Environmental Research Journal 2 (6): 348-350, 2008
ISSN: 1994-5396

Radiation Exposure to Workers and Villagers in and Around Some Quarry Sites in Ogun State of Nigeria

R.K. Odunaike, V.C. Ozebo, S.K. Alausa and I.M. Alausa
Department of Physics, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria

Abstract: In this research, the authors employed radiation detection methods to examine the radiation intensity or exposure at 5 quarry sites and their respective neighborhood villages in Ogun State of Nigeria. The highest annual dose rate or exposure of 49.1 μSv year^{-1} was recorded at Equation Limited (Q_3) in Obafemi Owode Local Government area in Ogun State of Nigeria. However, this result (49.1 μSv year^{-1}) and others from the remaining locations or sites are smaller than the world average of 70 μSv year^{-1} but recommended that workers at quarry sites should always put on masks to eliminate or reduce the amount of radioactive inhalation. Regular comprehensive monitoring of radiation level of each worker by putting on Thermo Luminescent Dosimeters (TLDs) which could be read and interpreted must be encouraged.

Key words: Radiation exposure, radiation detection, quarry site, world average motivation, neighbourhood

INTRODUCTION

Granite rocks are among the numerous Naturally Occurring Radioactive Materials (NORM). Today, these naturally occurring radioactive materials or sources deliver a large collective dose to the world population than do all man-made (artificial) sources combined.

However, granite rocks contain high concentration of radionuclides like uranium, thorium and potassium with uranium and thorium incorporated into the granite rocks in the crystallization of the last magma and residual solutions since their large ionic radii stop them from crystallizing out in the early silicates (Shiva *et al*., 2008).

Work activities, involving naturally occurring radioactive materials are potential sources of radiation exposures to workers and members of the public in general (Mustapha *et al*., 2007)

The activity at any quarry site involves blasting and crushing of granite rocks. The processing is open and a majority of it is manual, thus a lot of dust is raised. Besides, the radionuclides contained in the granite rocks emits ionizing radiation to the environment of the quarry, hence the workers are subjected to radiation exposure. The villagers around such sites are also susceptible to radiation exposure. As a result of this, it is important to measure or survey the radiation exposure rates at quarry sites.

In view of the type of basement complex with the granite rocks, Abeokuta and its immediate environs are on high background radiation levels. Therefore, motivated the survey of ionizing radiation from 5 quarry sites in Abeokuta the capital of Ogun State in the southern part of Nigeria and its immediate environs.

MATERIALS AND METHODS

Study area: The measurement conducted in June, 2007 was carried out in five quarry sites and their respective neighborhood villages in Ogun State. Ogun State that presently has a population of 3,658,098 as adapted by recent headcount in Nigeria had undergone considerable industrialization since its creation in 1976.

It has a land mass area of 16,409.26 km^2 and lie within longitude 2.5 and 5.0° E and latitude 6.0 and 8.0°N. The State shares boundaries with Oyo in the north, Lagos and Atlantic Ocean in the south, Ondo State in the east and Republic of Benin in the west.

Two of the quarry sites are located at Abeokuta Local Government area and three at Obafemi Owode Local Government area. The sites at Abeokuta North Local Government area are Associated granite Industry (Q_1), United Industry (Q_2) and their respective neighborhood villages are Sekere (QV_1) and Mologede (QV_2).

The sites at the Obafemi Owode Local Government area are Equation Limited (Q_3), Verytacs Limited (Q_4) and Phoenix Quarry (QV_5) and their respective neighborhood villages are Abule Jaguna (QV_3), Aberu Agba (QV_4) and Obafe (QV_5).

Corresponding Author: R.K. Odunaike, Department of Physics, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria

Measurement technique: A rapid method of assessing total radiation intensity was employed in the study, thus a typical portable cutie pie scintillation survey meter specified as Panoramic Victoreen was used to detect and measure the radiation exposure rate. The survey meter, model 407A, serial number 4093 has twelve overlapping ranges and is switchable between integral mode, where the measurements can be read in subdivisions of Rad (R) and count rate mode where the measurements are expressed in subdivisions of rad h^{-1} (R/h). The survey meter is run by two 1.5V D batteries and has temperature dependence less than 0.2% per degree Celsius. The humidity limits are 0-99% non-condensing.

Measurements were made randomly at 20 points at each quarry site and village. Three readings were taken and the average calculated at each point considered because radioactivity measurement or process is a statistical phenomenon.

At each point, the meter was held at the gonald level i.e., about 1.0 m above the ground level, switch on and µrad h^{-1} range was selected

The radiation dose rate in µrad h^{-1} from the meter was then converted to µGy h^{-1} using the relation

$$1.0 \text{ rad} = 1.0\times10^{-2} \text{ Gy}$$

Thus, 1.0 µrad h^{-1} = 10.0×10^{-9} Gy h^{-1}

In the recent (Turhan *et al*., 2007) research work, a value of 0.7 Sv/Gy was used for the conversion from radiation dose in air to effective dose received by the public and 0.2 for the outdoor occupancy factor, implying that an average of 20% of time is spent outdoors around the entire world.

Thus the annual dose rate in µSv $year^{-1}$ was calculated using:

$$H_R = D_R \times u \times K \times 8766$$

Where:

- H_R = Annual effective dose measure in µSv $year^{-1}$.
- D_R = The absorbed radiation dose in air measured in nGy h^{-1}.
- U = 0.2 (Outdoor occupancy factor).
- K = 0.7 Sv/Gy (conversion factor).

RESULTS AND DISCUSSION

From Table 1a, the mean annual dose rate at the quarry sites varies. Equation limited (Q_3) in Obafemi Owode has the highest dose rate of 49.1 µSu $year^{-1}$ while both the Associated Granite Industry (Q_1) and United Industry (Q_2) in Abeokuta North have the least radiation dose of 24.6 µSu $year^{-1}$ each as shown in Table 1b.

Table 1a: Dose rate, D_R (nGy h^{-1}) in the 5 quarry sites

Locations	Q_1	Q_2	Q_3	Q_4	Q_5
1	19.0	20.0	36.0	28.0	34.0
2	20.0	20.0	39.0	32.0	37.0
3	21.0	19.0	43.0	31.0	35.0
4	20.0	23.0	41.0	34.0	36.0
5	18.0	18.0	40.0	36.0	33.0
6	20.0	22.0	42.0	32.0	34.0
7	22.0	19.0	41.0	33.0	35.0
8	20.0	23.0	40.0	32.0	34.0
9	18.0	22.0	42.0	34.0	36.0
10	22.0	17.0	38.0	37.0	35.0
11	20.0	18.0	36.0	36.0	36.0
12	21.0	20.0	42.0	34.0	34.0
13	22.0	21.0	39.0	33.0	37.0
14	18.0	19.0	41.0	30.0	35.0
15	20.0	21.0	40.0	34.0	37.0
16	20.0	21.0	41.0	32.0	33.0
17	21.0	18.0	38.0	35.0	34.0
18	19.0	22.0	42.0	33.0	35.0
19	20.0	20.0	40.0	30.0	34.0
20	19.0	17.0	39.0	34.0	37.0

Table 1b: Annual effective dose (µSu $year^{-1}$) in the 5 quarry sites

Locations	Q_1	Q_2	Q_3	Q_4	Q_5
1	23.3	24.6	44.2	34.4	41.7
2	24.6	24.6	47.9	39.3	45.4
3	25.8	23.3	52.8	38.0	43.0
4	24.6	28.2	50.3	41.7	44.2
5	22.1	22.1	49.1	44.2	40.5
6	24.6	27.0	51.6	39.3	41.7
7	27.0	23.3	50.3	40.5	43.0
8	24.6	28.0	49.1	39.3	41.7
9	22.1	27.0	51.6	41.7	44.2
10	27.0	20.9	46.6	45.4	43.0
11	24.6	22.1	44.2	44.2	44.2
12	25.8	24.6	51.6	41.7	41.7
13	27.0	25.8	47.9	40.5	45.4
14	22.1	23.3	50.3	36.8	43.0
15	24.6	25.8	49.1	41.7	45.4
16	24.6	25.8	50.3	39.3	40.5
17	25.8	22.1	46.6	43.0	41.7
18	23.3	27.0	51.6	40.5	43.0
19	24.6	24.6	49.1	36.8	41.7
20	23.3	20.9	47.9	41.7	45.4
Mean	24.6	24.6	49.1	40.5	43.0

Infact the dose rate in any of the quarry sites at Obafemi Owode is higher than the dose rate from any quarry site at Abeokuta North. This implies that the granite rocks at Obafemi Owode emit ionizing radiation higher than those in Abeokuta North. So the workers at the quarry sites in Obafemi Owode are more vulnerable to radiation dose than the workers at the quarry sites in Abeokuta North.

From Table 2a, the mean annual dose rate at the villages also varies. The highest recorded dose rate of 40.5 µSu $year^{-1}$ is from Aberu Agba (QV_4) village which is in the vicinity of Verytacs Limited (Q_4).

The annual dose rate measured at Sekere (QV_1) and Mologede (QV_2) villages were same 24.6 µSu $year^{-1}$. This could be due to the closeness of the villages to their respective quarry sites shown in Table 2b.

Table 2a: Dose rate, D_R ($nGy\ h^{-1}$) measured in the 5 villages

Locations	QV_1	QV_2	QV_3	QV_4	QV_5
1	18.0	20.0	24.0	30.0	31.0
2	19.0	19.0	26.0	34.0	29.0
3	20.0	21.0	27.0	33.0	33.0
4	22.0	22.0	25.0	33.0	28.0
5	21.0	20.0	24.0	34.0	30.0
6	20.0	20.0	25.0	32.0	31.0
7	17.0	19.0	26.0	31.0	28.0
8	19.0	20.0	25.0	34.0	30.0
9	20.0	21.0	27.0	33.0	29.0
10	19.0	19.0	26.0	34.0	32.0
11	18.0	20.0	25.0	35.0	33.0
12	19.0	21.0	23.0	30.0	31.0
13	20.0	18.0	25.0	34.0	28.0
14	22.0	19.0	24.0	32.0	27.0
15	21.0	20.0	26.0	35.0	33.0
16	20.0	20.0	24.0	34.0	31.0
17	21.0	22.0	23.0	34.0	27.0
18	22.0	20.0	25.0	35.0	32.0
19	20.0	19.0	24.0	33.0	29.0
20	22.0	20.0	26.0	30.0	30.0

Table 2b: Annual effective dose H_R ($\mu Su\ year^{-1}$) in the 5 villages

Locations	QV_1	QV_2	QV_3	QV_4	QV_5
1	22.1	24.6	29.5	36.8	38.0
2	23.3	23.3	31.9	41.7	35.6
3	24.5	24.7	33.1	40.5	40.5
4	27.0	27.0	30.7	40.5	34.4
5	25.8	24.6	29.5	41.7	36.8
6	24.5	24.6	30.7	39.3	38.0
7	20.9	23.3	31.9	38.0	34.4
8	23.3	24.6	30.7	41.7	36.8
9	24.5	25.8	33.1	40.5	35.6
10	23.3	23.3	31.9	41.7	39.3
11	22.1	24.6	30.7	43.3	40.5
12	23.3	25.8	29.2	36.8	38.0
13	24.6	22.1	30.7	41.7	34.4
14	27.0	23.3	29.5	39.3	33.1
15	25.8	24.6	31.9	43.0	40.5
16	24.6	24.6	29.5	41.7	38.0
17	25.8	27.0	28.2	41.7	33.1
18	27.0	24.6	30.7	43.0	39.3
19	24.6	23.3	29.5	40.5	35.6
20	27.0	24.6	31.9	36.8	36.8
Mean	24.6	24.6	30.7	40.5	36.9

The Abule Jaguna and Obafe villages recorded less radiation dose rates than their respective quarry sites. This obeys inverse square law.

Obed *et al.* (2005) reported a dose rate of 24.6 $\mu Su\ year^{-1}$ in the Population dose distribution to soil radiaoactivity concentration levels in 18 cities across Nigeria. This is in agreement with the mean value obtained in the present study from each of either quarry or village sites in Abeokuta North Local Government Area. But the value is smaller than the mean value 30.7 $\mu Su\ year^{-1}$ obtained at Abule Jaguna (QV_3) and almost one-half of the highest mwan value 49.1 $\mu Su\ year^{-1}$ obtained Equation Limited Q_3 all in Obafemi Owode Local Government Area. None of the values from the present work nears the extraneous value of 10.6 $\mu Su\ h^{-1}$ (9.3×10^4 $\mu Su\ year^{-1}$) obtained for a *in-situ* measurements, in the Exposure to high background radiation level in the mining area of Jos Plateau by Ademola (2008).

The highest value from the present study is lower than the world average of 70.0 $\mu Su\ year^{-1}$. However, the authors recommended that workers at quarry sites should always put on masks to eliminate or reduce the amount of radioactive inhalation. Regular comprehensive monitoring of radiation level of each worker by putting on Thermo Luminescent Dosimeters (TLDs) which could be read and interpreted must be encouraged.

CONCLUSION AND RECOMMENDATION

The mean absorbed dose rate measured in any of the study area was comparable to those for the environs in Nigeria and the entire world. The result shows that the absorbed radiation dose in any of the study area is smaller than the Nigeria and the world average. Although no matter how low, all levels of ionizing radiation are hazardous to human health (Imtiaz *et al.*, 2005); there should be no fear of any serious health hazard from radiation exposure or dose emanating from any of the study areas in the present research.

REFERENCES

Ademola, J.A., 2008. Exposure to high background radiation level in the tin mining area of Jos Plateau, Nigeria. J. Radiol. Prot., 28: 93-99. DOI: 10.1088/0952-4746/28/1/006

Imtiaz, M.A., B. Aleya, A.S. Molla and M.A. Zaman, 2005. Measurement of radioactivity in Books and Calculations of resultant Eye Doses to readers. Health Phys., 88 (2): 169-174.

Mustapha, A.O., P. Mbuzukongira and M.J. Mangala, 2007. Occupational radiation exposures of artisans mining columbite-tantalite in the eastern Democratic Republic of Congo. J. Radiol. Prot., 27: 187-195.

Obed, R.I., I.P. Farai and N.N. Jibiri, 2005. Population Dose Distribution due to soil Radioactivity Concentration levels in 18 cities across Nigeria. J. Radiol Prot., 25: 305-312.

Shiva, N.G., N. Prasad, G.V. Nagaiah, Th. Ashok and Karunakara, 2008. Concentrations of Ra-226, Th-232 and K-40 in the soils of Bangalore Region, India. Health Phys., 94 (3): 246-271.

Turhan, A. and Lu. Gündüz, 2007. Determination of specific activityof Ra-226, Th-232 and K-40 for assessment of radiation hazards from Turkish pumice samples. J. Environ. Radioact., pp: 1-11.