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Radiation Exposure Level in some Granite Quarry sites within Ohimini and Gwer-East Local Government Areas of Benue State Nigeria

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Abstract

Radiation exposure level in some granite quarry sites in Ohimini and Gwer-East Local Government Areas of Benue State was carried out using radiation meter (radiation alert inspector). The research investigated only the exposure dose rate, the mean absorbed dose and the mean annual effective dose equivalent of the radiation. The investigation recorded a dose rate of 33.00-42.800 count per minute (CPM) with a background radiation of 23.00 (CPM), 31.200-42.200 count per minute with a background radiation of 18.00 (CPM), 36.00-51.00 count per minute with a background radiation of 20.00 (CPM) in Anmuda, Awulema and Ikpayongo quarry site respectively. The mean absorbed dose (Do) in Anmuda, Awulema and Ikpayongo are 12.3 nGy/h, 17.27 nGy/h and 18.87 nGy/h respectively and the corresponding mean Annual Effective Dose equivalent (AED) are 0.15 mSv/y, 0.21 mSv/y and 0.25 mSv/y which are below the recommended safe values. The investigated value falls within the global range of outdoor radiation exposure given by UNSCEAR.

Keywords: Radiation level; Dose rate; Absorb dose; Mean absorb dose; Annual effective dose

Introduction

Radiation is a reality of life because we live in a world in which radiation is naturally presents everywhere. Light and heat from nuclear reactions in the sun are essential to our existence.

Radioactive materials occur naturally throughout the environment and our bodies Contain radioactive materials such as carbon-14, potassium-40 and polonium-210 quite naturally. On Earth, all life has evolved in the presence of this radiation [1].

Radiation comes from disturbances or vibration of a system and the energies of the radiation depend on the energy-input into the system that caused the disturbance (instability). A stable system does not give out energy. Instability of the atomic system gives rise to atomic energy and instability in the nucleus of an atom gives rise to nuclear energy [1].

Radiation, either ionizing or non-ionizing can be found naturally within the environment where we live and their absorption levels depend on the distribution of natural radionuclides within that region. Activities of man such as mining in quarry sites can enhance the levels of environmental radiation.

Ionizing radiation comes from the nuclei of atoms, the basic building blocks of matter. Most atoms are stable, but certain atoms change or disintegrate into totally new atoms. These kinds of atoms are said to be 'unstable' or 'radioactive'. An unstable atom has excess internal energy, with the result that the nucleus can undergo a spontaneous change. This is called 'radioactive decay [2]. We all experience radiation from natural sources every day.

In Nigeria, mining activities like in granite quarry sites have been carried out since the beginning of the last century; however, their radiological investigation had started in 1970 by Sanni and 1981 by Babalola with a comprehensive analysis of their radionuclides composition. Mining activity can cause environmental pollution. This is because most of the accessories minerals are harmful even in low concentrations, to human beings and to animals. The mining of mineral resources also facilitates the release of radioactive materials from the host minerals into the environment [3].

Radiation can cause several hazards to man and the environment when and where radiation is not regulated and so exposure to radiation is expected to be within acceptable limits to avoid the risks. Some of the radiation risks ranging from malignancies and damage to genetic material have been observed from long term epidemiological studies of population exposed to radiation [4].

Effects of radiation as revealed through information come from studies of exposure groups and individuals, from animal experiment, and from studies at the cellular level. It is now well established that ionizing radiation has both prompt and delayed effects. Radiation doses of different sizes, delivered at different rates to different parts of the body, can cause different types of health effect at different times.

The energy transferred by ionizing radiation to the mass per unit volume, is called absorbed dose while the average dose per given time is called equivalent dose and the exposure is the amount of radiation received in a particular location per time. The probability of affecting the human health is directly related to the absorbed dose. The worldwide average natural dose to humans is about 2.4 mSv per year [5].

At very high radiation exposure, death will occur within several months or less. At moderate levels, exposure of radiation increases the chance that an individual will develop cancer, with a time delay of about ten years for most cancers. Similarly when the exposure level is low, the cancer risk decreases but the relationship between cancer risk and the size of the exposure is uncertain to determine. Among other risks, genetic effects and the exposure of fetus before birth with mental retardation, in terms of frequency of occurrence and severity of effects, cancer is the most serious consequence and receives the greatest attention [6].

As the United Nations agency for nuclear science and its peaceful applications, the IAEA offers a broad spectrum of expertise and programs to foster the safe use of radiation internationally. It has a statutory responsibility for the development of safety standards that are applicable to managing the wide variety of applications that use radiation. It provides assistance to its Member States on the application of those standards through technical co-operation projects such as training courses and advisory services. It also facilitates information exchange through conferences publications [7].

To ascertain whether or not the quarry sites are radiologically safe, this research was carried out in some selected granite quarry sites to compare the measured values with the safe level set by the radiation protection organizations or bodies like International Commission on Radiological Protection (ICRP).

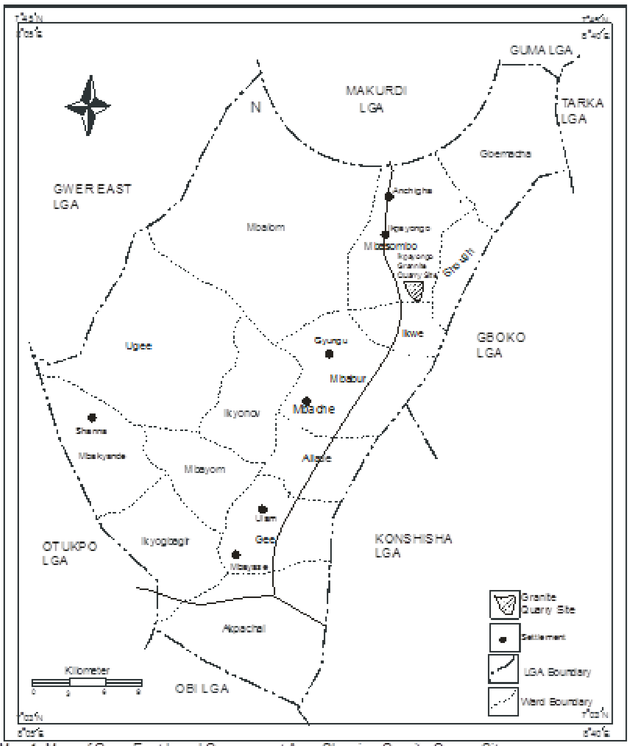
Materials and Methods

Geology of the area

Map 1 below shows the geographical location of Anmuda and Awulema in Ohimini Local Government Area while Map 2 shows the geographical location of Ikpayongo in Gwer-East local government area all in Benue State Nigeria. Anmuda lies within latitude 7.193° and longitude 8.09166° with a bearing of 249 and Awulema lies within latitude 7.22315° and latitude 8.09166° with a bearing of 262. Ikpayongo lies within latitude 7.58157° and longitude 9.69039° with a bearing of 288° [8].

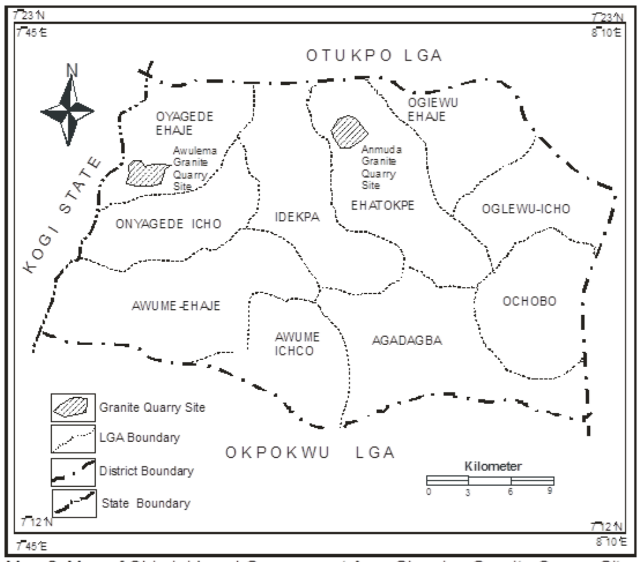
The maps of the study areas are represented in **Figures 1 and 2** as shown below.

The assessment of the present of radiation in the sites was carried out using radiation meter (radiation alert inspector). The choice of this meter was based on its portability, sensitivity and response, which are appropriate since the radiation measurements are for low radiation field. The radiation measurement method used in this work was a direct observation and measurement of radiation level from various granite sites locations visited with the radiation inspector. The background radiation within the environment was measured at about 350 meters away from the sites.



Map 1: Map of Gwer East Local Government Area Showing Granite Quarry Site
Source: Ministry of Lands and Survey Makurdi

Figure 1 Showing the map of Gwer-East local government area.



Map 2: Map of Ohimini Local Government Area Showing Granite Quarry Sites
Source: Ministry of Lands and Survey, Makurdi

Figure 2 Showing the map of Ohimini local government area.

A small hand microprocessor attached to monitor was held about 4-5 cm above the sea level and the radiation emitted was recorded within an interval of one minute (60 seconds) each. Three different readings were taking in four different locations named; North, South, Center, East and West within each of the sites and an average reading was obtained from the three readings for measurement location in all the quarry sites. The average dose rate was measured in count per minute and converted to exposure dose rate using 1200 (CPM)=1 µSv/h as conversion factor. Also a conversion factor of 1 µSv/h=1000 nGy/h for absorbed dose rate enabled the estimation of annual effective dose rate [5].

Results

The following tables show a comparative result of the radioactivity measured in terms of dose rate and exposure in different locations within the three quarry sites with the use of radiation meter inspection.

Table 1 Doses at different locations in Anmuda quarry site with a background radiation of 23.0 Counts Per Minute (CPM).

S/No	Sample code	Dose rate (CPM)	Actual Dose rate(CPM)	Exposure (µSv/hr)	Annual effective Dose (mSv/yr)
1	NN1	40.500	16.900	0.014	0.172
2	NW1	36.500	12.900	0.011	0.135
3	NC1	40.300	16.700	0.014	0.172
4	NE1	42.000	18.400	0.015	0.184
5	NS1	36.000	12.400	0.010	0.123
6	NN2	37.500	13.000	0.011	0.135
7	NW2	33.000	9.4000	0.008	0.098
8	NC2	41.000	17.000	0.014	0.172
9	NE2	39.500	15.900	0.013	0.160
10	NS2	38.000	14.400	0.012	0.147
11	NN3	36.800	13.200	0.011	0.135
12	NW3	40.000	16.400	0.014	0.172
13	NC3	42.800	19.200	0.016	0.196
14	NE3	35.500	11.900	0.010	0.127
15	NS3	37.000	13.400	0.011	0.135
NN=Anmuda North; NW=Anmuda West; NC=Anmuda Center; NE=Anmuda East; NS=Anmuda South,					

Table 2 Doses in different locations in Awulema quarry site with a background radiation of 18.0 Count Per Minute (CPM).

S/No	Sample code	Dose rate (CPM)	Actual Dose rate(CPM)	Exposure (µSv/hr)	Annual effective Dose (mSv/yr)
1	WN1	41.000	23.000	0.019	0.233
2	WW1	38.000	20.000	0.017	0.208
3	WC1	40.200	22.200	0.019	0.233
4	WE1	40.800	22.800	0.019	0.233
5	WS1	31.200	13.200	0.011	0.135
6	WN2	38.800	20.000	0.017	0.208
7	WW2	42.000	24.000	0.020	0.245
8	WC2	41.000	23.000	0.019	0.233
9	WE2	36.400	18.400	0.015	0.184

10	WS2	38.500	20.000	0.016	0.196
11	WN3	40.000	22.000	0.018	0.221
12	WW3	41.500	23.500	0.020	0.245
13	WC3	36.000	18.000	0.015	0.184
14	WE3	35.800	17.800	0.014	0.172
15	WS3	42.200	24.200	0.020	0.245

Table 3 Doses in different locations in Ikpayongo quarry site with a background radiation of 20.0 Count Per Minute (CPM).

S/No	Sample code	Dose rate (CPM)	Actual Dose rate(CPM)	Exposure (µSv/hr)	Annual effective Dose (mSv/yr)
1	IN1	44.000	24.000	0.020	0.245
2	IW1	45.000	25.000	0.021	0.256
3	IC1	45.800	25.000	0.021	0.256
4	IE1	45.500	25.500	0.021	0.256
5	IS1	46.800	26.800	0.022	0.270
6	IN2	48.000	28.000	0.023	0.282
7	IW2	37.000	17.000	0.014	0.172
8	IC2	48.500	28.500	0.024	0.294
9	IE2	51.200	31.200	0.026	0.319
10	IS2	44.800	24.800	0.021	0.256
11	IN3	41.500	21.500	0.018	0.221
12	IW3	41.000	21.000	0.018	0.221
13	IC3	52.000	32.000	0.027	0.331
14	IE3	42.000	22.000	0.018	0.221
15	IS3	36.000	16.000	0.013	0.159

Discussion

Assessing the level of radiation in the granite quarry sites was to evaluate whether the levels of exposure are sufficiently high to the extent that radiological health effect may occur among the quarry workers and the people living around such areas to enable implementation of regulatory control. From **Tables 1-3**, this investigation recorded a dose rate of 33.00-42.800 count per minute (CPM) with a background radiation of 23.00 (CPM), 31.200-42.200 Count per Minute with a background radiation of 18.00 (CPM), 36.00-51.00 Count per Minute with a background radiation of 20.00 (CPM) in Anmuda, Awulema and Ikpayongo quarry site respectively. The mean absorbed dose (Do) in Anmuda, Awulema and Ikpayongo are 12.3 nGy/h, 17.27 nGy/h and 18.87 nGy/h respectively which are all lower than 30-70 nGy/h according to UNSCEAR 2000. Similarly, the annual effective dose rates in Anmuda, Awulema and Ikpayongo are 0.15 mSv/y, 0.21 mSv/y and 0.25 mSv/y which is all below the recommended safe value of 0.50 mSvy-1 by UNSCEAR (2000) [9].

Conclusion

The preliminary investigation shows that the mean absorbed dose (Do) in Anmuda, Awulema and Ikpayongo are 12.3 nGy/h, 17.27 nGy/h and 18.87 nGy/h respectively and the corresponding mean Annual Effective Dose equivalent (AED) are 0.15 mSv/y, 0.21 mSv/y and 0.25 mSv/y which are below the recommended safe values. However, further investigation is necessary to establish the types and concentrations of the radionuclides present in the granite in those quarry sites.

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