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THE IMPACT OF ROCK CRUSHING ON THE QUALITY OF AIR AND SOIL WITHIN AND OUTSIDE THE CRUSHING SITE

Ipeghan Jonathan Otaraku[1], Yirakpoa Patience Nwambo[2], Ishioma Laurene Egun[3]
[1.2.3] *Department of Chemical Engineering, University of Port Harcourt, Port Harcourt, Nigeria*

ABSTRACT: *This study investigates the effect of rock crushing on Ishiagu environment in Enugu State, Nigeria. The quality of air dust and soil samples within and outside the crushing area was analyzed by taking samples of rock dust), soil and underground water. The amount of iron, zinc, copper, lead, cadmium, chromium and nickel were determined in the rock dust and soil samples collected within and outside the crushing sites. The results indicated that the concentration of metals in all samples were significant ranging from 1425-48180mg/kg in air dust sample, 120-44000mg/kg in soil samples while the metals in the underground water was seen to be decreasing as the distance from the crushing site increased .The underground water samples were observed to have high total dissolved solids (754,587 and 604) ppm respectively, total chloride and total hardness. All underground water samples were in excess of 150 mg/l total chloride with pH values between the ranges of 4.5 to 5.5 which is acidic.*

KEYWORDS: rock dust, metals, soil, concentration, water, rock

INTRODUCTION

Rock crushing is a way of reducing rock sizes. It helps one to access the mineral content of the rock. While rock crushing is of great benefit to man it is also a source of pollution to man and his environment. According to Aigbedion (2005) different types of environmental damage accompany stages of mineral development. The complex mixture of gases that make up the earth atmosphere has been altered much more in recent time as the activities of man are increasing. Human activities that range from domestic energy utilization to large scale industrial operations are largely responsible for this undesirable status of the atmospheric constituents due to addition of pollutants.

LITERATURE REVIEW

Humans have a long history of involvement with rocks-a history that goes far back to the aptly named Stone Age. The Earth’s crust including the lithosphere and mantle are formed

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of rock. The lightest rocks form the continents, which are made mostly of the rock granite (Busbey and Bresnahan, 2004). Soil itself is made up of tiny bits of rocks usually mixed with organic materials from plants and animals. Rocks are all around us, especially in our buildings but also in everything from jewelry to chalk (Vernon, 2000). Rocks provide clues to the history of our planet and record changes in the environment that occurred millions of years ago (Manahan, 2000).

Rocks and minerals of economic values are called ores and their mining gives us raw materials, such as iron, petroleum, coal, gravel, which are essential in our everyday lives (Smith, 2000). While mining activity can be good for economic growth, it is an activity which directly impacts the land (Alloway and Ayres, 1997). The impact of crushing activity affects the soil samples around the crushing site (Bliss 2002). Great care must be taken in order to ensure that the environment is protected. The minerals find their way into the ground and affect the underground water around the area where the mining activities occur (Jordan and Stamer, 1995). Garba (2001) observed that in states where people live close to the quarries, they are affected by the activities that go on in that area. In quarrying areas, like the village of Pali in India, the safety of human beings is not put into considerations. There is no personal protective equipment being provided to workers, helmet, safety belts, masks, safety shoes are foreign.

MATERIALS AND METHODS

SAMPLE COLLECTION

Crushed Rock Dust Samples

Two crushed rock dust samples were collected from the site during crushing. Quantities of the crushed rock dust were packed into polyethylene bags, tied and labeled as samples using RDS1 (Rock Dust Sample 1) and RDS2 (Rock Dust Sample 2) to differentiate them.

Soil Samples

Two soil surface samples of about 20cm depth were collected inside the crushing area and five soil samples of the same depth were collected at five points at radial distances of 500m, 1000m, 1500m, 2000m, 2500m and 3000m from the crushing site and stored in polyethylene bags. They were tied tightly and labeled using code. The samples were kept in relatively cool place and also away from sunlight.

Water Samples

The three water samples were collected from the site at the same day in 1.5 liters capacity plastic containers. The containers were rinsed two or three times with distilled water and then with the raw sample water before collection. After filling, the containers were then tightly covered or capped under water before being brought out of the water, the containers were labeled appropriately and they were representatives of the source that is to be evaluated.

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METHODOLOGY

The Crushed Rock dust and the soil samples collected were digested using Mixed-Acid digestion method and water samples digested using Nitric acid digestion methods before determination of the concentration of metals by Atomic Absorption Spectrophotometric Method (AAS). Conductivity, total dissolve solids, pH, total chloride, total alkalinity, total acidity, total hardness, calcium hardness and magnesium hardness of the surface water samples were determined using standard laboratory methods (Arbogast, 1996).

RESULTS

The results of the Rock Dust Sample and Soil Samples from crushing sites at various distances is given below:

Table 1: Metals result of Rock Dust Samples 1 and 2

METAL	WAVELENTH(nm)	CONC.(mg/kg) RDS1	CONC.(mg/kg) RDS2
Iron	248.3	48180	47990
Zinc	213.8	25900	26040
Cadmium	229.0	1200	1190
Nickel	232.0	970	976
Chromium	357.9	1000	1080
Copper	324.8	17960	17560
Lead	283.3	1425	1500

Source: Laboratory analysis

Table 2: Metals result of Soil Samples (inside) S1 and S2

METALS	WAVELENTH(nm)	CONC. (mg/kg) S1	CONC.(mg/kg) S2
Iron	248.3	44000	43900
Zinc	213.8	22800	22740
Cadmium	229.0	980	1000
Nickel	232.0	660	700
Chromium	357.9	886	902
Copper	324.8	15078	15020
Lead	283.3	996	1140

Source: Laboratory analysis

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Table 3: Average concentration (mg/kg) of metals in the soil at various distances

Metals	500m	1000m	1500m	2000m	2500m	3000m
Iron	40180	38924	35847	33260	30080	26102
Zinc	20500	19120	18058	16654	14122	11100
Cadmium	586	448	329	288	140	108
Nickel	500	396	280	225	114	87
Chromium	534	415	312	256	122	96
Copper	13860	12232	10420	10168	8000	6265
Lead	725	602	500	348	226	124

Source: Laboratory analysis

Table 4: Results of Water Samples Analysis

S/N	PARAMETER	W1	W2	W3
1.	Conductivity	123µS/cm	79µS/cm	12µS/cm
2.	Total Dissolved Solids	754 ppm	587 ppm	604 ppm
3.	pH	4.5	5.23	5.50
4.	Total Chloride	407.79 mg/l	280.134 mg/l	301.41 mg/l
5.	Total Alkalinity	212 mg/l	185.5 mg/l	265 mg/l
6.	Total Acidity	274.40 mg/l	195.02 mg/l	313.6 mg/l
7.	Total Hardness	250 mg/l	282 mg/l	390 mg/l
8.	Calcium Hardness	215.63 mg/l	180.642 mg/l	145.66 mg/l
9.	Magnesium Hardness	174.37 mg/l	101.385 mg/l	104.344 mg/l
10.	Iron	0.695 mg/l	0.590 mg/l	0.475 mg/l
11.	Zinc	0.582 mg/l	0.480 mg/l	0.327 mg/l
12.	Cadmium	0.367 mg/l	0.304 mg/l	0.216 mg/l
13.	Nickel	0.358 mg/l	0.299 mg/l	0.208 mg/l
14.	Chromium	0.473 mg/l	0.345 mg/l	0.288 mg/l
15.	Copper	0.524 mg/l	0.457 mg/l	0.300 mg/l
16.	Lead	0.386 mg/l	0.321 mg/l	0.220 mg/l

Source: Laboratory analysis

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DISCUSSION

From the Table 1, it is seen that crushed rock dust samples contain heavy metals. It is observed that the various metals have different wavelengths. The concentration of metals in both samples is seen to be increasing in the following order: Nickel<Chromium<Cadmium<Lead< Copper<Zinc< Iron. This means part of the concentration of the metals must have been transferred from the rock to the soil and water as conformity with U.S. Environmental Protection Agency and corroborated by Bliss (2002) that heavy metals are associated with crushing sites.

From Table 2, it is seen that the soil samples inside the crushing area sample S1 and S2 also have high concentration of the metals. The concentration of metals in both samples is seen to be increasing in the following order: Nickel<Chromium<Cadmium<Lead< Copper<Zinc< Iron. This means part of the concentration of the metals must have been transferred from the rock to the soil and underground water.

From Table 3, it is seen that the concentrations of metals were found to decrease with increase in distance from 500m to 3000m in the soil samples outside the crushing area. This is because the impact of crushing on the earth reduces with distance. The further the distance from the crushing site, the less the concentration of minerals. This is in line with Rikhtegar N et al, (2014) that seasons and times affect the concentration of minerals.

It was observed from Table 4, that the water inside the crushing area (Sample W1) of the study site contains the highest concentrations of the water quality parameters analyzed; which include total dissolved solids, conductivity total chlorides, total hardness, calcium hardness, Iron, Zinc, and Lead and so on. The other water samples (W2 and W3) contain all the parameters but in lower concentrations as compared to sample W1. This means that rock crushing had a significant effect on the physical and chemical characteristics of the water around the area. The samples were observed to have high total dissolved solids (754,587 and 604) ppm respectively, total chloride and total hardness. High value of conductivity is harmful to living organism because of increase in osmotic pressure. All the water samples were in excess of 150 mg/l, total chloride which may cause physiological damage and also increase the corrosiveness of water thereby causing toxicity to plants corroborating with Rikhtegar N et al, (2014).

The water samples were also observed to be hard which have detrimental effects such as excessive soaps consumption in homes, laundries and formation of scales in boilers, hot water heaters, pipes and utensils. Water with high dissolved solids often has a laxative effect on people whose bodies have not adjusted to them. It causes foaming in boilers and interferes with clarity, colour and taste of finished products. The pH of the water samples was between the ranges of 4.5 to 5.5 which is acidic and causes skin irritation and chemical burns on the body. Iron has the highest concentration, followed by Zinc, copper among the

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heavy metals analyzed. Generally, TDS, total chloride, total hardness, Iron; Cadmium, Chromium and Lead were above W.H.O Guideline standard for portable water quality.

IMPLICATION TO RESEARCH AND PRACTICE

This work reveals the effect of crushing activities on the environment. It exposes the extent of the activity on the air quality, soil and water. It also exposes the amount of metals contained in the air, soil and water. This research will help the personnel on crushing site to know the requied personal protective equipment to put on during operation.

CONCLUSION

From the research it is seen that the air dust around crushing contains heavy metals. The soil samples inside the crushing area and within the crushing area have high concentration of the metals. The concentration of metals in the various samples were seen to be decreasing as the distance from crushing site increased. The concentration of metals in the air dust sample, soil sample and underground water has a resulting environmental degradation effect on people.

FUTURE RESEARCH

The future research will be to look at the nature of crushing equipment on the quantity of metals released into the air, soil and water. Crushing activities that involve trapping of metals to minimize and prevent pollution of air, soil and soil water.

REFERENCES

Aigbedion I.W. (2005) Environmental pollution in Nigeria. Habit Internat 3: 205-210.

Alloway, B.J., and Ayres, D.C. (1997) Chemical principles of environmental pollution (2ed.): New York, Blackie Academic & Professional, 359 p.

Arbogast, B.F. (1996) Analytical methods manual for the Mineral Resource Surveys Program: U.S. Geological Survey Open-File Report 96-525, 248 p.

Bliss, J. D. (2002) Modeling Sand and Gravel Deposits-Initial Strategy and Preliminary Examples: U. S. Geological Survey Open-File Report 93-200, 31 p.

Busbey and Arthur B. (2004) Rocks and Fossils Alexandria, VA: Time-Life Books,

Garba H. I. (2001) Sustainable industrial development in a developing economy, Nigeria. Niger J Indust pollut 1: 8-12.

Jordan, P.R., and Stamer, J.K. (1995) Surface-water-quality assessment of the lower Kansas River Basin, Kansas and Nebraska-analysis of available data through 1986: U.S. Geological Survey Water-Supply Paper 2352-B, 161 p.

Manahan, S.E. (2000) Environmental chemistry (7th ed.): Boca Raton, Florida, Lewis Publ., 898p.

Rikhtegar N, Mansouri N, Oroumieh AA, Yazdani-Chamzini A, Zavadskas EK, (2014) Environmental impact assessment based on group decision-making methods in mining projects. Econom Res 27: 378-392.

Smith, M. R., and Collins, L. (2000) Aggregates: sand, gravel and crushed rock aggregates for construction purposes (2nd edition): Geological Society of London, Geological Society of Engineering, Geological Special Publication No. 9, 339 p.

U.S. Environmental Protection Agency, (1991) Guidance of water quality-based decisions—the TMDL process: Washington, D.C., Office of Water, EPA440/4-91-001, 59 p.

Vernon, R.H. (2000) Beneath Our Feet: The Rocks of Planet Earth, Cambridge University Press, New York.

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