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Measurement of Ionizing Radiation Level in an High Altitude Town of Imesi-Ile, Osun State, Southwestern, Nigeria

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Abstract

The present work attempts to measure background ionizing radiation in an high altitude town of Imesi-Ile, Osun State, Southwestern, Nigeria. The measurements were carried out in 20 locations within the town using portable Digilert 50 Nuclear Radiation monitor. The absorbed dose rates obtained ranges from 26.6 to 48.6nGyh^{-1} with a mean value 37.19nGyh^{-1}. The estimated annual effective dose is 0.46mSv. This value is less than annual dose unit of 1mSv recommended by UNSCEAR for normal environment.

Keywords: Ionizing radiation, Absorbed dose, Environment, Effective dose

1.0 Introduction

Our world is radioactive and has been since it was created. Over 60 radionuclides (radioactive elements) can be found in nature. Human beings are exposed to natural background radioactive every day from the ground, building materials, air, food, drinking water, the universe and even elements in their own bodies [1].

It is well known that a large percentage of human exposure to ionizing radiation comes from natural origin, the major contributors being the naturally occurring radioactive elements of the uranium and thorium series and non-series radioactive potassium [2].

Average annual exposure worldwide to natural radiation sources would generally to be in the range of 1-10 mSv, with 2.4 mSv being the present estimate of the central value [3]. Of this amount, about one-half (1.2mSv per year) comes from radon and its decay products. After radon, the next highest percentage of natural ionizing radiation exposure comes from cosmic rays, followed by terrestrial sources and "internal" emissions.

Cosmic radiation permeates all of space, the source being primarily outside of our solar system. The radiation is in many forms, from high speed heavy particle to high energy photons and muons [4]. The exposure of an individual to cosmic rays is greater at higher elevations than at sea level. The cosmic radiation does increases with altitude, roughly doubling every 6,000 feet. This radiation is much more intense in the upper troposphere, around 10km altitude and is thus of particular concern for airline crews and frequent passengers, who spend many hours per year in this environment [3].

The amount of terrestrial radiation from rocks and soils varies geographically. Terrestrial radiation originates mostly from radiations of thorium (^{232}Th), radium (^{238}U) series radionuclides and potassium (^{40}K). Both ^{238}U and ^{232}Th have long decay series with members (^{226}Ra, ^{222}Rn, ^{214}Bi etc), all of which are radioactive. Natural potassium, an ubiquitous element in the soil, contains 0.0119% radioactive ^{40}K. Radiations emitted by these elements within 15-30cm top soil reach the earth surface. We also have radioactivity in air due mainly to the presence of radon (^{222}Rn) gases formed as daughter products in the ^{238}U and ^{232}Th series, respectively. They emanate readily from the soil to build up in air at concentrations that depend on meteorological conditions and ventilation in dwelling volumes [5].

Internal emissions come from radioactive isotopes in food and water and from the human body itself. Exposures from eating and drinking are due in part to the uranium and thorium series of radioisotopes present in food and drinking water [3].

Generally, background radiation levels are from a combination of terrestrial (from the ^{40}K, ^{232}Th, ^{226}Ra etc.) and cosmic radiation (Photons, Muons, etc.).

In addition to the inevitable natural background radiation sources, man can be exposed to various man-made radiations sources such as X-ray equipment and radioactive materials used in medicine, research and industry. Also, consumer products like colour televisions, smoke detectors, gas lantern, mantles, tobacco natural gas heating and cooking fuel, mining and agriculture products, such as coal, granite and potassium salt contribute small amounts of man-made background radiation [6].

Other sources and radioactive wastes, fall-out from nuclear weapon tests, and occupational exposures from nuclear reactors and accelerators.

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In developing countries, like Nigeria, the main source of human exposure is natural radiation. Natural radiation made up 94% of radiation source [7]. Since natural radiation is the main source of human exposure, studies of the dose from this source and its effect on health are of great value as reference when standard and regulatory control actions on radiation are to be done. Interest in this kind of study has led to many surveys on natural radiation [8 – 11]. Also in Nigeria some studies have been carried out on natural radiation [12 – 20].
This study aimed at employing radiation detection method to examine the outdoor ionizing radiation levels in Imesi-Ile, Osun state, southwest of Nigeria. No report of the radiation levels in this environment is available in literature.

2.0 Materials and Methods

Location

The study area is Imesi-Ile in Osun State, Southwestern, Nigeria. The town lies between latitude 7^0 50^I E and longitude 4^0 50^I N and height 574.3 metres above sea levels. Apart from altitude, the town is amidst of a group of granite rocks. Most of the houses in the town were built on the rocks or surrounded by rocks. These may influence the level of the background ionizing radiation, thus the need to establish the levels of radiation in the town.

Measurement Procedure

An in-situ measurement of the outdoor ionizing radiation level was carried out using portable Digilert 50 Nuclear Radiation Monitor and a stopwatch. The radiation meter was calibrated using the facilities of the Secondary Standard Dosimetry Laboratory (SSDL) at National Institute of Radiation Protection and Research, Nigerian Nuclear Regulatory Authority, University of Ibadan, Nigeria.
The Digilert-50 is optimized to detect low levels of alpha, beta, gamma and x-ray radiation, measures radiation parameters in units of dose rate, exposure rate and activity. The meter consists of halogen-quenched Geiger Mueller tube with mica end window. Mica window density 1.5 – 2.0mg/cm^2.
Operating Range: µSv/hr – .01 to 500
CPM – 1 to 50,000 counts
Total: 1 to 60,000 counts
Energy sensitivity is 1000 CMP/mR/hr referenced to Cs – 137 and the meter has an accuracy of 15% and operating within the temperature range of -10^{o}C to 50^{o}C.
Measurements were taken in 20 locations in the town. The locations were chosen in order to ensure the total coverage of the town. In each location, five successive readings were obtained at every 10 minutes interval.
At each point, the metre was held at the gonad level i.e. about 1.0m above the ground level. To estimate the annual effective dose rates, the conversion coefficient from absorbed dose in air to effective dose (0.7Sv/Gy) and outdoor occupancy factor (0.2) proposed by UNSCEAR [3] was used. Thus the annual dose rate in mSv/year was calculated using:

$$Hr = Dr \times U \times K \times 8766$$

Where:
Hr = Annual effective dose measure in mSv/year
Dr = The absorbed radiation dose in air measured in nGyh^{-1}
U = 0.2 (Outdoor occupancy factor)
K = 0.7Sv/Gy (Conversion factor)

3.0 Results and Discussions

The results obtained from the 20 locations in the town is shown in Table 1.
The results obtained from the measurements carried out varies from 25.6nGyh^{-1} to 48.6nGyh^{-1}. The mean absorbed dose rate was calculated to be 37.19 nGyh^{-1}.
The annual effective dose was found to be 0.46mSv.
The wide variation in the absorbed rate with minimum value of 25.6nGyh^{-1} and maximum value of 48.6nGyh^{-1}, show the spatial variation in the natural radiation level within the town. With Olorunsogo with minimum absorbed dose rate of 25.6nGyh^{-1} and Ijana-Oke area having maximum absorbed rate in air of 48.6nGyh^{-1}. The higher absorbed dose rate measured in this area is due to the presence of granite rocks in the environment.

Table 1: Results of Dose Measurement in $nGyh^{-1}$

Location Code	Sampling Locations	Range of Absorbed Dose ($nGyh^{-1}$)	Mean Absorbed Dose ($nGyh^{-1}$)
A	Ajedan	28.6 – 45.7	37.5 ± 1.2
B	Orudi	25.7 – 37.1	33.9 ± 0.5
C	Oke-Iro	34.3 – 42.9	38.2 ± 2.7
D	Odoba	28.6 – 42.8	37.1 ± 0.6
E	Odowo	27.2 – 40.0	36.1 ± 2.5
F	Okerena	25.7 – 44.3	39.0 ± 0.3
G	Temidire	37.1 – 45.7	43.1 ± 0.7
H	Ayetoro	28.6 – 42.8	37.1 ± 0.6
I	Obaala	27.3 – 37.2	33.0 ± 0.5
J	Itiwo	30.0 – 40.5	35.8 ± 2.3
K	Oke Aye	30.5 – 37.2	34.3 ± 0.8
L	Ayeso	28.6 – 35.7	32.4 ± 0.5
M	Ijana Oke	28.4 – 48.6	42.5 ± 0.2
N	Market Square	35.7 – 45.8	38.9 ± 1.5
O	Ijana	32.8 – 42.8	37.8 ± 0.5
P	Oke Ayo	37.2 – 48.5	45.6 ± 0.8
Q	Oke Iwo	27.2 – 37.3	35.3 ± 0.5
R	Odo Obi	28.4 – 45.7	40.5 ± 0.2
S	Odo Ese	32.8 – 37.2	35.2 ± 0.8
T	Olorunsogo	25.6 – 42.8	38.5 ± 0.6

[11] reported a dose rate of $49nGyh^{-1}$ in the natural background radiation dosimetry in the highest altitude region of Iran. This is higher than the mean value of 37.19 $nGyh^{-1}$ obtained in the present study, since the altitude of the town is not as high as that of Chaharmal and Barkhtiari Province, in the southwest of Iran.

4.0 Conclusion

Altitude has been discovered as one of the important factors relevant to the measured dose rate the results of this work showed that the altitude of the region had a significant effect on the level of background radiation. Some areas showed low background radiation in spite of the high altitude, as a result of the low concentrations of radionuclides in their soils. The absorbed dose rate varies from $25.6nGyh^{-1}$ to $48.6nGyh^{-1}$ with average absorbed dose of $37.19nGyh^{-1}$ and annual effective of dose of 0.46mSv are much lower than the annual dose limit of 1mSv recommended by ICRP for the members of the public.

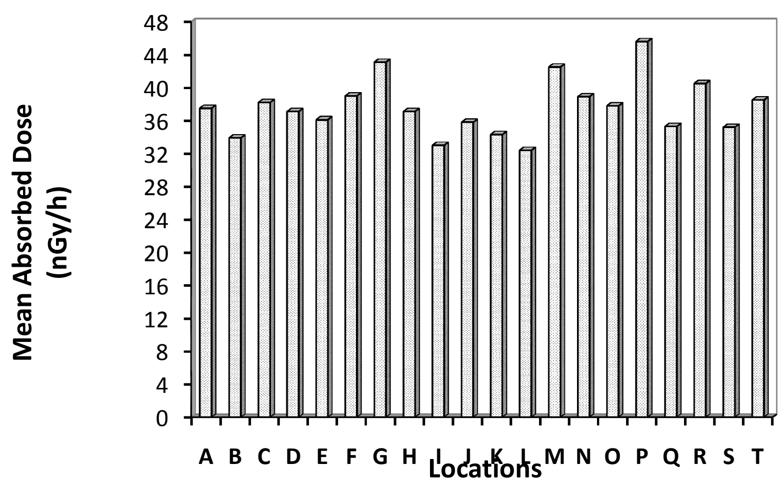

Fig. 1: Distribution of Absorbed Dose ($nGyh^{-1}$) in Imesi-Ile

References

[1] NCRP (1976): National Council on Radiation Protection and Measurement on environment radiation measurement. NCRP Report No. 50.

[2] Farai,I.P ,Jibiri N.N (2003):Baseline studies of terrestrial gamma radiation sources ,effects and risk of ionizing radiation .Oxford university Press, 15 :14 – 16.

[3] UNSCEAR (2000): Sources and Effects of Ionizing Radiation; United Nations Scientific Committee on the Effects of Atomic Radiation. New York, United Nations.

[4] Ron Kathren (1997): Radioactivity in the Environment. Taylor & Francis Pub. pp 25-30.

[5] Cember, H. (1983): Radiation Dosimetry: In Cember H. Introduction to Health Physics 1st Ed., Pergamon press, New York, USA; 175-176.

[6] BEIR (2006): Health Risks from Exposure to Low Levels Ionizing Radiation: BEIR VII Phase Board on Radiation Effects Research

[7] Neimann, E.G. (1984): Radiation Biophysics. In: Biophysics Eds. W. Hoope; W. Lohmann, H.; Mark, I.; and H., Zeigler P. 299, Spriner Verlag, Berlin, Germany.

[8] Butt, K.A.; Ali, A. and Qureshi A. (1998): Estimation of environmental gamma radiation levels in Pakistan. Health Physics. 75:63

[9] Jagger, J. (1990): Natural background radiation and Cancer death in rocky mountains states and gulf coast states. *Health Phys*. 75: 428-430

[10] Karumakara, N.; Somashekarappa, H.M.; Avadhani, D.N.; Mahesh, H.M.; Narayana, Y. and Sidappa, K. (2001): Radium 226, Th 232 and K-40 distribution in the environment of Kaiga of South coast of India. *Health Physics* 80: 470-476.

[11] Daryoushi, Shahbazi-Gahrouei (2003): Natural Background radiation dosimetry in the highest altitude region of Iran. *J. Radiat. Res*. 44. 285-287.

[12] Sanni, A.O. (1973): Seasonal Variation of Atmospheric Radioactivity at Ibadan. Tellus 25: 80-85

[13] Avwiri, G.O.; Ebeniro, J.O. (1998): Internal environmental radiation in an industrial areaof River State. *Nigeria Journal of Physics* 10:105-107.

[14] Ademola, J.A. (2008): Exposure to high background level in the tin mining area of Jos Plateau. *J Radiol. Prot.* 28(1). 93-99.

[15] Ademola, J.A. and Okpalaonwuka (2010): Occupational exposure to radionuclides due to mining activities in Ibadan, Southwestern, Nigeria. *J. Radiol. Prot*. 45(1). 43-45.

[16] Nwankwo, I.I. and Akoshile C.O. (2006): Monitoring of external background radiation level in Asa Dam Industrial area of Ilorin, Kwara State, Nigeria. *J. Appl. Sci. Environ. Mgt. 9(3). 91-94.*

[17] Avwiri, G.O. and Ebeniro J.O. (2002): A survey of the background radiation levels of the sub-industrial area of Port-Harcourt. *Global J. Pure and Appli. Sci.* (8). 111-113

[18] Farai, I.P. and Jibiri N.N. (2000): Baseline Studies of Terrestrial Outdoor gamma dose rate levels in Nigeria. *Radiat. Prot. Dosim.* 88(3) 247-254.

[19] Farai I.P. and Ademola J.A. (2005): Radium equivalent activity concentration in concrete building blocks in eight cities in Southwestern Nigeria. *Nigeria Journal of Environmental Radioactivity. 79: 119-125*

[20] Farai I.P and Vincent U.E (2006): Outdoor radiation level measurement in Abeokuta, Nigeria, by Thermolumnescent Dosimetry. *Nig. J. Phys*; 18 (1): 121 – 126.

[21] ICRP (1991): The 1990-1991 Recommendations of International Commission on Radiological Protection. Publication 60. Ann. ICRP 21(1-3). Pergamon Press, Elinsford, NY.