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MEASUREMENT OF RADIATION DOSE IN SELECTED CEMENT STORES IN ABEOKUTA, OGUN STATE, USING GM SURVEY METER

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ABSTRACT

Measurements were carried out using a Geiger Muller Survey Meter and a Global Positioning System (GPS) to find the outdoor absorbed dose rates in selected cement stores in Abeokuta, Ogun State, Nigeria. The outdoor absorbed dose rates (control sites 10m away from cement depot) ranged from 400 nGy/hr) (Sapon) to 740 nGy/hr (Adatan) with the mean 554.7 ± 0.08 nGy/hr and the indoor absorbed dose rate (store) ranged from 740 nGy/hr (Lafenwa1&2) to 1240 nGy/hr (Isale-Ake) with the mean 909.3 ± 16 nGy/hr. The corresponding annual effective dose rates for the control sites ranged from 1.13 mSv/yr (sapon) to 2.09 mSv/yr (Adatan) with the mean 1.57 ± 0.32 mSv/yr, while it ranged from 2.45 mSv/yr (Lafenwa1&2) to 4.11 mSv/yr (Isale ake) for the cement depots with the mean 3.01 ± 0.52 mSv/yr. It has been revealed from this study that cement may enhance exposure to radiation, since the value of the absorbed dose rates in the stores are higher than thoseof the control sites. The values for the annual effective dose calculated are higher than 1mSv/yr.

Keywords: Radiation dose, Cement stores attendants, Abeokuta

INTRODUCTION

Human exposure to ionizing radiation due to naturally occurring radionuclides has long been a cause of concern (Brahmanandhan *et al*., 2007; Jibiri and Okeyode, 2012). Environmental pollution has remained a threat and recent challenge following a large increase in industrial concentration (Jibiri *et al*., 2010). The essential constituents of cement like lime, silica and alumina are derived from earth's crust in which radioactive elements like Uranium, Thorium etc are also present in varying amounts almost everywhere (Nain *et al*., 2006). Kalacic (1973) reported that in the cement production process the aerodynamic diameter range is 0.05- 5.0 μm, which is produced by hearing ground cement rock or other limestone-bearing materials into a fused clinker that, is then ground into a fine powder (Abdolhossein *et al*., 2010). Portland cement dust is a gray powder with an aerodynamic diameter ranging from 0.05 to 5.0 mm (Kalacic, 1973). This size is within the range of sizes of respirable particles, and, therefore, exposure to Portland cement dust has long been associated with respiratory symptoms and varying degrees of airway obstruction in people who work with Portland cement (Bazas, 1980; ElSewefy *et al*., 1970; Kalacic, 1973a, b; Oleru, 1984; Shamssain *et al*., 1988; Saric *et al*., 1976; Noor et al., 2000; Yang *et al*., 1996; Kpeglo *et al*., 2011). There has been an increasing demand for cement production throughout the world with the ever increasing growth in human civilization, (increasing population and expansion of infrastructure). Portland cement is one of the common type of cement in general usage in Nigeria and in many parts of the world, as it is a basic ingredient of concrete, mortar, stucco and most nonspecialty grout. Considering Ogun State in Nigeria and Abeokuta town in particular, sales of cement either in concrete shops or iron container shops is part of the major business in the town. Therefore the aim of this study was to assess the radiation dose that may be caused by cement stored in these selected cement stores made either of concrete shops or iron containers in Abeokuta using GM survey meter.

MATERIALS AND METHODS

The Study Area

Abeokuta is the capital city of Ogun state, South-western Nigeria. It is situated between latitudes 3 20"and 3 54" and longitude 7 9" and 7 39" on the east bank of the Ogun River, around a group of rocky outcroppings that rise above the surrounding wooded savanna. Abeokuta means "Refuge Among Rocks" in the local language and it was so called because the caves of the outcrop rocks provided shelter and safe havens for the early settlers from invaders (Britannica, 2012; Demeji, 2010). The geology of Abeokuta comprises a rock sequence that starts with the Precambrian Basement and consists of quartzites and biotite schist, hornblende-biotite, granite and gneisses. The sedimentary rock sequences are from Cretaceous to Recent; the oldest of them, the Abeota formation, consists of grey sand intercalated with brown to dark grey clay. It is overlain by the *Ewekoro* formation, which typically contains thick limestone layers at its base (Jibiri and Okeyode, 2012). Figure 1 shows the locations of the sampling points.

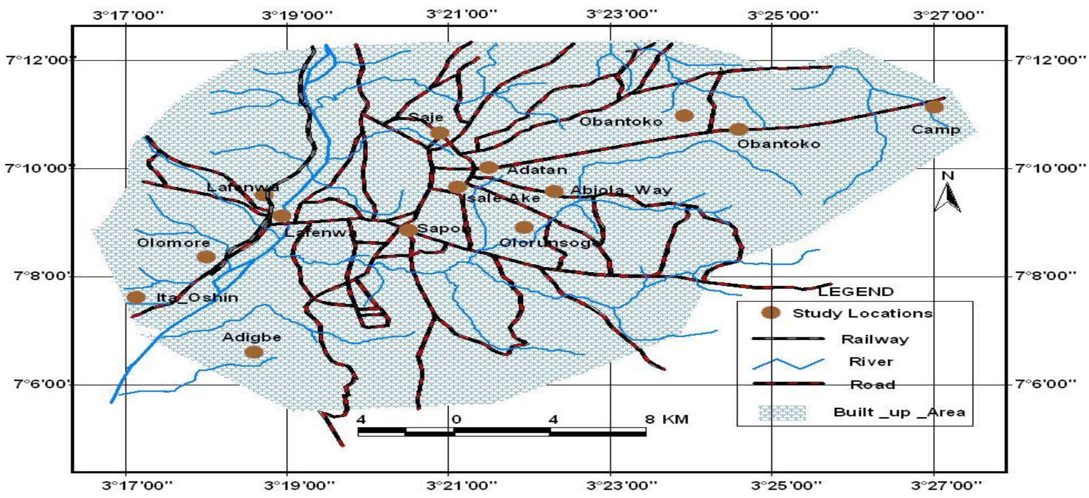

Figure 1: Map of the study area

Absorbed Dose Rates Measurement

The absorbed radiation dose (i.e the energy deposited per unit mass of medium, which may be measured as joules per kilogram and represented by the equivalent SI unit, gray (Gy)) at selected cement stores were measured using a survey meter. This consists of a graduated screen with a moving coil counter and use a 6V (d.c) battery as its power source. The survey meter is a Geiger-Müller detector incorporating a large-area 45 mm diameter pancake-geometry Geiger tube with mica window, sensitive to alpha, beta, gamma radiation and X-rays. Measurements were taken from both control sites which were 10meters away from the cement depots (shops) and inside the depots (shops). When taking the measurements, the survey meter was held 1meter above the ground surface. The highest deflection within 30sec was recorded for each measurement. The large digital display shows count rates and dose rates in Cpm and mRad/hr, respectively. Five readings were taken at each location and the average computed, Table 1.

Effective Dose Rate Calculation

The annual effective dose rates H_E(mSv/y) that would be received in the stores and in the control sites were derived from the expressions (UNSCEAR, 2000):

$$H_E(mSv/yr)_{Store} = D(nGy/hr) \times 8760(hr/y) \times 0.54 \times 0.7(Sv/Gy) \times 10^{-6} \quad (1)$$

and

$$H_E(mSv/yr)_{Control} = D(nGy/hr) \times 8760(hr/y) \times 0.46 \times 0.7(Sv/Gy) \times 10^{-6} \quad (2)$$

{UNSCEAR, 2000}

where $D(nGy/hr)$ is the total absorbed dose in air, $8760(hr/y)$ is the number of hours per year (24×365), $0.7(Sv/Gy)$ is the conversion from absorbed dose in air to effective dose in tissues. The occupancy factor varies for different location, the in-door occupancy factor used for this study is 0.54 for the store because the highest time spent by the attendants in the stores is 13hrs and the Outdoor (control sites) occu-pancy factor used in the work is $0.46(11/24)$ hours which is the fraction of the time spent outdoor by the attendants. The effective dose rates calculated for the control sites and the cement stores are shown in Table 2.

RESULTS AND DISCUSSION

Results

The Results of the measured absorbed doses and the corresponding effective doses at the selected Control sites and cement stores are presented in Tables 1 and 2 respectively. The distribution of the absorbed doses are also presented in Figure 2.

Table 1: *Absorbed dose rates in the Control Sites and the Selected Cement Stores*

Sample locations	Latitude	Longitude	Absorbed dose rates (104nGy/hr) Control sites	Stores	Time Spent (Hrs) by attendants	Nature of Depot
ADIGBE	7.12317	3.32400	0.046	0.076	9	Concrete
SAJE	7.17760	3.35376	0.064	0.090	9	Container
ADATAN	7.16895	3.36174	0.074	0.110	9	Concrete
ISOLU	7.21746	3.44631	0.064	0.084	9	Container
SAPON	7.15351	3.34832	0.040	0.080	12	Concrete
OBANTOKO1	7.17845	3.40182	0.050	0.080	12	Container
OLORUNSOGO	7.15418	3.36744	0.052	0.096	10	Concrete
ABIOLAWAY	7.16319	3.37210	0.072	0.118	9	Concrete
ISALE AKE	7.16409	3.35662	0.042	0.124	12	Concrete
OBANTOKO2	7.18187	3.39306	0.070	0.096	10	Container
OLOMORE	7.14684	3.31630	0.046	0.080	---	Concrete
ITA-OSHIN	7.13689	3.30693	0.054	0.086	8	Concrete
LAFENWA1	7.16230	3.32557	0.058	0.074	11	Container
LAFENWA2	7.15703	3.32848	0.042	0.074	13	Container
CAMP	7.18410	3.43331	0.058	0.096	9	Container
Average			554.7 ± 11	909.3 ± 16		

Table 2: The annual effective dose rates for the control sites and the cement stores

Sample locations	Annual effective dose (mSv/y) Control sites	Annual effective dose (mSv/y) Cement Stores
ADIGBE	1.298	2.517
SAJE	1.805	2.980
ADATAN	2.087	3.642
ISOLU	1.805	2.781
SAPON	1.128	2.649
OBANTOKO1	1.410	2.649
OLORUNSOGO	1.467	3.179
ABIOLA WAY	2.031	3.907
ISALE AKE	1.185	4.106
OBANTOKO2	1.975	3.179
OLOMORE	1.298	2.649
ITA-OSHIN	1.523	2.848
LAFENWA1	1.636	2.450
LAFENWA2	1.185	2.450
CAMP	1.636	3.179
Average	1.57 ± 0.32	3.01 ± 0.52

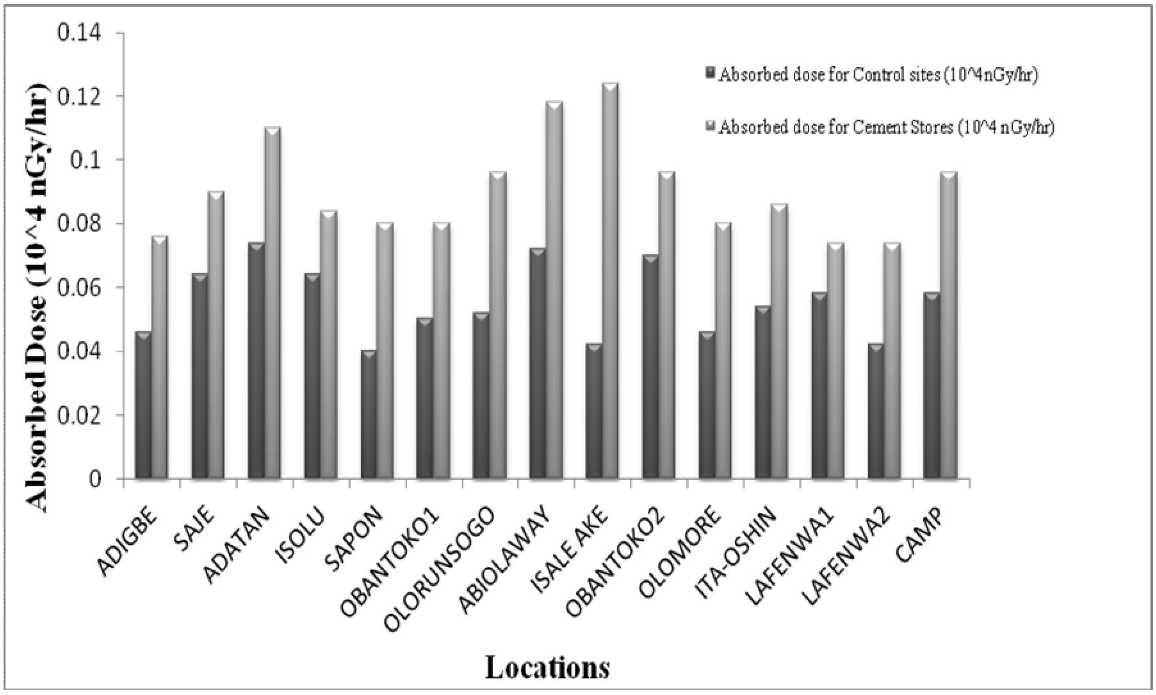

Fig. 2: Bar chart showing the annual effective dose rates (mSv/y) against locations

DISCUSSION

The outdoor absorbed dose rates (control sites 10m away from cement depot) ranged from 400 nGy/hr) (Sapon) to 740 nGy/hr (adatan) with the mean 554.7 ± 0.08 nGy/hr and the indoor absorbed dose rate (store) ranged from 740 nGy/hr (lafenwa1&2) to 1240 nGy/hr (Isale-Ake) with the mean 909.3 ± 16 nGy/hr. For the corresponding annual effective dose rates for the control sites, it ranged from 1.13 mSv/yr (sapon) to 2.09 mSv/yr (adatan) with the mean 1.57 ± 0.32 mSv/yr while it ranged from 2.45 mSv/yr (lafenwa1&2) to 4.11 mSv/yr (isale ake) for the cement depots with the mean 3.01 ± 0.52 mSv/yr, Tables 1 and 2 respectively. Figure 2 shows the distribution of the absorbed dose rates for the control sites and the cement depot. It has been revealed from this study that cement may enhance expose to higher level of radiation, since the value of the absorbed dose rates in the stores are higher than the values of the control sites. It was also revealed from the study that those stores with highest absorbed dose rates and corresponding effective dose rates were those whose attendants spent most time indoor. One can also see from the study that depot stores made with concrete had higher absorbed dose rates than the container stores, this buttressed the fact that building materials like bricks, cement, sand etc contribute to radiation exposures.

CONCLUSION

Generally, comparing the absorbed dose rates and the effective dose rates obtained from this study with the ICRP recommendation dose limit for the public, it was observed that the values were a bit high. The annual effective dose rates were higher than 1mSv/yr as recommended by ICRP.

It was observed that the average annual absorbed dose rate and the annual effective dose rate for the outdoor (control sites) were lower than the annual absorbed dose rate and the effective dose rate for the indoor (cement stores).

Cement may enhance exposure to radiation. Cement attendants may be regarded as being occupationally exposed to radiation. From the results, depots made with containers are better for the attendant staying inside the shop for a very long time than the cement store made of concrete but it is advised that the attendants do not stay in any of the stores as both the values are higher than 1mSv/yr.

REFERENCE

Abbady, A. 2006. Radiological hazard and radiogenic heat production in some building materials in upper Egypt, *Journal of Radioanalytical and Nuclear Chemistry,*268 (2):243–246.

Abdolhossein, P., Hossein, K., Mostafa, H., Farhad. F., Hojattollah, K. 2010. The Effect of Cement Dust on the Lung Function. *International Journal of Occupational Hygiene.* 2(2): 74-78.

Bazas, T., 1980. Effects of occupational exposure to dust on the respiratory system of cement workers. *J. Soc. Occup. Med.*, 30: 31-36.

Britannica Inc., 2012. Abeokuta Encyclopædia. *Encyclopædia Britannica Online*. Web.

Dimeji K . A. 2010. *Water scarcity bites harder in Abeokuta.* Retrieved 2010-05-22.

El-Sewefy, A.Z., Awad, S., Metwally, M. 1970. Spirometric measurements in an Egyptian Portland cement factory. *J. Egypt. Med. Assoc.*, 53: 179-186.

Jibiri N. N, Adewole O.O., Egunjobi K.A. 2010. Variation of Mean Radiation Dose with Distance of Sites Proximal to PURECHEM Cement Factory, Onigbedu Ogun State, Nigeria *The Pacific Journal of Science and Technology.* 11(2).

Jibiri, N.N., Okeyode, I.C. 2012. Evaluation of radiological hazards in these dements of Ogun river, South-Western Nigeria. *Radiation Physics and Chemistry* 81 : 103–112

Jones, H. A., Hockey, R. D. 1964. The Geology of SouthWestern Nigeria. *Bulletin Geological Survey,* 31-pp 100.

Kalacic, I., 1973. Chronic nonspecific lung disease in cement workers. Arch. *Environ. Health*, 26: 78-83.

Kpeglo, D.O., Lawluvi, H., Faanu, A., Awudu, A.R., Deatanyah, P., Wotorchi, S.G., Arwui, C.C., Emi-Reynolds, G., Darko, E.O. 2011. Natural Radioactivity and its Associated Radiological Hazards in Ghanaian Cement. *Research Journal of Environmental and Earth Sciences* 3(2): 160-166.

Nain, M., Chauhan, R.P., Chakarvarti, S.K. 2006 . Alpha radioactivity in Indian cement samples. *Iranian Journal of Radiation Research*. 3(4): 171-176.

Noor, H., Yap, C.L., Zolkepli, O., Faridah, M. 2000. Effect of exposure to dust on lung function of cement factory workers. *Med. J. Malays.*, 55: 51-57.

Oleru, U.G., 1984. Pulmonary function and symptoms of Nigerian workers exposed to cement dust. *Environ. Res.*, 33: 379-385.

Saric, M., Kalacic, I., Holetic, A. 1976. Follow-up ventilatory lung function in a group of cement workers. Br. *J. Ind. Med.*, 33: 18-24.

Shamssain, M.H., J. Thompson, S.A. Ogston, 1988. Effect of cement dust on lung function in Libyans. *Ergonomics*, 31: 1299-1303.

UNSCEAR, 2000. United Nations Scientific Committee on the Effect of Atomic Radiation. Report to the general assembly. *Annex B: exposures from natural radiation sources.*

Yang, C.Y., Huang, C.C., Chiu, H.F., Chiu, J.F., Lan, S.J., Ko, Y.C. 1996. Effects of occupational dust exposure on the respiratory health of Portland cement workers. *J. Toxicol. Environ. Health,* 49: 581-588.

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