MEASUREMENT OF GAMMA RADIATION EMISSION FROM NATURALLY OCCURRING RADIOACTIVE SAMPLES OF USHONGO GEOLOGICAL ROCKS, NORTH CENTRAL NIGERIA.

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ABSTRACT
The gamma ray measurement of naturally occurring radioactive samples from Ushongo characteristics geological rocks was carried out using a halogen-quenched GM detector (radiation meter), measuring tape and a geographical compass. The absorbed dose rates in air outdoors at approximately 1m above the ground were measured and their values were in the range of 212·86 - 295·71 $nGyh^{-1}$, 235·71-351·43 $nGyh^{-1}$, 270·00 - 422·86 $nGyh^{-1}$, and 205·71- 345·71 $nGyh^{-1}$ with overall mean values of 249·52$nGyh^{-1}$, 283·81$nGyh^{-1}$, 333·33$nGyh^{-1}$ and 270·47$nGyh^{-1}$ for sample locations; Ushongo Hills (A), Ibya-Avie (B), Mata (C) and Mbaakorsu (D) respectively. The values corresponds to the total individual annual effective dose rates of0·91805 $mSvy^{-1}$, 1·04419$mSvy^{-1}$, 1·2264$mSvy^{-1}$ and 0·99512$mSvy^{-1}$, (assuming a 20% (0·2) occupancy factor) for sample location A, B, C and D respectively. Thus, annual effective dose rates in Ushongo town are much higher than the global value of 0·64$mSvy^{-1}$. The radiological implication of these radionuclides is due to the gamma ray exposure of the body and irradiation of lungs tissue from inhalation of radon and its daughters.

Keywords: Radioactive samples, Gamma irradiation, rocks, radiation protection.

INTRODUCTION

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) report of 2001 emphasizes more the need for current data on exposures from natural, man-made and occupational sources. Concentration of natural radio nuclide's in the environment differ from one sample to another depending on the nature of the sample, its chemical composition, its density, sampling site and collection depth (Lakehal et al, 2010). Gamma radiation depends primarily on the geological and geographical conditions and appears at different levels in the soil of each region in the world (Tu - fail et al, 2006). The components of natural environments such as soils, rocks, sediments, vegetation, air and water are included as naturally occurring radioactive materials (NORM). These materials may contain ^{238}U, ^{232}Th, their radioactive daughters and the primordial radioactive isotope such as ^{40}K. These radio nuclides give rise to internal and external radiation exposures, both indoor and outdoor.Gamma radiations from radio nuclides with half-lives comparable to the age of the earth such as K-40 and radio nuclides from U-238 and Th-232 series and their decay products are the main contributors of external sources of irradiation to human body. Of these naturally occurring radionuclide material (NORM) potassium is the most abundant and is found in earth's crust (average up to 2.6%) while uranium and thorium are present in levels of parts per million (Sunaree et al, 2011). Primordial radio nuclides comprise those formed at the inception of the planet earth. Only those with half-lives comparable to the age of the earth such as ^{40}K, and ^{232}Th and^{235}U decay series, and their decay products, can still be found today (Mohanty et al, 2004). Gamma radiation from these radio nuclides represents the main contributions to the external exposure of the human body. This is demonstrated especially by the gamma spectrometric analysis of the soil samples from Udagamandalam in Nilgiri District of Tanil Nadu, India (Selvasekarapandian et al, 1999).

The existence of High-Level Natural Radiation Areas (HLNRAs) is attributed to the availability of certain radioactive minerals or elements embedded in the continental rock system of these areas. Such high levels of natural background radiations have been associated with minerals such as monazites and pyrochlore, which can be of economic value (Karam, 2002). The estimation of exposures to ionizing radiation is an important goal of regulatory authorities and radiation protection scientist. The data generated in environmental radioactivity assessment/monitoring provides base-line values of exposure to radiation in an environment where mining activities are carried out and maybe useful for authorities in implementation of radiation protection standards for the general population in the country (Sadiq and Agba, 2011; Ibrahim et al., 2013). The areas investigated in the present study are Ushongo hills; in Ushongo Local Government Area Benue State of Nigeria. The town (Ushongo) itself is surrounded by rocks, which are known to be mostly rocks of older granites.

MATERIALS AND METHOD

The research work covers four major rocks in Ushongo local government area, and most of these rocks surround Ushongo town. The study map in Fig. 1 showed samples locations marked with alphabets within the sketched map and the map key.

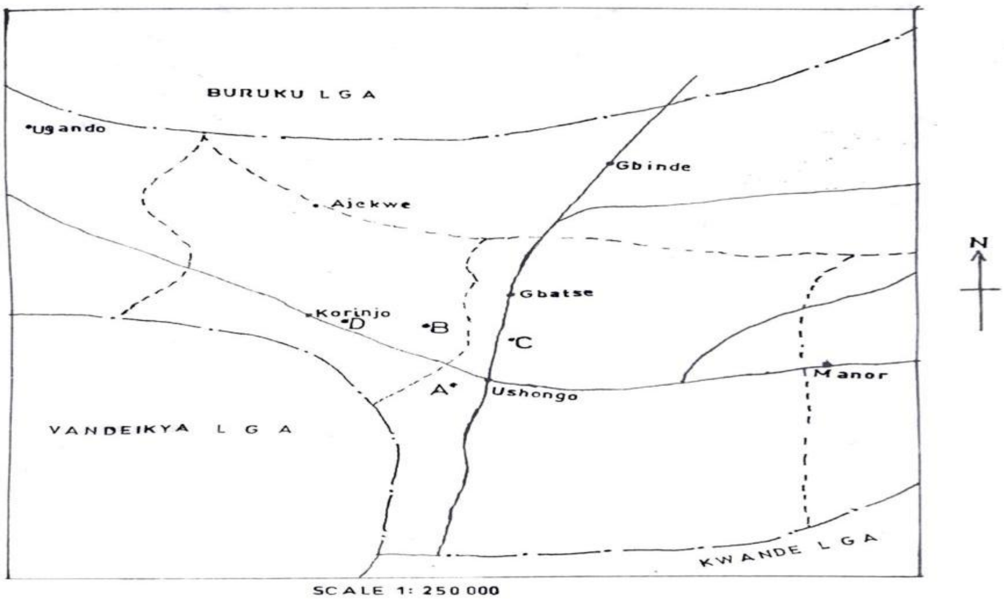


Fig. 1 Shows samples locations marked with alphabets and the map key.

Sample Locations/Rocks		Key	
A	Ushongo Town		Roads
B	Ibya-Aive	…………..	District Boundary
C	Mata		Local Govt Boundary
D	Mbaakorsu	A B C D	Sample Locations

Table 1 Sampling Sites and their Codes and Coordinates

S/No	Sampling Site	Site code	Coordinates
1	Ushongo Hills	A	2.5km North
2	Ibya-Avie	B	2.5km North-West
3	Mata	C	2km Northeast

4	Mbaakorsu	D	2.5km Southeast

The sample collected at station marked A are known as Ushongo (Town) Hill rocks. The sample rocks collected here were coarse grain granites. At station marked B are Ibya-Aive rocks, the rocks found here were porphyritic rocks. At stations C which are identified as Mata rocks, the identified rocks present were coarse grain granite. Also at the station D named as Mbaakorsu rocks, the present rocks were coarse grain granite. The Table1 below shows the sampling sites and their codes and coordinates as taken from the sample locations using geographical compass. A radiation meter (Inspector Exp), held at gonadal level (1m above ground) of gamma radiation concentration around Ushongo geological rock at distances of 1m, 21m and 41m away from the rocks, to determine the exposure rate at a stipulated time of 1hour. This was in turn used to evaluate the absorbed dose rate and annual effective dose rates at the respective distances. Details of this procedure can be found from (Mohammed et al., 2014).

The exposure rate, absorbed dose rate and Annual effective dose rates were obtained using the following formulas as given by UNSCEAR (2000).

$$\text{Exposure rate } \left({}^{mR}/_{hr}\right) = \frac{X(mR)}{hr} \quad (1)$$

where X is the exposure in mR and T is the exposure time.

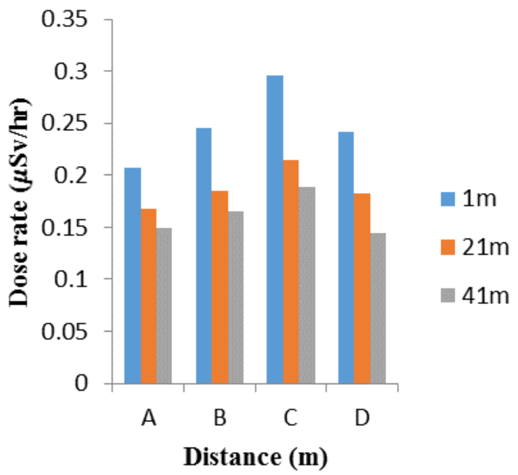
$$\text{Absorbed dose rates } (nGyh^{-1}) = \text{ Dose rate } (\mu Svh^{-1})/(0.70SvGy^{-1}) \times (10^{-3}) \quad (2)$$

$$\text{Annual effective dose rate } (\mu Svh^{-1}) = Dose\,rate(nGyh^{-1}) \times 24hr \times 365d \times K \times (0.70SvGy^{-1}) \times (10^{-3}), \quad (3)$$

where K is the occupancy factor (0.2), $0.70SvGy^{-1}$ is the conversion coefficient and 10^{-3} converts nano- Grays to micro Grays.

RESULTS

The results of radiation measurements from rocks in the study area are presented in Figs 2 to 5.



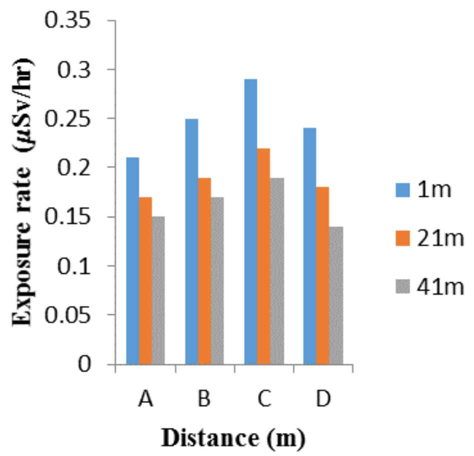


Fig. 2 Dose rate at varying distances from the rocks. Fig. 3 Exposure rate at varying distances from the rocks.

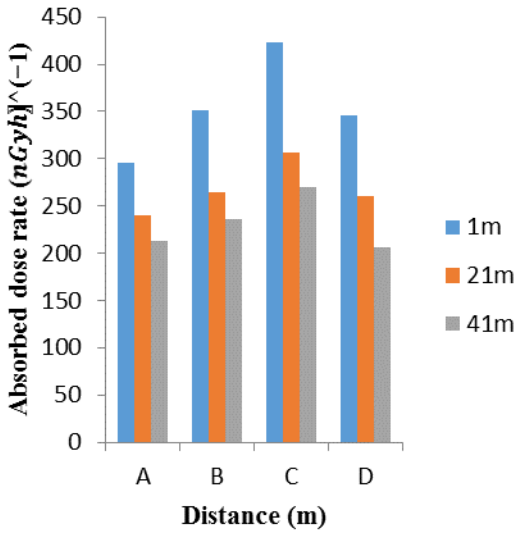


Fig. 4 Absorbed dose rate at varying distances from the rocks.

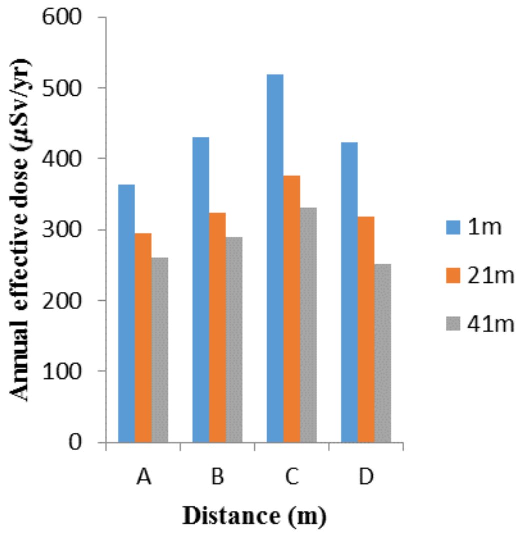


Fig.5 Annual effective dose (μSvh^{-1}) at varying distances from the rocks.

DISCUSSION

Results of the research showed that the exposure rate from Mata rocks which the identified rocks were coarse grain granite are higher than other areas just as the higher dose rate observed in Fig 2; closely followed by rocks from Ibya-avie(porphyritic granites)and least at Ushongo hills(coarse grain rocks). The readings are found in the range of 0.53 μSvh^{-1} – 0.70 μSvh^{-1}as shown in Fig. 3. Exposure from the rocks studies is within or above the recommended safe limit of 1.0 mSv/yr set by ICRP (2007) and UNSCEAR (2000). From Fig.4, the absorbed dose rate obtained from the study areas are higher than that of other high background areas (HBRAS) such as that of Imesi-Ie, Osun State, Nigeria which ranges from 25.6 – 48.6 $nGyh^{-1}$ and Udagamandalam, India which ranges from 31.6 – 221.1 $nGyh^{-1}$ with the mean value of 121.08 $nGyh^{-1}$. The estimated dose rate is within the UNSCEAR (2000) recommended safe limit of 60$nGyh^{-1}$. Fig. 5 shows that the annual effective dose rate of the four studied areas at 41m are higher than those of some mining areas in Nasarawa State, Nigeria which has minimum and maximum values of 0.41$\pm$ 0.01mSv/yr and 0.45 $\pm$ 0.02 mSv/yr at 100m away from the mining spot (Ibrahim et al., 2013). It is also higher than that of Akwanga (0.31 $\pm$ 0.04mS/yr) and Keffi (0.25$\pm$ 0.04mSv/yr) (Ranli et al., 2014) and the Nigeria mean annual effective dose equivalent of 0.27mSv/yr (Farai & Jibril, 2000). These values are higher than the safety limit to public exposure of 1mSv/yr (UNSCEAR, 2000). This indicates that there is higher potential for radiation health hazards from naturally occurring radionuclides to the people of Ushongo community.

High background radiation in an environment is indicative of the contamination of the environment by radionuclides washed/weathers from other sources to the area under study or the presence of deposits of mineral sources such as Uranium ore and Phosphates, commonly found around geological formation of granite rocks. This also suggests the presence of high level of radionuclides in the granite rocks of Ushongo region studied.

CONCLUSION

The results of this work establish the presence of radionuclide in Ushongo granitic rocks and suggest the possibility of occurrence of radiation health hazards for inhabitants of Ushongo community living, farming and crushing the stones for constructional commercial purposes. It was observed that in a few areas the public exposure to radiation from Ushongo rocks is significantly high (above safe limit of 1mSv/yr.) and decreases with increase in distance from the rocks. Alao, the dose rate and annual effective dose rate of the four study areas were found to be below the ICRP and UNSCEAR safety limit of 1mSv/yr and 2.4mSv/yr. respectively. In areas of significant radiation, the Government and Radiation safety offices need to sensitize the inhabitants of the danger of residing close to the rocks.

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REFERENCES

Agba E. H, Onjefu S. A and Ugwuanyi J. U (2006). Preliminary investigation of the ambient radiation levels of mining sites in Benue State, Nigeria. Nigerian Journal of Physics, 18(2) pp 219-222.

Farai I. P and Jibril N. N (2000). Baseline Studies of terrestrial outdoor gamma dose rate levels in Nigeria. Radiation Protection Dosimetry, Vol. 88: pp 247-254

Ibrahim U, Akpa T. C and Daniel I. H (2013). Assessment of Radioactivity Concentration in soil of some Mining Areas in Central Nasarawa State, Nigeria. Science World Journal Vol. 8(2).

International Commission on Radiological Protection (ICRP, 2007). ICRP Publication 103.

Karam, P. A. (2002). The high background radiation area in Ramsar Iran: Geology, Norm, Biology, LNT, and possible regulatory fun. Proceedings of WM'02 Conference, Feb. 24-28, Tucson,AZ.

Lakehal Ch., Ramdhane M. , Boucenna A., (2010). Natural radionuclide concentrations in two phosphate ores of east Algeria. J. of Env. Radioactivity, 101: 377-379.

Mohammed, A. Kobeissi, Omar E. S. Khaled, Z. and Ibrahim R. (2014). Assessment of indoor and Outdoor Radon Levels in South Lebanon. Springer pp.214-226.

Mohanty, A. K., SenguptaaD., Dasb S. K., Vijayanc, V., Sahab S.K. (2004). Natural radioactivity in the new discovered high background radiation area on the eastern coast of Orissa, India; Radiation measurements 38, 153-165.

Ranli A. T, Aliyu A. S, Agba E. H and Saleh M. A (2014). Effective dose from natural background radiation in Keffi and Akwanga towns, Central Nigeria. International Journal of Radiation Research Vol. 12 (1).

Sadiq A. A. and Agba E. H (2013). Background Radiation in Akwanga, Nigeria. Working and and Living Environmental Protection, Vol.8(1) pp 7-11.

Selvasekarapandian S., Muguntha N., Sivakumar R., Balasubramanian S., Venkatesan T., Meenakshisundram V., Ragunath V. and Gajendra V. (1999). Gamma radiation dose from radionuclides in soil samples of Udagamandalam (Ooty) in India. Radiation protection dosimetry, Vol. 82, No. 3.pp. 225-228.

Sunaree, B., Bhongsuwan D., Pungrassami T. and Bhongsuwan T. (2011). Natural Radionuclide contents in ceramic clays in Southern Thailand and their radiation hazard indices; Kaset. J. Nat.Sc. 45: 28-39.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Report 2000.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Report 2002.