield serves In reducing different radiation hazards. The soft component of cosmic rays, consisting of photons and electrons, is reduced to avery low level by 100mm of the lead shielding. The x-rays (73.9keV) emitted from lead by its interaction with external radiation is suppressed by the cupper layer.

The emitted x-rays from lead which contains radioactive impurities due to antimony impurities due to antimony impurities can be absorbed by lining the inside of the shield with a graded layer of 0.05 inch cadmium and 0.25 inch prespex. To minimize the effect of the scattered radiation from the shield, the detector is located in the chamber.

The spectra were evaluated with the computer software program maestro (EG &GORTIC) or manually with the use of a spread sheet (micro excel) to calculate the natural radioactivity, 226 Ra activity of the sample was determined through the intensity of the 295.2 keV, 351.9keV and 609.3keV y-lines for ^{214}Pb and ^{214}Bi respectively. ^{232}Th activity was determined through 238, 583.1 and 911.1 keV y-lines for ^{212} Pb, 208TI and ^{228}Ac respectively ^{40}K measured directly through the gamma line emission at 1460.8keV.

TABLE OF RESULTS: Activity Concentration of K,Ra and Th (B/Kg)

	C_K	C_{Th}	C_{Ra}	Ra_{eq}
Kuba-Bagodu road				
1	397.20±13.32	146.7±5.33	44.19±1.22	289.79
2	211.70±9.13	118.3±6.44	35.93±1.11	214.97
3	129.80±11.51	162.1±7.11	37.88±1.33	278.73
Kuba-Kafuta road				
1	116.70±9.24	103.6±5.23	43.87±1.02	200.35
2	182.10±10.31	140.1±7.61	52.58±1.42	265.77
3	321.00±14.41	133.5±6.48	78.65±1.22	292.08
Kuba-Butura road				
1	347.30±13.23	142±6.37	49.09±1.03	276.58
2	215.80±10.61	110.4±6.51	60.81±1.41	233.83
3	263.30±11.42	119.9±7.34	93.16±1.30	283.02
4	275.10±10.22	117.8±5.54	88.09±1.14	275.95
AVERAGE	246.40±11.32	129.4±6.44	57.92±1.22	261.04

^{40}K, ^{232}Th and ^{226}Ra, activity concentrations measured in soil samples Kuba

All the values of the activity per unit mass are in the range of the corresponding typical world values which 400Bq.kg-1 for ^{40}K while for ^{232}Th an ^{226}Ra the values obtained are above the world permissible limit of 30Bq/Kg. and 35Bq/Kg (UNSCEAR,2000) respectively. The results of the present work indicate that the area under investigation may has a high level of natural background radiation, so these materials do pose a significant radiological hazard when used for construction of buildings and even the workers.

RADIUM EQUIVALENT ACTIVITY (Raeq): The associated radium equivalent activity was calculated using the formula

$$Ra_{eq} = C_{Ra} + 1.43C_{Th} + 0.077^{C}k$$

Where : C_{Ra} and C_K are the specific activities of ^{226}Ra and ^{40}K in $Bq.kg^{-1}$ respectively. The radium equivalent activities of samples under investigation were calculated on the basis of the above equation and are shown in the table above. For all soil samples under investigation, the radium equivalent value are lower than the acceptable value of 370 $Bq.Kg^{-1}$, ranging from 200.35 to 289.79 $Bq.kg^{-1}$

CONCLUSIONS

The investigation carried out showed the the results of measuring the activity concentrated of terrestrial gamma emitters for soil samples from Kuba village, Butura ward of Bokkos Local Government Area, Plateau State, Nigeria. The results obtain indicate that there could be high exposure for either inhabitants or workers dealing with transportation of soil and there is no good safety index for all building made from these materials and the inhabitants due to high activity concentration of ^{232}Th and ^{226}Ra.

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