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Measurement of Background Gamma Radiation Level of Udi, Enugu-South And Ezeagu Lgas Of Enugu State, Nigeria.

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----------ABSTRACT----------
A study of the external background radiation of Udi, Enugu-South and Ezeagu LGA's of Enugu State, Nigeria was carried out. An in-situ measurement using two Digilert Radiation Monitors: Radalart-50 and Radalart-100, was used to carry out this radiation measurement at the two solid mineral sites in the sampling state. The results of the background ionizing radiation measurementsfrom themeasurement points around each of the solid mineral sites in the study areas show that the exposure dose rate ranged from 0.010 mR/hr to 0.025 mR/hr with an average of 0.014 mR/hr at location 1 (Amagu-Umuene), 0.012 mR/hr to 0.022 mR/hr with an average of 0.0165mR/hr at the location 2 (Ogulogo-olo) and 0.011 mR/hr to 0.022 mR/hr with an average of 0.0153 mR/hr at location 3. The total average BIR from the three local government areas was found to be 0.0153 mR/hr. From the ongoing, it isrecommended that control mechanism be put in place to protect members of the public thatapproach the area as well as to protect theenvironment.
KEYWORDS: *Radiation, Ionizing Radiation, Background Ionizing Radiation, GammaRadiation, Environment.*

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I. INTRODUCTION

The unending and unpredictable phenomenon of man's exposure to background ionizing radiation of various kinds and from different sources- naturally and from anthropogenic activitiesis of serious concern to humans and the environment. This situation is a clear indication that life has evolved in an environment with significant levels of ionizing radiations. This position follows the fact that radiation is emitted from both natural ionizing radiation sources (cosmic radiations, terrestrial radiations and some forms of radiation is even present in the human bodies as a result of ingested food, water and the air) while there also exists the human-made radiation which enters the environment through consumer products and industrial activities, including medical products and nuclear power plants, ([1]; [2]).

While there significant contributions to environmental radiations from high-speed cosmic ray particles incident on the earth's atmosphere and the primordial radionuclides present in the Earth's crust as well as the presence of significant quantities of radionuclides in the human body;there also existsexposure to natural radiation sources through modifications of the natural states of the environmentby anthropogenic activities. These activities includethe release of natural radionuclides into the environment from mineral processing andphosphate fertilizer processing; fossil fuel combustion and quarry activity; causing tremendous increase in natural radiation exposures. There are also exposed to higher levels of natural radiation by workers that work in such places as underground mines and those involved in mineral processing ([2]; [3]).The contributions of terrestrial radionuclides to the total exposures to radionuclides outdoors are due to the presence of these radionuclides in trace levels in all soil types. [4]in supporting this position stated that radiation emitted by these radionuclides within 15-30cm of the topsoil reach the earth surface. It should be noted at thispoint that only those components of these radionuclides with half-lives comparable to the age of the earth, and their decay products, will exist in significant quantities in these materials.

Background radiation is the radiation that exists naturally within man's environment, and consists of what comes from Cosmic rays, the naturally radioactive elements of the earth and from within man's body ([5], [6]). The main sources of natural radiation are cosmic rays, primordial radionuclides in the earth's crust, ingested radionuclides and lung irradiation due to radon (^{222}Rn) and thoron (^{230}Th) in air; which are classified into external and internal sources. Therefore, radiation is the product of the spontaneous decay of the nuclei of heavy

isotopes leading to the emissions of other forms of radiations and energy, as represented in a set of chemical equations by [7] as shown below.

$$^{222}_{86}Rn \rightarrow {}^{222}_{88}Ra + 2\_^{0}_{-1}e + energy$$
$$^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + \_^{0}_{-1}e + energy$$
$$^{238}_{92}U \rightarrow {}^{230}_{90}Th + 2^{4}_{2}He + 2\_^{0}_{-1}e + energy$$

There are various categories of effects from ionizing radiation depending on the dose available within the environment. Therefore, when the dose and dose rate is within the accepted level, the effect of radiation is minimal and most times no effect is noticed, although the effect of low level radiation are not yet completely ignored[8]. It has been established that chronic exposure to low dose-rate of nuclear radiation from an irradiated building has potential to induce cytogenic damage in human, [9]. Due to the lethal effects of acute and chronic exposure to ionizing radiation,practice of protection, within the framework of radiation safety, has always been to monitor and assess human exposure levels and keep exposure levels to 'As Low As Reasonably Achievable' (ALARA) Principle [10]. This position is a clear indication of the significant harmful effects of radiation, especially when there is exposure to radiation dose that is beyond the acceptable limits for longer period of time. Other factors upon which ionizing radiation injury depends include the nature (alpha (α), betta (β), and gamma (γ)) of the radiation, the strength or energy of the radiation, the dose, homogeneity of dose and presence of shielding. Therefore, there is a serious need for concern as it has been reported that man's exposure to natural radiation exceeds that from all technologies put together; and the International Atomic Energy Agency (IAEA) estimate of the dose contribution to the environment shows that over 85% of background radiation to which man is exposed comes from natural radio-nuclide sources, while the remaining 15% is from cosmic rays and nuclear process ([11]; [12]). Therefore, radiation has no boundaries and the injuries as well as clinical symptoms induced by exposure to ionizing radiation have been widely reported by various researchers. The researchers separately agreed that ionizing radiation is responsible for modifications of tissues and organs of living organisms. For instance, [13] stated that radiation has the ability to affect the chemical state of the material to which it is in contact thereby causing changes which are biologically significant. Other studies had consensus concerning the fact that exposure to ionizing radiation can result to direct chromosomal transformation, indirect free-radical formation, radiation cataractogenesis, cancer induction, bone necrosis andblood cell destructions [14],[15],[16].

The estimation of exposure to ionizing radiation is an important goal of regulatory authorities and radiation protection scientists. In public health management of radiation emergencies, one of the essential components of integrated assessment is to quickly and accurately assess and categorize the exposure. Thus knowledge of the background radiation level is of paramount importance [17],[18],[19]. Therefore, this study seeks to evaluate the gamma radiation levels around three (3) mining sites in Udi, Enugu South and Ezeagu Local Government Areas of Enugu State, Nigeria by undertaking radiation level measurements, at the stated locations, and compare with standards as shown in table 1 below.

Table 1: International standards for external radiation levels [20]. 2005)

S/No	Exposure	Significance
1	0.011mR/hr	Continuous whole body Background radiation, sea level out of door
2	0.010mR/hr	Continuous whole body Radiation inside wooden house at sea level
3	0.021mR/hr	Continuous whole body Background radiation, ground level
4	0.625mR/hr	Limit for occupational exposure of whole body
5	9.375mRhr	Limit for occupational exposure of hands
6	0.0625mR/hr	Limit for non-occupational exposure (including exposure of minors)
7	<2mR/hr and <100mR/hr in any consecutive days unrestricted area	No control or sign required
8	<2mR/hr or >100 mR/hr in any 7 consecutive days Radiation area.	Sign required
9	>5mR on one hour to major portion of the body Radiation area.	Sign required

II. MATERIALS AND METHODS

The assessment was undertaken with the use of a factory calibrated Inspector Alert Nuclear Radiation Meter (SN:35440 manufactured by SE international, Inc. USA). The meter's sensitivity is 3500 mR/hr referenced to Cs-137 and its maximum alpha and beta efficiencies are 18% and 33% respectively. It has a halogen-quenched Geiger-Muller detector tube of 45mm effective diameter and a mica window density of 1.5-2.0$mgcm^{-2}$ (Inspector alert operation manual).

The readings were taken 10meters apart covering a distance of 100meters of the cardinal points (East, West, North and South) from the solid mineral sites and around the neighbouring environment. Also used for the study was a Geographical Positioning System (GPS) to locate and map-out the area.

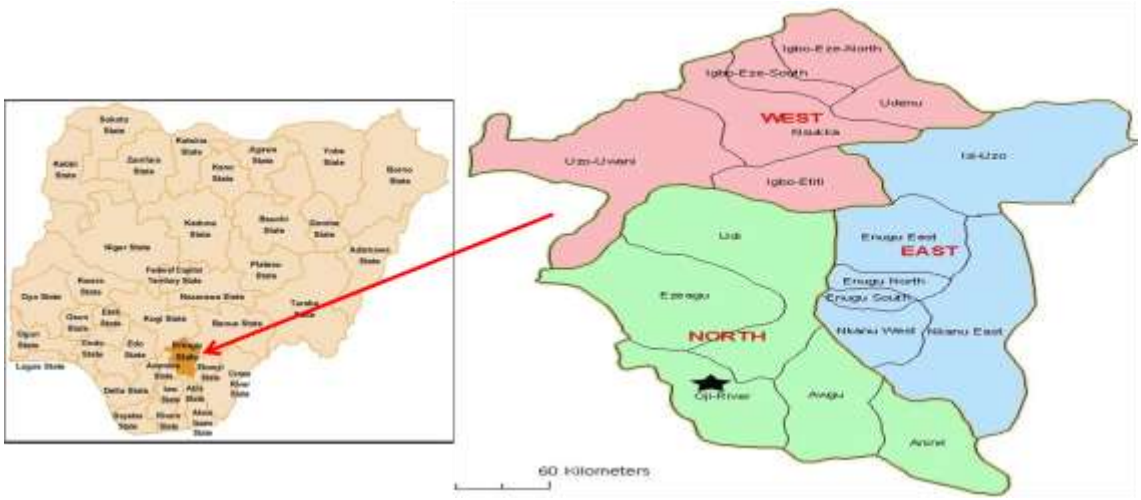

Fig. 1: Map showing the study area.

III. RESULTS

The results of the in-situ measurement of the background ionizing radiation levels of the study area are presented in Tables 2 to 4 and their comparison with standards displayedin Figures 1 to 3.

Table 2: BIR at Amagwu-Umuene, in Udi LGA of Enugu State
Elevation: 480m, Location: E007^{0}25′15.4″: N06^{0}34′03.7″. On the point **0.011mR/hr**

Distance from well 1 (m)	Background Ionized Radiation BIR (mR/hr)			
	East	West	North	South
10	0.011	0.013	0.013	0.011
20	0.015	0.011	0.013	0.015
30	0.014	0.015	0.014	0.012
40	0.011	0.014	0.013	0.019
50	0.016	0.012	0.013	0.010
60	0.010	0.012	0.013	0.011
70	0.013	0.015	0.014	0.016
80	0.017	0.017	0.018	0.013
90	0.010	0.012	0.025	0.015
100	0.010	0.014	0.017	0.014
Average	**0.013±0.0007**	**0.014±0.0005**	**0.015±0.0003**	**0.014±0.0002**

Table 3:Ogulogu-OloEzeagu in Ezeagu LGA of Enugu State
Elevation: 490m. **Location:** E007^0 08′12.2″ N06^{0}24′44.5″. On point **0.015mR/hr**

Distance from well 2 (m)	Background Ionizing Radiation BIR (mR/hr)			
	East	West	North	South
10	0.018	0.012	0.017	0.019
20	0.020	0.018	0.020	0.017
30	0.015	0.018	0.019	0.018
40	0.019	0.019	0.013	0.015
50	0.017	0.013	0.018	0.017
60	0.012	0.011	0.012	0.014
70	0.013	0.012	0.020	0.012
80	0.021	0.023	0.015	0.023
90	0.019	0.013	0.013	0.016
100	0.018	0.017	0.012	0.013
Average	**0.017±0.0002**	**0.016±0.0006**	**0.016±0.0007**	**0.017±0.0004**

Table 4: Maryland, Enugu South L.G.A of Enugu State
Elevation: 482m. Location: E007^{0}21$'$17.2$"$ N06^{0}40$'$31.2". On point 0.017mR/hr

Distance from GPS point (m)	Background Ionizing Radiation BIR (mR/hr)			
	East	West	North	South
10	0.012	0.019	0.014	0.011
20	0.014	0.014	0.016	0.018
30	0.011	0.011	0.015	0.019
40	0.015	0.012	0.012	0.015
50	0.012	0.016	0.011	0.014
60	0.017	0.014	0.014	0.016
70	0.011	0.013	0.021	0.012
80	0.020	0.021	0.022	0.019
90	0.013	0.019	0.017	0.020
100	0.018	0.017	0.019	0.013
Average	**0.014±0.0003**	**0.015±0.0006**	**0.016±0.0001**	**0.016±0.0008**

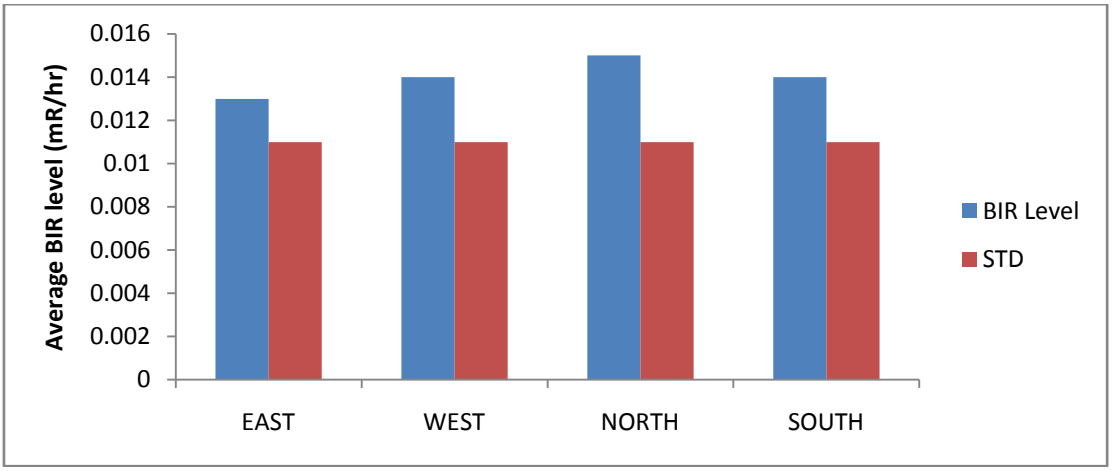

Fig. 2: Comparison of the measured BIR levels with standard BIR level for Amagu-Umuene, Udi LGA.

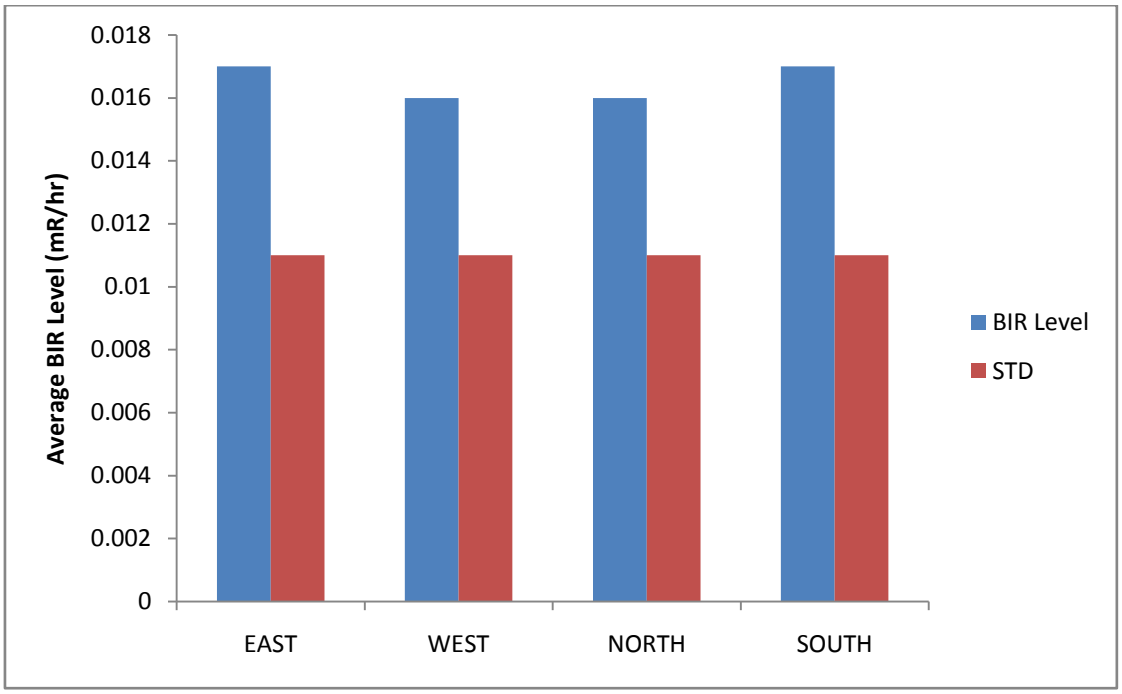

Fig. 3: Comparison of the measured BIR levels with standard BIR level for Ogulogu-Olo, Ezeagu LGA.

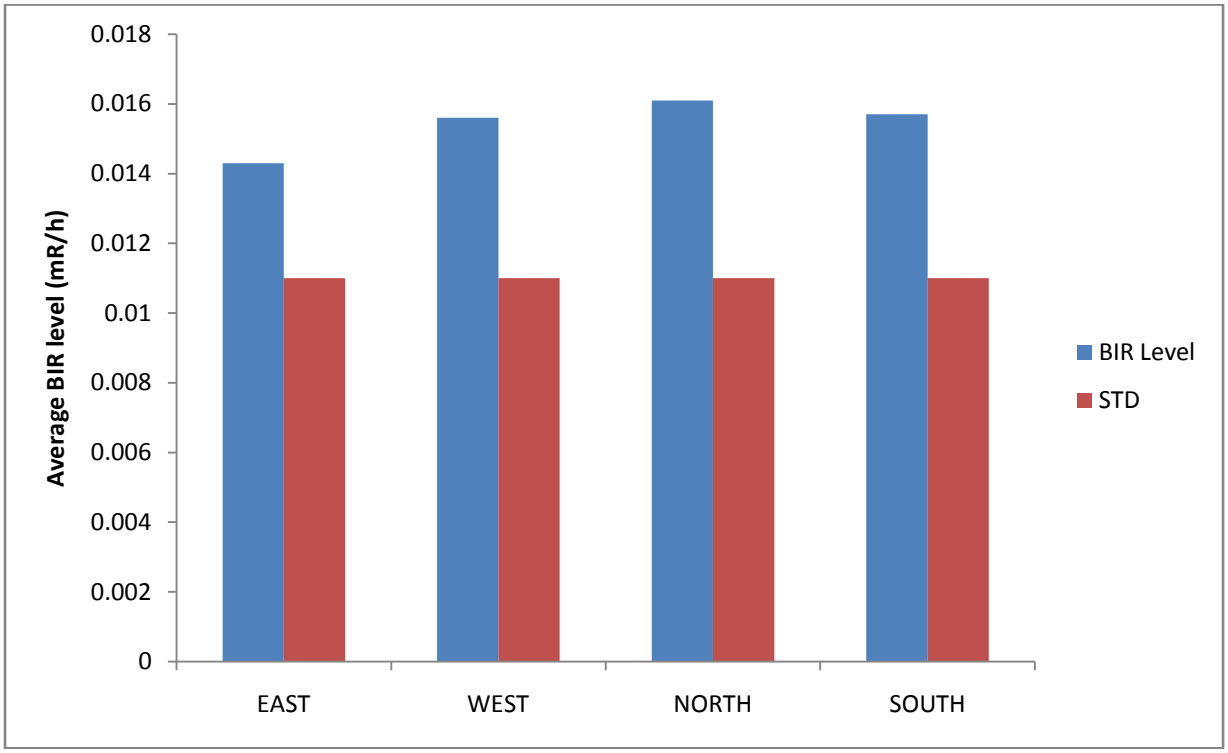

Fig. 4: Comparison of the measured BIR levels with standard BIR level for Maryland, Enugu South LGA.

IV. DISCUSSION OF RESULTS

Tables 2 to 4 show the results of the background ionizing radiation measurement carried out in three locations around the study areas. The exposure dose rate ranged from 0.010mR/hr to 0.025mR/hr with an average value of 0.014mR/hr at location 1 (Amagu-Umuene); 0.012mR/hr to 0.022mR/hr with an average of 0.0165mR/hr at the location 2 (Ogulogo-olo) and 0.011mR/hr to 0.022mR/hr with an average of 0.0153mR/hr at location 3. The total average BIR from the three local government areas is 0.0153 mR/hr.

Also, as shownon figures (2), (3) and (4) above, the background ionizing radiation measured from the study area is higher than the ICRP permissible values. The results showed that the BIR of the locations exceeded the standard BIR level.Amongst the three LGA's, Ezeagu LGA has the highest BIR value, followed by Enugu-South and then Udi LGA.

The measured radiation levels are comparable to the works of [9] and [18] whoundertook similar study that indicates that the BIR level from the study areas where higher than the stipulated BIR standard. The reason for the higher BIR value in the current study could be associated with the abundance of coal and other solid minerals in the environment and the high elevation of the study area. Though the values is not alarming when compared with the ranges shown in table 1 above, there is still need to put measures in place to control the exposure of humans to prevent any possible hazards.

V. CONCLUSION

This study has revealed that the background ionizing radiation of the solid mineral producing areas of Enugu state, Nigeria is higher than the recommended standard. The BIR of Bunker mines averaged 0.016mR/hr and that of Okpara mines, 0.017mR/hr, bringing the average of both to 0.0165mR/hr. Thisis an indicationthat the average BIR from both mines is 50% higher than the stipulated standard value. The high background radiation observed at the surveyed areas could be attributed to natural (cosmic and terrestrial) and artificial (coal mining) sources. The geology of the town suggests that the soil in the study area has a large deposit of coal. It is well known that coal contains high concentrations of uranium, thorium and potassium.

There is thus a need for a comprehensive radiological study in the areas covered by this work to ascertain the radionuclide responsible for the elevated gamma dose rates. There might be deposit of radioactive minerals around the survey areas. This study has established an external gamma dose rate for the people living around there and could serve as a baseline for setting up coal mines. From the foregoing, it isrecommended that control mechanisms be adopted for the members of the public thatapproach the area as well as to protect the environment.

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