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Heavy Metal Contamination of Plants and Soil in Itakpe Iron Ore Deposit Area of Kogi State, Nigeria

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Abstract: The effect of mining of iron ore on soil on the iron ore deposit area of Itakpe was investigated. The study involved determination of some heavy metal content of soil in order to have baseline data for assessing the impact of iron ore mining in the future. Leaf of plants and Soil samples at 0-15 cm depth were randomly collected, predigested and analysed using Bulk 2000, A model of Atomic Absorption Spectrophotometer (AAS) for content of lead, iron, copper and Zinc. Results reveal that soil and plant species of the mine plots contain higher level of heavy metal, compared to the unmined (Control plots). Possible implications of this development on the inhabitants and the larger society consuming farm products from the area are discussed. Suggestions are made on how to mitigate the impact of iron ore mining on the soil and therefore plant species.

Key words: Mining, heavy metal, mitigate, gold deposit, atomic absorption spectrophotometer

INTRODUCTION

Spoil heaps and tailings from mining pits discharge into the physical environment constitute environmental problem. Spoil heaps made up of a mixture of overburden soil and rock are deposited as mine waste on the surface terrain.

Mining brings about considerable changes to the physical environment, particularly the soil (Ratcliffe, 1974; Muogahalu, 1996). It is accompanied by soil degradation in the forms of soil compaction and pollution or contamination with trace metals from mine waste (Barrow, 1995).

Mining makes heavy metals present in minute quantities to become more abundant in the soil. It is the principal source of soil pollution due to heavy metal. (Ademoroti, 1996). As mine waste, become incorporated into the soil, their heavy metal contents are absorbed by plants and when those plants are consumed by man, they can give him silent epidemic of environmental poisoning. Heavy metals are absorbed by plants and when consumed as tool or medicine by man and as forage by animal find their way into their bodies, there they accumulate, interfere with the working order of the system and pose servere health problems ranging from cancer to heart diseases (Ademoroti, 1996; Jimoh, 2006).

Itakpe is situated near Okene in the North Central part of Nigeria. It lies within longitude 6°16' E and latitude 7°36' N and 7° 39'N.

The cilimate of the study area is tropical and consists of 6 months (May-October) of wet season and 6 months (November-April) of dry season. Agriculture is the major activities of the inhabitants of this area. They cultivate economic food crops as melon, groundnut, cassava, yam, tomatoes, rowpea etc.

The objective of this study is to provide baseline data on the levels of the contamination for assessing the impact of iron ore mining in the area. This is with the perspective of considering possible implications of the heavy metal contamination on the inhabitants of the area in particular and larger community in general feeding on agricultural products from the area and recommend measure to mitigate the impact of iron ore mining on the environment.

MATERIALS AND METHODS

Three replicates of composite samples of the top soil (0-15 cm) were randomly collected from each site. Soil samples were taken with the aid of steel batch auger. Soil samples were collected from the waste dump of each segment of the mine i.e. west mine, east mine and the pilot mine.

The control soil was taken from unmined area several kilometres away from the mine.

Representative matured leaf of sample of water leaf plants were collected from farms at west mine, East mine and control site.

The method of partial digestion was used to digest soil samples in accordance with USEPA SW-846 1996. Sun dried sample were ground into fine power. One gram of sample was weighed on an analytical balance then put into a plastic container of 100 mL capacity. Five mililiter of Aquregic (Solution of $HN0_3$ and HCL) was added to each of the samples then shaken thoroughly. The sampples were then allowed to stay from some hours. Distilled water was added to the solution to produce 100 mL solution. The prepared sample was then filtered and metal analyses using Atomic Absorption spectrometry was used.

Leaf sample were ground, ashed and digested using nitric-perchloric-hydrochloric acid mixture (AOAC, 1970). Atomic absorption spectrophotometry, AAS was used for the analysis for heavy metals.

The plant of soil samples was measured with a plant meter in accordance with BS 1377-3: 1990. Five grams of powdered sample were weighted in on analytical balance, 5 mL of distilled water was added. The solution was stirred for one minute, the mud was filtered paper with a piece of Whatman no. 1 filter paper. The plant of around water was measured.

RESULTS AND DISCUSSION

The mean heavy metal contents of soil at 0.15 cm depth are shown in Table 1- 3. Limiting the investigation in this study to the topsoil was based in the study by Nyagababo and Hamya that surface soils are better indicator of metallic burden. Mean iron content of soil in East Mine (EM) is 7.41 mg g^{-1}, in West Mine (WM), 7.38 mg and 7.45 mg kg^{-1} at pilot mine. The highest value is at East mine and least at West mine. These values are greater than 2.35 mg kg^{-1} at Control Site (CS). Mean copper content of soil at East mine is 3.24 mg kg^{-1}, at west mine, 3.17 and 3.10 mg kg^{-1} at pilot mine. The highest is at east mine and least at Pilot Mine (PM). These values are greater than 2.05 mg kg^{-1} which is the value at Control Site (CS). Mean zinc contest is 3.07 mg kg^{-1} at East mine, 3.10 mg kg^{-1} at West mine, 3.15 mg kg^{-1} at pilot mine. The highest is at East mine. These values are greater than 2.03 mg kg^{-1} which the value at Control Site (CS).
Lead was not detected in the soil samples.

The heavy, metal content of representative farm leaf samples are shown in Table 3-5. Plants are liable to absorb minerals from the soil as mining contaminates soil through their introduction (Ademoriti, 1996). This creates a pathway for them into food chain hence they are passed to animals and man (consumers). Mean iron content of representative water leaf leaf was 78 mg kg^{-1} at East mine (Em), 73 mg kg^{-1} at West mine (Wm) and 40 mg kg^{-1} at Control Site (CS) mean copper content was 9.5 mg lg^{-1} (East mine) 8.8 mg kg^{-1} (West mine) all 6.4 mg kg^{-1} Control Site (CS). Mean zinc content was 40.32 mg kg^{-1} at East mine, 36.10 at West mine and 28.14 mg kg^{-1} at Control Site (CS). Lead was not detected in any of the leaves. The highest value of heavy metal was found at East mine and the lowest at control site (mined area) (CS).

Table1: Iron content of soil

	1st mg kg^{-1}	2nd mg kg^{-1}	3rd mg kg^{-1}	Mean mg kg^{-1}	S.D.	Min mg kg^{-1}	Max mgkg^{-1}
EM	7.40	7.44	7.36	7.41	0.021	7.39	7.44
WM	7.38	7.40	7.36	7.35	0.020	7.36	7.40
PM	7.44	7.44	7.47	7.45	0.022	7.44	7.47
FA	3.90	4.00	4.05	4.00	0.079	3.90	4.05
FB	3.54	3.58	3.53	3.55	0.025	3.53	3.58
FC (CS)	2.34	2.39	2.32	2.37	2.350	0.035	2.32

Table 2: Copper content of the soil

	1st mg kg^{-1}	2nd mg kg^{-1}	3rd mg kg^{-1}	Mean mg kg^{-1}	S.D.	Min mg kg^{-1}	Max mgkg^{-1}
EM	3.21	3.27	3.24	3.24	0.030	3.24	3.27
WM	3.16	3.18	3.19	3.17	0.010	3.16	3.18
PM	3.08	3.11	3.11	3.10	0.016	3.08	3.11
FA	2.10	2.13	2.10	2.11	0.023	2.10	2.13
FB	2.07	2.08	2.09	2.08	0.010	0.07	2.09
FC (CS)	2.04	2.07	2.04	2.05	0.016	2.04	0.07

Table 3: Zinc content of the soil

	1st mg kg^{-1}	2nd mg kg^{-1}	3rd mg kg^{-1}	Mean mg kg^{-1}	S.D.	Min mg kg^{-1}	Max mgkg^{-1}
EM	3.06	3.05	3.40	3.07	0.032	3.05	3.10
WM	3.10	3.12	3.08	3.10	0.020	3.08	3.12
PM	3.14	3.17	3.14	3.15	0.016	314.00	3.17
FA	2.05	3.08	2.05	2.06	0.158	2.05	2.08
FB	2.05	2.04	2.05	2.05	0.010	2.04	2.06
FC (CS)	2.00	2.05	2.03	2.03	0.225	2.00	2.05

Table 4: Iron content of water leaf leaves from the study farms

	1st mg kg^{-1}	2nd mg kg^{-1}	3rd mg kg^{-1}	Mean mg kg^{-1}	S.D.	Min mg kg^{-1}	Max mgkg^{-1}
FA	78.10	78.30	77.60	78	0.354	77.60	78.30
FB	72.50	73.50	73.00	73	0.500	72.50	73.50
FC (CS)	39.80	40.00	40.20	40	0.200	39.80	40.20

Table 5: Copper content of water leaf leaves from the study farms

	1st mg kg^{-1}	2nd mg kg^{-1}	3rd mg kg^{-1}	Mean mg kg^{-1}	S.D.	Min mg kg^{-1}	Max mgkg^{-1}
FA	9.30	9.60	9.60	9.5	0.158	9.30	9.60
FB	8.80	8.70	8.90	8.8	0.100	8.70	8.90
FC(CS)	6.40	6.33	6.47	6.4	0.070	6.33	6.47

Table 6: Zinc content of water leaf leaves from the study farms

	1st mg kg^{-1}	2nd mg kg^{-1}	3rd mg kg^{-1}	Mean mg kg^{-1}	S.D.	Min mg kg^{-1}	Max mgkg^{-1}
FA	39.50	39.60	39.55	39.55	0.05	39.50	39.60
FB	38.40	38.60	38.50	38.50	0.10	38.40	38.60
FC(CS)	27.21	27.19	27.20	27.20	0.01	27.19	27.21

CONCLUSION

Based on the data obtained from the study, mining practices are possible sources, of heavy metal contamination of soil and plants in Itakpe, Okene area. The heavy meatals studied are Pb, Fe, Zn and Cu. i Deposited mine waste on the surface adds metallic contaminants to the soil on which economic crops are cultivated. There metals which are potentially toxic get incorporated into the biogeochemical cycle and hence food chains. There is need for bioremediation programme for the soil that can reduce the concentration of heavy metals to tolerable levels. It is also required that environmental impact study and assessment of mining areas be done regularly. The Federal ministry of solid minerals and Federal ministry of Environment should enforce appropriate edicts to ensure compliance.

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