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ANALYSIS OF THE DUST GENERATED FROM POINT SOURCE IN RELATION TO THE DISTANCE FROM THE POINT OF GENERATION IN GBOSE QUARRY, OMU-ARAN, NIGERIA

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Abstract
The study analyzed the impacts of dust generated from the crushing plant (point source) to its immediate environment in Gbose Quarry. The objectives of the research were achieved through sample collection from the study area and quantitative method. The collected samples were labelled SS_1, SS_2, SS_3, SS_4, SS_5, SS_6 and S_C. The samples were taken to the laboratory for analyses using atomic absorption spectrometer (AAS). The results obtained from the laboratory were subjected to statistical analysis using SPSS. Analysis of variance (ANOVA) was employed for between and within group comparison while student's test was used for paired comparison. The T-tests associated with all the elements (silicon, aluminum, iron, calcium, zinc, lead, potassium, strontium, bromine, europium, hafnium, bismuth, niobium, and manganese) present and pH were found to be significant at $p < 0.05$. Questionnaire which serves as the quantitative method was also prepared. The prepared questionnaire was administered to 30 quarry workers and 50 non- quarry workers. The results obtained from the questionnaires showed that quarry workers are more exposed to the effects of dust than the non-quarry workers due to the proximity. About 80% of the quarry workers have the symptom of silicosis and pneumoconiosis caused by inhalation of dust particle and those having the same symptom are less than 50% and no chronic condition was recorded.

Key Words: *Point source, quantitative method, AAS, SPSS, ANOVA, student's test, questionnaire*

Introduction

Dust is often used in a generic sense to describe particles which are capable of becoming airborne to disperse in the atmosphere prior to returning to surface. However, dust is considered to be any solid matter emanating from a surface mineral working, or from vehicles serving it, which is borne by the air (BSI, 1994). Dust is particle of matter in the size range of 1 – 75 µm diameters, with particles less than 1 µm being classified as smoke or fumes (BSI, 1994). Dust particles will eventually settle out under their own weight, but may remain suspended for some time. The finest particles between 1 and 10µm in diameter will be respirable and are associated with health effects. Therefore, particle less than 10 µm can cause concern with health effects; particles greater than 10 µm are associated with public perception and nuisance. Nuisance dust may be described as the coarse fraction of airborne particulates, typically greater than about 20µm.The Environment Agency, 2003 stated that particles greater than 30 – 50 µm tend to be deposited quickly and as such this particle size approximates to annoyance, or nuisance dust. Such settled particles may show up as a deposit on clean surfaces such as cars and window ledges.

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Dust has different origins in a quarry site such as mechanical handling operations that include crushing and grinding process; haulage with which is related to the vehicle, and the nature and condition of the way; blasting; additional manufacturing operations and wind blow from paved areas, stockpiles etc. Dust concentration levels are monitored in two ways, active monitoring in which the system is suited to measuring over minutes, hours and days; and passive monitoring which are suited for measuring over days, weeks and months. Some ways for mitigation of dust emission are to consider the planning conditions relating to the layout of the site, design of stockpiles, hard surfacing of vehicle areas, containment of conveyors and processing plant and dust collection equipment, use of moistening equipment's on the dusty places, design of material-handling systems, provision of monitoring facilities, and measurement of limiting levels of dust.

Dust generated from granite quarry and crushing plant for construction and related industries has caused environmental problem at Gbose quarry and the near-by area. The dust problem has been so serious for the mine workers and the people living in the area. Attempts in the past has been tried to solve the problem, however it is still not so successful .The problem is increasing more serious in the past few years as the demand for the construction materials of the country is increasing. Very few quarries in the area have installed dust suppression equipment. Since 1999, the Department of Mineral Resources (DMR) of Nigeria has put strict measure to force the owner of quarries to install dust suppression equipment with the aim to reduce the dust pollution in the area to acceptable level.

Increased local and global attention being given to control of air pollution contaminant of nuisance dust in all industrial application is becoming increasingly important. This call for proper control of dusts generated, design installation, operation and maintenance of dust collection equipment. Since its inception, the fabric style dust collector (bag house) has offered companies the ability to effectively capture airborne particulate from an air stream whether toxic or not, it is necessary to provide a healthy and clean work environment (Sly, 2009). This paper therefore analysis the effect of dust generated from the point source in relation to the point of generation in Gbose Quarry.

Geology of the Study Area

Gbose quarry is located at 3km to Omu-aran along Oko Express Road Kwara State, Nigeria. It lies within latitude 88 9.509N and 88 9.2639N and longitude 58 8.31149E and 58 8.30689E. The area falls within the southern limits of the tropical Savannah one of Nigeria with mean annual rainfall of 1200mm concentrated between the months of April and October and mean annual temperature varying between 31.5°C and 35°C. More than 90% of the state is underlain by the basement complex rock of the Precambrian and Cambrian ages while the remaining part is underlain by cretaceous and younger sediments (Rahaman, 1976; Oyegun, 1983) undifferentiated metasediments are found in numerous large patches of the state like Lafiagi, Oke-Ode. Oke Onigbin, Omu-Aran while the older granites arc also found in numerous patches in parts of Moro. Asa and Ifelodun Local Government Areas. Quartzites are found in North Western part of Ilorin (Oyegun, 1983). Figure 1 shows the map of the study area.

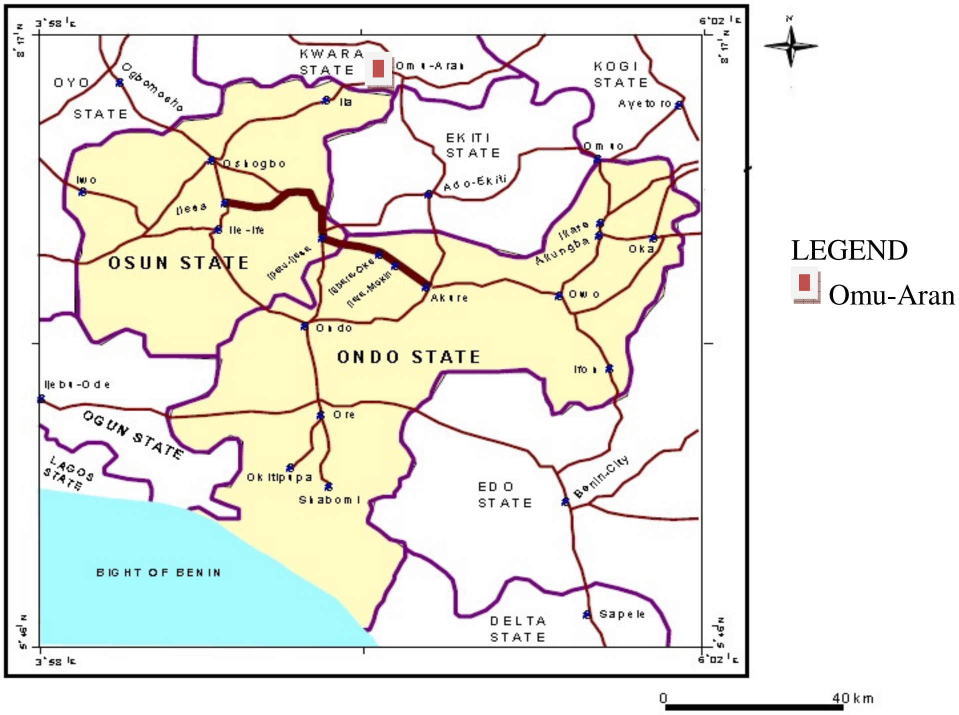

Figure 1: Map of the Study Area (adopted from Akintorinwa *et al*., 2010)

Sample Collection and Preparation

Dust samples were collected at the two major emission source, which are fugitive source (not collectable) and the processed source (final product) within the crushing plant using manual system. In the manual system, the crushing area was marked with poles about 20 m tall with polythene attached at the top at six points at 50 m intervals. One control sample was also taken at 300.0 m away from the quarry site. The samples were collected into appropriately labelled containers, preserved and stored. Samples SS_1, SS_2, SS_3, SS_4, SS_5 and SS_6 indicate dust samples taken from the quarry area while SS_C indicates sample taken from control station. The adopted preparation method followed the standard suggested by Asia Life Science Service Resource Guide.

Test Equipment and Materials

The equipment and materials used are: freeze dryer, specimen cup, minipal 4 spectrometer, and Pentium M Computer.

Procedure

Some portion of samples from the study areas were taken and dried in a freeze drier. 1g of each of the samples were weighed and put in a specimen cup (Plate 3.1 shows a typical specimen cup). The specimen cups were loaded into a minipal 4 spectrometer. The spectrometer was put on and it accelerated centrifugally for several minutes until it stops automatically. The elements present in the dust particle sample were displayed on the screen of attached computer and the results were printed.

Determination of pH of the Dust Particle

The pH measurement involved inserting the probe of the pH meter into a 1:1 ratio suspension of the sample in distilled water. The pH of each sample was determined with a pH meter in accordance with ASTM D4972. Prior to sample analysis, the meter was calibrated according to manufacturer instruction with buffer solutions 4, 7 and 10. 10g of dust sample was weighed into 100 ml baker. 20 ml of distilled water was added to each. The suspension was stirred several times over a 30 minute interval with a glass rod. The pH of the dust in each beaker was measured and recorded. The same procedures were followed for the remaining samples.

Data Analyses

Chemical composition of dust samples were analyzed statistically using a Statistical Package for Social Sciences (SPSS) software. The analyses of all the samples at each distance from the source were carried out in quadriplicates. The statistical values were reported as mean 6 standard error of the mean (SEM) and analysis of variance (ANOVA) was also used for group comparison for between and within group while student's test was used for paired comparison. The p-value of $p < 0.05$ is statistically considered significant.

Field Data

Questionnaires were administered to 30 quarry workers and a control population of 50 non-quarry workers (smokers and those who responded affirmatively to the question). Demographic data of respondents were collected to ascertain the occurrence of respiratory symptoms.

Results and Discussion

Tables 1a and 1b shows the percentage chemical composition of dust sample using statistical package for social sciences software (SPSS). Tables 2 to 5 show the result from the analyses of the retrieved questionnaires.

The mean values of the chemical elements present in the dust samples obtained at 0.00 m, 50 m, 100 m, 150 m, 200 m, 250 m and 300 m from the sources as obtained from the SPSS software are presented in Tables 4.1a and 4.1b respectively. From Table 4.1a the mean value of pH ranges from 3.52 6 0.004 to 8.50 6 0.004. The pH of dust sample at 0 m distance is 4.40 6 0.071 which is highly acidic, at 200 m distance from the source of generation the pH is of low acidic and at 300 m distance from the source the pH value is high alkalinity. The mean values of Aluminum range between 6.67 6 0.004 and 14.76 6 0.051 respectively while that of silicon varies between 13.83 6 0.007 and 22.80 6 0.007 respectively as show in Table 4.1a. According to Lenntech, (1998) silicon has little adverse effect on lungs and does not appear to produce significant organic disease when exposure is kept below the exposure limit. The mean values of potassium obtained from the analysis ranges between 0.004 60.041 and 0.70 6 0.004. The mean values of calcium present varies from 2.93 6 0.025 to 4.00 6 0.041 respectively. The distribution of calcium is wide and this element is essential for life of plant and animal for growth and low concentration of calcium is one of the main causes of osteoporosis (Lenntech, 1998). The mean values of iron oxide varies from 7.648 60.005 to 18.806 0.041 respectively. Chronic inhalation of excessive concentration of iron oxide fumes or dust may result in development of benign pneumoconiosis called siderosis which is observable as an x-ray change. The mean values of bromine vary between 0.040 $\pm$ 0.041 and 0.20 $\pm$ 0.011 respectively while that of Strontium vary from 2.80 6 0.011 to 1.32 6 0.040 as shown in Table 4.1a respectively. Strontium in its elemental form occur relatively in many compartment of the environment including rocks dust particle that contain strontium will settle to surface water soil or plant at source point (Lenntech, 1998). The mean values of the lead concentration in the samples range from 3.6760.007 to 0.030 60.0041 while the mean concentration of europium varies between 0.030 6 0.0041 and 2.20 $\pm$ 0.015 as shown in Table 1b. The concentration of Hafium varies between 1.54 $\pm$0.0041 and 7.40 $\pm$0.091 and that of bismuth varies between 0.003 $\pm$ 0.000 and 0.013 $\pm$ 0.004 respectively as shown in Table 1b. The mean concentration of niobium varies between 0.0975 ± 0.009 and 0.020 ±

0.004 and that of zinc ranges between 0.005±0.001 and 0.0008±0.000 as shown in Table 4.1b respectively. The mean concentration of manganese varies between 0.30±0.004 and 0.008±0.000 respectively. Tables 4.2 to 4.4 show the results obtained from the accomplished questionnaires. From the results the main ailment that affects the people in and around the quarry is asthma, headache and shock as a result of the noises generated from the quarry.

Conclusion

This study reveals that occupational exposure to dust is still a major cause of concern in quarries in Nigeria where quarrying is a means of earning a living, especially for people in Omu Aran. This study at Gbose quarry is just the tip of the iceberg and is indicative of what is obtainable in other quarry Companies in Nigeria. The chemical analysis of the dust generated from the study area was carried out and questionnaires were also accomplished to both the workers and people living around the quarry. From the results of the analysis and accomplished questionnaires the following conclusions were reached: All the elements that are present in the dust samples and their pH are significant at 5% significant level. Silicosis is the main disease affecting the quarry workers and cough, catarrh and shock are the main effects caused by the quarry activities to the people leaving around the quarry site.

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Table 1a: Chemical Analysis Result of a Dust Samples using (SPSS)

*DQ	pH	Al	Si	K	Ca	Fe	Br	Sr
0.00	4.40 ± 0.071	14.76 ± 0.051	22.80 ± 0.007	0.70 ± 0.004	4.00 ± 0.041	18.80 ± 0.041	0.20 ± 0.011	2.80 ± 0.011
50.00	4.90 ± 0.004	13.64 ± 0.009	20.73 ± 0.0041	0.70 ± 0.0204	3.70 ± 0.041	17.40± 0.041	0.20 ± 0.007	2.65± 0.007
100.00	4.96 ± 0.009	12.50 ± 0.037	19.81 ± 0.0041	0.653 ± 0.005	3.550 ± 0.004	16.90 ± 0.007	0.180 ± 0.004	2.550± 0.004
150.00	3.52 ± 0.004	10.38 ± 0.004	17.985 ± 0.00645	0.0048± 0.005	0.0041 ± 0.0041	15.45 ± 0.065	0.170 ± 0.004	2.47 ± 0.004
200.00	6.788 ± 0.005	9.453 ± 0.006	16.848 ± 0.125	0.618 ± 0.005	3.48 ± 0.0041	14.90± 0.041	0.153 ± 0.005	2.408 ± 0.005
250.00	7.891± 0.004	7.54 ± 0.004	14.80 ± 0.0071	0.590 ± 0.004	3.07 ± 0.0041	10.80 ± 0.041	0.090 ± 0.004	2.35 ± 0.004
300.00	8.50 ± 0.004	6.67 ± 0.004	13.83 ± 0.0071	0.400 ± 0.041	2.93 ± 0.02	7.648 ± 0.005	0.040 ± 0.041	1.32 ± 0.040

*D_Q means distance from the source

Table 1b: Chemical Analysis Result of a Dust Samples using (SPSS)

*DQ	Pb	Eu	Hf	Bi	Nb	Zn	Mn
0.00	9.40 ± 0.108	2.20 ± 0.015	7.40 ± 0.091	0.013 ± 0.004	0.0975 ± 0.009	0.005 ± 0.001	0.30 ± 0.004
50.00	8.40 ± 0.041	2.10± 0.007	6.0± 0.071	0.012 ± 0.000	0.090± 0.004	0.004 ± 0.000	0.300 ± 0.008
107.00	7.95 ± 0.004	1.80 ± 0.007	5.52 ± 0.004	0.011 ± 0.000	0.080 ± 0.004	0.0035± 0.000	0.250± 0.000
150.00	7.45 ± 0.004	1.65± 0.004	5.08 ± 0.004	0.009 ± 0.000	0.068± 0.005	0.003 ± 0.000	0.245 ± 0.004
200.00	6.45± 0.004	1.53 ± 0.804	4.82 ± 0.004	0.008 ± 0.000	0.058± 0.005	0.0025± 0.000	0.221± 0.0005
250.00	5.45 ± 0.007	1.100 ±0.004	3.67± 0.007	0.006 ±0.000	0.050± 0.004	0.002± 0.000	0.199 ±0.000
300.00	3.67 ±0.007	0.030 ±0.004	1.54 ±0.004	0.003 ± 0.00	0.020 ±0.004	0.0008± 0.000	0.008 ±0.000

*D_Q means distance from the source

Table 2: Showing Sex, Residency Duration, and Distance to Quarry, Observed Impacts and Health Problems Experienced by People Living near Quarry Site

Sex	No. of respondent	Percentage %
Male	37	74
Female	13	26
Total	50	100
Residency duration		
1-5 years	13	26
6-10 years	10	20
11-15 years	11	22
16-20 years	9	18
>20 years	7	24
Total	50	100
Distance to Quarry site		
<100 m	8	16
100-250 m	3	6
251-500 m	9	18
500-1000 m	30	60
Total	50	100
Quarrying Impact		
Noise and ground Vibration	10	20
Noise alone	7	14
Air pollution by dust	13	26
Ground vibration alone	19	38
No felt problem	1	2
Total	50	100
Health problems		
catarrh	18	36
Shock	20	40
Cough	12	24
Total	50	100

Table 3: Showing Age- Group and Job Specification of Sampled Quarry Workers

Age-group	No. of respondents	Percentage
20-35 years	9	30
36- 50 years	15	50
>50 years	6	20
Total	30	100
Job specification		
Drillers	3	10
Blasters	6	20
Maintenance worker	4	13
Administrative worker	5	17
Crusher mechanics	7	23
Crusher operators	5	17
Total	30	100

Table 4: Relationship between Quarrying and Occurrence of Respiratory Disease Symptoms and Dermatoses

Characteristic	Yes	No	Percentage Yes	Percentage No
Knowledge of effect on health	6	24	20	80
Wearing of overalls	8	22	27	73
Covering of nostrils	14	16	46	54
Eye goggles	0	30	0	100

Table 5: Health Problems Diagnosed among Quarry Workers

Health problem	Very High	High	Average	Low	Very Low	Percentage (average) %
Cough	5	3	10	2	3	33
Acute malaria	0	0	0	10	19	0
Dermatitis (skin infection)	0	0	4	7	10	13
Hypertension	0	0	3	17	10	10
Nausea (vomiting)	0	0	6	7	10	20
Catarrh	3	2	8	0	13	27
Chest pain	0	5	10	6	4	33
Asthma	0	2	17	6	5	57
Headaches	1	9	14	3	3	47
Silicosis (lung disease)	0	3	18	3	3	60