International Journal of Advanced Research in Physical Science (IJARPS)
Volume 1, Issue 6, October 2014, PP 56-62
ISSN 2349-7874 (Print) & ISSN 2349-7882 (Online)
www.arcjournals.org

Investigation of the Radiation Exposure Rate and Noise Levels within Crush Rock Quarry Site in Ishiagu, Ebonyi State, Nigeria

P.I. Enyinna, M. Onwuka

Department of Physics, University of Port Harcourt Choba,
Port Harcourt, Rivers State, Nigeria.
paschal.enyinna@uniport.edu.ng
maduonwus@gmail.com

Abstract: *Environmental assessments of background radiation exposure rate and noise levels were carried out using radalert-100 and B.K 732 sound meter. The results obtained showed that the zonal mean radiation exposure rate ranged from 12.7 µR/hr to 14.6 µR/hr. also, the mean noise level ranged from 55.6 dB (A) to 106.5 dB (A) as compared to the control background noise level of 49.0 dB (A). Most of these results showed an elevation over the control and standard limits with respect to noise levels. These elevations could be attributed to the quarrying activities. Therefore, these quarry workers ought to be protected to avoid much occupational hazard.*

Keywords: *Radiation Exposure, Noise level, Quarry site, Radiation survey, Noise survey*

1. INTRODUCTION

Radionuclides that were part of the original composition of the earth and their progenies emit gamma radiation which contributes to a large share of environmental radiation dose [1]. Although most of the gamma photons emitted in the subsurface are absorbed by the ground, solid mineral mining and quarrying activities perturb the subsurface content of the earth and have the capability of harnessing the environmental background radiation. Radionuclides exist everywhere on Earth – atmosphere, surface soil and subsurface rocks and radiation from these radionuclides mainly depends on geological and geophysical Conditions, the radiation being higher in igneous (e.g. granite) and lower in sedimentary rocks with the exception of shale and phosphate rocks which in some cases may have relatively high content of radionuclides [2]

Quarrying activities produce a lot of dust particles which can be transported away from the source. Enger and Smith [3] reported that radionuclides from dust owing to their half-life can linger on the environment for a long time and can cause mutation, abnormality and cancer to human tissues. Okeke and Okoro [4] emphasized that granite dust radio-elements of about 0.3µm in diameter when deposited on building surfaces, furniture, equipment, etc could cause soiling or damage the materials. This deposited dust facilitates corrosion rate in metals and causes alteration in climatic environment. Acute inhalations of radioactive elements have been reported in animal studies to have caused inflammatory reactions in the nasal passage and kidney damage [5].

In quarrying operations, high level noise is being introduced into the environment through drilling, blasting, crushing, noise from generating sets, haulaging etc. According to Muhammad and Huma [6], the general meaning of 'noise' is an over loud or disturbing sound, which breaks the calmness of the atmosphere and the undesirable level of sound may adversely affect the health and well-being of the individuals or the community.

Heavy equipment that are used at quarry sites generate noise and this is more pronounced when they have faulty parts. Nte [7] reported that apart from all the negative impacts of noise, it could be a good indicator of faults in engines and machines. It could also serve as an alarm for most physical systems.

Among all the complaints resulting from Quarrying activities, of major concern is blasting which is necessary to break down the rocks from the ground for subsequent processing into aggregates [8]. Blasting and crushing of rocks generate so much noise. Quite communities Act [9], shows a link between noise and health. Problems related to noise include stress related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption and reduction in productivity. Noise pollution affects both health and behavior, and can damage psychological health. It can cause hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances and other harmful effects. Stress and hypertension are the leading causes to health problems associated with noise [10]. Among the negative impacts of noise are that it affects workers productivity, scares away wildlife and distorts birds' sanctuary [11].

So many environmental laws and edicts have been enacted both locally and internationally to guide against the negative impacts of quarrying activities on the workers, the populace and the ecosystem but in many cases, these laws have been neglected by the operators of quarry sites. This research work was carried out in a bid to assess the background radiological and noise levels within Ishiagu quarry site to ascertain the level of compliance with safety standards.

2. STUDY AREA

Ishiagu is a town in the Ivo Local Government Area in Ebonyi State, Nigeria, located on the plains of South-Eastern Savanna belt. According to [12], Ishiagu area of the southern end of the lower Benue trough of Nigeria is associated with the occurrence of igneous intrusion and volcanic with sedimentary rocks. Ishiagu lies within latitudes 5º52'– 6º00' N and Longitude 7º30'-7º35' E. Ishiagu area is generally a dominant low lying to gentle undulating shaly terrain of 85-100m above sea level and punctuated by few isolated low hills [13].

There are many mineral deposits in Ebonyi State as identified by [14]; these include Lead, Zinc, Copper, Gypsum, Granite, Limestone, Marble stone, Aluminium, False gold, Uranium, Igneous rock among others. Presently, quarrying activities are going on within Ishiagu locality due to its richness in solid mineral deposits. Picture showing quarrying activities taking place in Ishiagu quarry site with dust particles spreading within the immediate environment is presented in Fig 1.

Fig 1. *Picture showing quarrying activities taking place in Ishiagu quarry site*

3. MATERIALS AND METHODS

3.1. Radiation Survey

An in-situ approach of background radiation measurement using a nuclear radiation monitor (Radalert-100) and Digialert was adopted in this measurement. These two radiation meters were

set to the total count-mode and the counting taken for a timed period of five (5) minutes with the end windows facing the point under investigation. A timed total count was preferable in determining the average counts per minute over a period of time since the number of counts detected by the Radalert-100 varies from minute to minute due to the spontaneous nature of radioactivity [15]. At the end of the timed period, the radiation meters beeped three times, and repeated the beeping several times. The number displayed at this point is the total count. These measurements were carried out at 7 different locations between the hours of 8.00 am to 3:30 pm when generators, crushing, blasting, drilling and haulaging operations are usually on (referred to as Active Radiation Exposure). 7 different measurements were done for each location using each of the 2 radiation meters.

The mean total count was computed as follows:

$T_m = (\text{Count 1} + \text{Count 2}) \div 2$ (1)

The average count per minute was computed as follows:

$CPM = T_m \div 5$ (2)

The mean exposure rate was computed in µR/hr by using the approximate relation [15];
$1000CPM = ImR/hr$ (3)

Therefore, 1 CPM = 1 µR/hr (4)

The results of the active mean radiation exposure rate were compared with the mean background radiation (measured during non-working hours). The mean percentage (%) deviation from background radiation (PR) was computed using the equation;

$$PR = \left[\frac{(AR-BR)}{BR}\right] \times 100 \quad (5)$$

Where AR = Mean Active Radiation Exposure, BR = Mean Background Radiation Exposure

The standard errors in the mean presented in the result were calculated using the formula, Standard Error in the mean;

$$S.E = \frac{\sigma}{\sqrt{n}} \quad (6)$$

Where σ is standard deviation and n is number of measurements taken.

3.2. Noise Level Survey

In taking the noise level measurements, the digital noise level meter (B.K precision 732 models) was held at arm's length at the ear height estimated to be 1.2 and 1.5 meters above the ground level [16]. The readings were taken on slow response rate since noise level measurements should preferably be taken on slow response. These measurements were carried out at 7 different locations between the hours of 8.00 am and 3:30 pm when crushing, blasting, drilling and haulaging operations are usually on (referred to as Active Noise Levels). 14 different measurements were done for each location and the mean active noise levels recorded against each location.

The results of the mean active noise levels were compared with the mean background noise levels (measured during non-working hours). The mean percentage (%) deviation from background noise level (PB) was computed using the equation;

$$PB = \left[\frac{(ANL-BNL))}{BNL}\right] \times 100 \quad (7)$$

Where, ANL = Mean active noise Level and BNL = Mean background noise level

4. RESULTS AND DISCUSSION

The results of zonal mean radiation exposure rate measured within the surveyed area have been presented in table 1 and illustrated in figure 1. The results show that the exposure rate ranged between 12.7 ± 1.1µR/hr to 14.6 ± 2.5 µR/hr, whereas the background exposure rate (control) recorded was 13.3 ± 1.1µR/hr. These results indicate a mean deviation range of between - 4.5% and 9.8% from the background radiation exposure rate within the surveyed area (tagged

background radiation). Also, most of the recorded exposure rates were above the normal background ionization radiation of between 11 µR/hr and 13 µR/hr, as have been recorded within this south eastern region of Nigeria by previous researchers [16]. This deviation in radiation exposure rate could be attributed to natural radioactivity of granite rock as well as the formation of carbon monoxide due to incomplete combustion of fuel from vehicular sources, generators and heavy duty machines used in the study area.

The results of noise exposure levels measured within the surveyed area have been presented in table 2 and illustrated in figure 2. These results show that the noise exposure levels measured, ranged between 55.6 dB (A) and 106.5 dB (A) whereas, the background noise exposure level was 49.0 dB (A). These results indicate a deviation range of between 13.5% and 117.3% from background noise exposure level within the surveyed area. This range of deviation is high and according to [16], could bring about normal speech interference which could lead to a number of personal disabilities, handicaps, and behavioral changes which may include problems with concentration, fatigue and irritation. The deviation could equally bring about sleep disturbance and serious annoyance which may bring about long-term effects on health and well-being. The range of noise levels recorded in this work is comparable to the range of between 70.2 dB (A) and 96.8 dB (A) recorded by [11] around a quarry site in Uturu, Nigeria. The maximum noise level of 106.5 dB (A) was recorded at the point designated dynamite safe distance (where staff converge during rock blasting). From figure 2, the noise levels recorded during the survey were higher than World Health Organization (WHO) limit set for speech interference, sleep disturbance and serious annoyance given as 35 dB(A), 45 dB(A) and 55 dB(A) respectively [17]. The noise exposure levels measured at crusher plant area, generator house and dynamite safe distance were higher than the [18] limit of 90 dB(A) for 8 working hours and WHO limit of 85 dB(A) set for hearing impairment.

Table 1. *Results of Mean Radiation Exposure Rate Recorded during Radiation Measurement at Crushed Rock Mining Site, Ishiagu*

S/N	Location	Maximum Count (cpm)	Minimum Count (cpm)	Mean Count (cpm)	Mean Radiation Exposure (µR/hr)	Deviation from Background Radiation (%)
1	Pit Quarry Area N05^{0}57′; E007^{0}34′	15.2	11.6	13.8	13.8±0.3	3.8
2	Crusher Plant Area N05^{0}56′; E007^{0}34′	15.5	11.3	13.6	13.6±2.5	2.3
3	Administrative Block N05^{0}57′; E007^{0}34′	16.0	13.2	14.6	14.6±2.5	9.8
4	Generator House N05^{0}56′; E007^{0}34′	15.0	11.7	13.3	13.3±6.3	0.0
5	Maintenance/Scrap Yard N05^{0}57′; E007^{0}34′	13.6	9.9	12.7	12.7±1.1	- 4.5
6	Main Entrance Portal N05^{0}56′; E007^{0}34′	13.8	11.7	12.8	12.8±0.4	-3.8
7	Dynamite Safe Distance N05^{0}56′; E007^{0}34′	13.4	13.4	13.4	13.4±6.4	0.8
8	Control N05^{0}51′; E007^{0}30′	14.1	12.5	13.3	13.3±1.1	0.0

Table 2. *Results of Mean Noise Levels Recorded during the Noise Survey at Crushed Rock Mining Site, Ishiagu*

S/N	Location	Maximum Noise Level (dBA)	Minimum Noise Level (dBA)	Mean Noise Level (dBA)	Deviation from Background Noise Level (%)
1	Pit Quarry Area N05^{0}57′; E007^{0}34′	93.5	65.5	78.1	59.4
2	Crusher Plant Area N05^{0}56′; E007^{0}34′	102.5	83.0	93.1	90.0
3	Administrative Block N05^{0}57′; E007^{0}34′	59.0	50.0	55.6	13.5
4	Generator House	107.0	85.5	94.2	92.2

	N05^{0}56′; E007^{0}34′				
5	Maintenance/Scrap Yard N05^{0}57′; E007^{0}34′	71.5	64.5	67.3	37.3
6	Main Entrance Portal N05^{0}56′; E007^{0}34′	83.5	77.5	80.6	64.5
7	Dynamite Safe Distance N05^{0}56′; E007^{0}34′	106.0	107.0	106.5	117.3
8	Control N05^{0}51′; E007^{0}30′	51.5	46.5	49.0	0.0

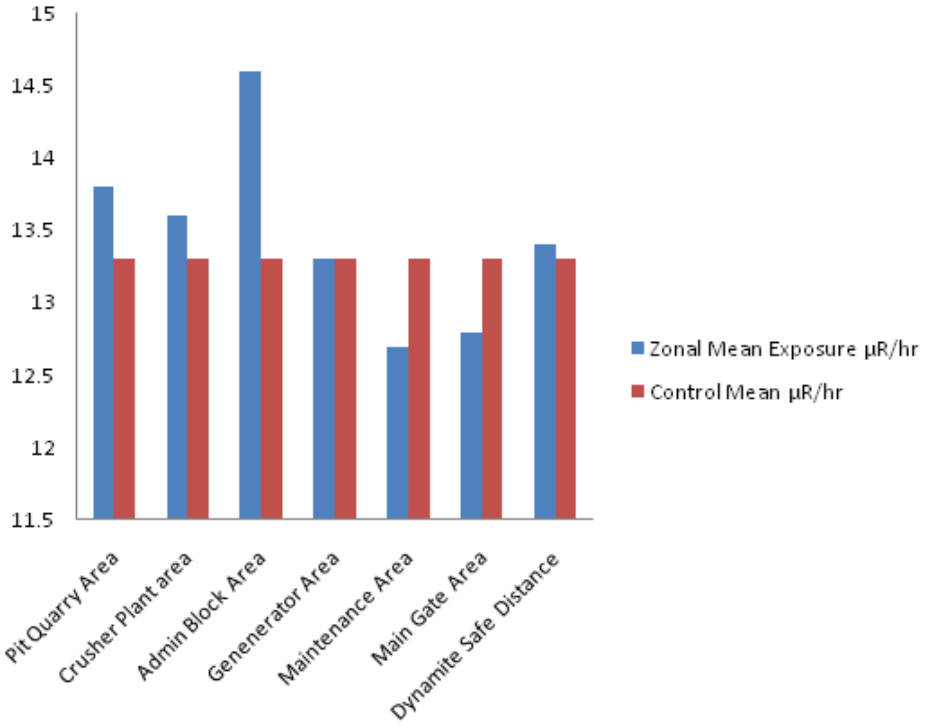

Fig 1. *Bar chart comparing the mean radiation exposure rate with control mean*

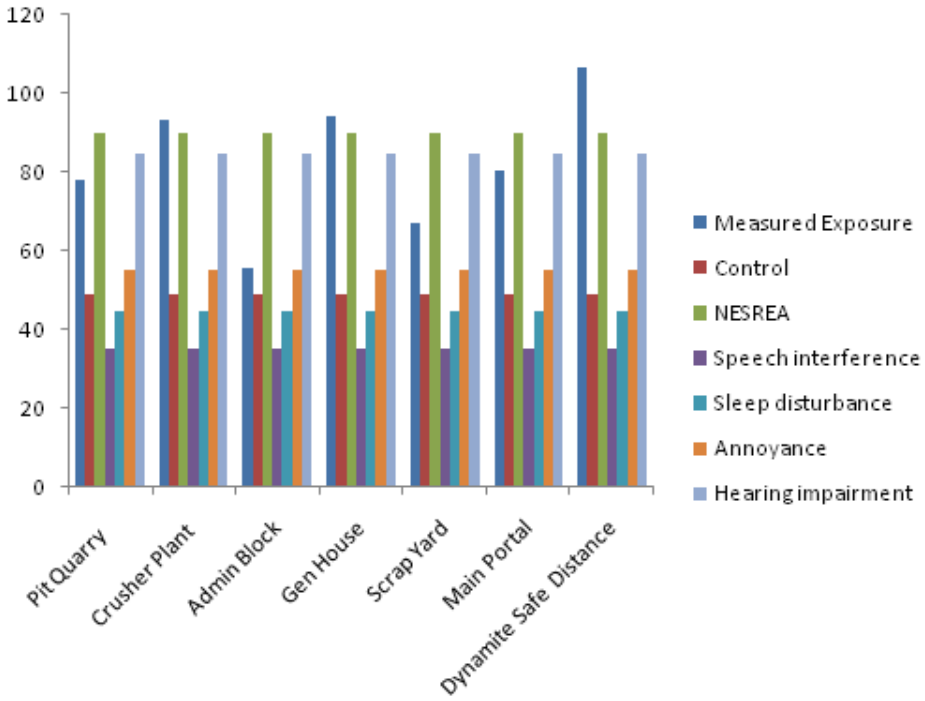

Fig 2. *Bar chart comparing measured noise levels with permissible standards*

5. CONCLUSION

The investigation of the radiation exposure rate and noise exposure levels have been carried out within Ishiagu quarry site. The results showed that the measured radiation exposure rates within the site were within the range of 11 µR/hr to 13 µR/hr, as have been recorded within the south eastern region of Nigeria by previous researchers [16]. These levels of radiation exposure may not pose any immediate negative health impact on the workers and the populace. The results of the noise exposure levels indicate high level of deviation in the negative sense from permissible standards. Exposure to this noise is capable of detoriating both the psychological and health status of those who are occupationally affected and the populace. The environmental agencies in the country should assist to ensure that operators of quarry sites comply with environmental standards.

REFERENCES

[1] Shapiro, J. Radiation Protection, A Guide for Scientists and Physicians, Second Edition, (Harvard University Press, Cambridge), 1981, Part vi, Pp 356.

[2] Joshua, E.O., Ehinola, O.A, Akpanowo, M. A. and Oyebanjo, O.A European Journal of Scientific Research ISSN 1450-216X Vol.23 No.2 (2008), pp.305- 316.

[3] Enger E. D. & Smith B. F, Environmental Sciences, a study of interrelationship (8th Edition), McGraw-hill Higher Education, New York. Pg.372-372, (2002).

[4] Okeke F. N and Okoro E. C., Aerosol Research in Nigeria, Nigeria Journal of Space Research 9:17-36, (2010).

[5] ATSDR (Agency for Toxic Substances and Diseases Registry), Toxicological profile for radon. Public Health Services, US Department of Health and Human Services, Atlanta G.A., (1999).

[6] Muhammad, A. K. S. and Huma, B. Psychological and physiological effects of noise pollution on the residents of major cities of Punjab (Pakistan), Peak Journal of Physical and Environmental Science Research Vol.1(4), pp. 41-50, (2013).

[7] Nte F. I., Environmental Physics Research, Nigeria. A case study of the Niger Delta, an Executive Summary. Pearl Communication Publisher, Port Harcourt, (2005).

[8] Omosanya, K.O. and Ajibade, O.M., Environmental Impact of Quarrying on Otere Village, Odeda, Southwestern Nigeria, Ozean Journal of Applied Sciences 4(1), 75, (2011),

[9] Quit community Act, Public Law (95-609) amended portion of the 1972 Noise Control Act, (1978).

[10] Field J. M., Effect of personal and structural variables upon noise annoyance on residential areas, journal of the acoustical society of America, 93-2753-2763, (1993).

[11] Etusim, P.E.1, Njemanze, G.1, Efekalam I. C. and Onwuegbuche A.A., The Environmental Impact Assessment of Quarry Mining on Noise Pollution in Uturu Community, Abia State, Nigeria, Journal of Environmental Sciences and Policy Evaluation, Vol. 3, Number 1, 2013.

[12] Chiadikobi, K.C., Beka, F.T. and Chiaghanam, O.I. , Structural Attributes of Igneous Intrusives in Ishiagu Area of Ebonyi State, Nigeria, Scholars research library, Archives of Applied Science Research, 2011, 3 (5):390-403

[13] Ezepue M. C., Geologic setting of lead –zinc deposit at Ishiage, South-Eastern Nigeria, Journal of Africa Earth Science, Vol. 2, Pg.97- 101, (1984).

[14] Ebure,C.I. and Ezeribe, I.E, Geology of Ishiagu Area, Eastern Nigeria. Unpublished BSc Project, University of Nigeria, Nssuka (1997).

[15] Radalert-100 Users Technical Manual, Toms Gadgets, 74 Upper Green Road, Tewin, Herdfordshire,(2007).

[16] Enyinna P. I., Background Noise and Radiation Levels. Perturbation within Rumuodara Residential Area, Port Harcourt Nigeria. Journal of Fizik Malaysis vol.33.No.4.2013.

[17] Berglund, B., Lindvall, T. and Schwela, D. H., Guidelines for community noise, WHO-expert task force meeting, London, UK., (1999).

[18] NESREA, Federal Republic of Nigeria, Official Gazette vol.96.No.63, (2009).

AUTHORS' BIOGRAPHY

Dr. Enyinna, Paschal Ikenna holds a Doctor of Philosophy degree (PhD) in Environmental Physics from the University of Port Harcourt, Nigeria. His core research interest is in the Physics of Radiation. He lectures in the Department of Physics, University of Port Harcourt, Nigeria. He is currently the Departmental Coordinator of Postgraduate Programmes and Research Liaison Officer. He is an Environmental Consultant and has attended so many conferences and professional trainings locally and internationally. He also has many scholarly awards to his credit.

Onwuka Maduabuchi holds a Postgraduate Diploma Certificate in Radiation Physics and Environmental Protection from Rivers State University of Science and Technology, Port Harcourt and Master of Science Degree in Environmental Physics from University of Port Harcourt, Nigeria. He is into academic research especially, in the area of environmental monitoring.