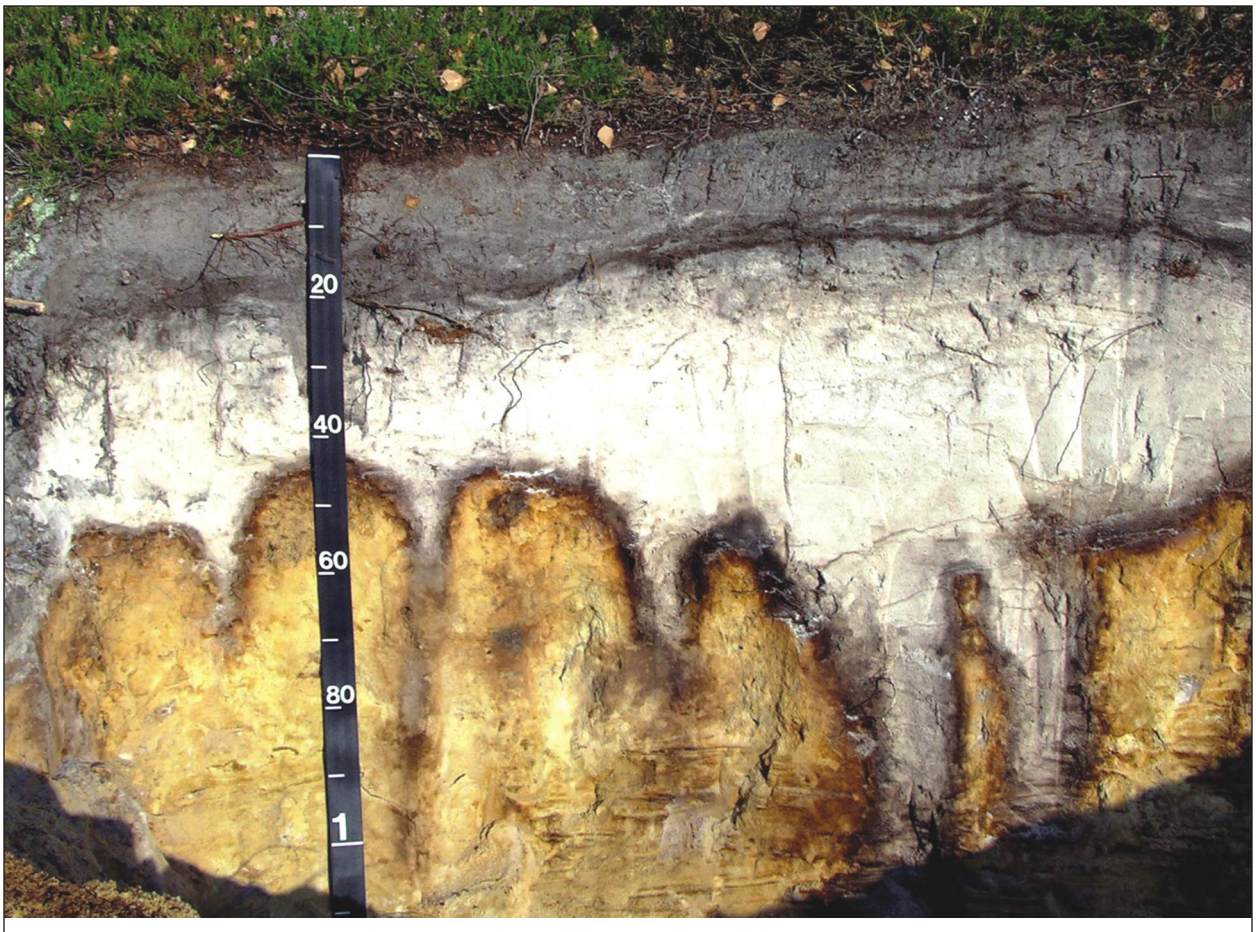

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Characteristic Levels of Total Petroleum Hydrocarbon in Soil Profiles of Automobile Mechanic Waste Dumps

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Abstract: This communication present the results of the determination of total petroleum hydrocarbon content of soil profiles of automobile mechanic waste dumps. The levels of petroleum hydrocarbon in all sites ranged from 486-4438.7, 116.3-433.4 and 54.5-244.2 mg kg^{-1} for 0-15, 15-30 and 30-60 cm depths, respectively. The concentrations of petroleum hydrocarbon in automobile waste dump sites are relatively high and represent elevated concentrations above background levels found in unpolluted soils. The hydrocarbon concentrations show no relationship with the soil physicochemical characteristics and ages of the dumpsites. Automobile mechanic waste dumps represent a potential sources of petroleum hydrocarbon contamination in soils, sediments, surface water and groundwater in areas remote from oil exploration and production sites.

Key words: Soil contamination, petroleum hydrocarbon, automobile mechanic wastes, non-exploration, production sites

INTRODUCTION

Petroleum hydrocarbon oils are of environmental interest because they are toxic to the human system, plants and animal resources. Yet, they pervade the environment beyond the vicinities of petroleum exploration and production activities due to storage, disposal and other handling activities during which contamination of the environment sometimes occur. Hence urban centre remote from production activities are sometimes as much polluted as the surrounding production areas (Onianwa and Essien, 1999). Previously, in Port Harcourt, automobile workshops were scattered all over the city and occupied almost every vacant lot along major roads. Waste were indiscriminately dumped on every available space and all categories of urban waste ranging from lubricating oil films, junked cans to tyres were found to litter along street and major roads. In 1990, two mechanic villages were established in Port Harcourt municipality by River State Government to curb the menace of wastes deposited by automobile works and to improve the general aesthetics of the city (Iwegbue *et al*., 2006a).

Wastes from automobile workshop activities include solvent, paints, spent heat transfer fluids, hydraulic fluids, spent lubricants and stripped oily sludge. Most of these wastes are dumped on land. In such urban centre, there is contamination of surface water, sediment and groundwater with petroleum hydrocarbon from poor handling and disposal practices. Limited data are currently available on petroleum contamination from a non-petroleum production sites in the Nigeria. The aim of present study is to determine the characteristic levels of total petroleum hydrocarbon in soil profiles of automobile mechanic waste dumps.

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MATERIALS AND METHODS

Soil samples were collected from 5 designated automobile waste dumps in January - March 2005 within Port-Harcourt metropolis, namely East West Road (1) Elekohia (2), Miles 3 Diobu (3), Trans Amadi (4) Borokiri (5) and control site (6), which was collected from the Rivers State University of Science and Technology, Port Harcourt teaching farm. The status of the automobile mechanic waste dump studied has been reported elsewhere (Iwegbue *et al*., 2006a). The soil samples were collected within 100×100 m quadrant around the dumpsites. The quadrant was divided into 10 cells (10×10 m) with each cell denoting a sample station. A composite sample consisting of at least 5 random samples were collected in each cell at 0-15, 15-30 and 30-60 cm depths (Iwegbue *et al*., 2006a). Soil particle size distribution, electrical conductivity (EC), soil pH, Cation Exchange Capacity (CEC) and total organic matter determination have been previously described by Iwegbue *et al*. (2006a).

Total petroleum hydrocarbon of the soil sample was determined by the method of Intergovernmental Oceanographic Commission (IOC) as described by Onianwa and Essein (1999), Iwegbue *et al*. (2007). Hundred gram of the soil samples were refluxed with 100 mL of methanol containing about 3.0 g of KOH for 2.5 h. The refluxed mixture was filtered and the filtrate was extracted with two 2.5 mL portion of redistilled hexane. The combined extracts were evaporated to about 1.0 mL and then subjected to clean up in a silica column, eluted with n-hexane. The eluate was subsequently evaporated to isolate the hydrocarbon oil which was then weighed. A recovery study of the procedure was carried out with varying amount of fresh automobile engine oil and then repeating the analysis. An average recovery of 90.7±2.3% was obtained.

RESULTS AND DISCUSSION

The results of physico-chemical characteristics and total petroleum hydrocarbon content of soil profile of automobile mechanic dumps are presented in Table 1 and 2, respectively. Sand forms the predominant particle size and ranged from 66.8-88.4% in all sites and depth. The sand fractions showed a regular decrease with depth while the silt and clay fractions increase with depth of the soil profile. The silt and clay fraction never exceeded 10-22.2%, respectively in all sites and depths. pH, total organic matter (OM) and cation exchange capacity (CEC) decreases with increasing depth of the profile. The pH values reported in this study are similar to pH value recorded for some other Nigeria soils (Odu *et al*., 1985; Isirimah, 1987; Banjoko and Sobulo, 1990; Iwegbue *et al*., 2006b). All

Table 1: Some physicochemical properties of soils profiles of the automobile mechanic waste dumps

Site	Depth (cm)	pH (H_2O)	EC ($\mu S\ cm^{-1}$)	Organic matter (%)	CEC (C mol kg^{-1})	Particle sand (%)	Size silt (%)	Distribution clay (%)
1	0-15	6.6	0.24	2.60	26.2	88.4	3.4	8.2
	15-30	5.6	0.16	4.93	22.0	86.4	3.4	10.2
	30-60	5.4	0.23	2.80	20.5	69.4	10.4	20.2
2	0-15	6.8	0.24	6.80	34.8	86.9	3.8	9.4
	15-30	7.0	0.26	5.80	35.4	82.8	4.4	12.4
	30-60	7.0	0.39	5.00	92.1	71.8	7.8	20.4
3	0-15	7.2	0.32	6.90	78.8	80.8	7.2	11.8
	15-30	7.1	0.24	6.40	35.4	79.8	4.4	11.8
	30-60	7.0	0.15	5.50	12.9	66.8	8.4	24.8
4	0-15	6.7	0.24	5.60	24.9	80.0	10.0	10.0
	15-30	6.4	0.16	5.60	19.7	92.0	8.0	20.0
	30-60	6.3	0.14	3.60	17.5	71.0	7.0	22.0
5	0-15	5.8	0.18	4.20	32.8	78.0	10.0	12.0
	15-30	5.6	0.16	3.60	23.9	72.0	8.0	20.0
	30-60	5.4	0.14	1.80	19.2	72.0	6.0	22.0
6	0-15	5.7	0.10	1.00	10.0	66.8	8.4	24.8

CEC: Cation Exchange Capacity, EC: Electrical Conductivity

Table 2: Levels of total petroleum hydrocarbon in soil profiles automobile mechanic waste dumps (mg kg^{-1})

Depth (cm)		1	2	3	4	5	6
0-15	Mean	486.00	353.6	2408.0	4438.7	3618.0	5.0
	Max	498.20	3384.7	2613.7	4773.4	4003.6	-
	Min	473.00	2922.5	2202.3	4104.0	3232.3	-
	SD	12.20	231.1	205.7	334.7	385.6	-
15-30	Mean	116.30	324.0	433.4	397.5	362.2	-
	Max	130.60	353.7	469.6	647.5	415.2	-
	Min	101.90	294.3	397.2	147.5	308.6	-
	SD	14.40	29.7	36.2	250.0	53.6	-
30-60	Mean	54.50	162.6	237.5	179.4	244.2	-
	Max	65.00	191.2	276.7	225.0	306.5	-
	Min	44.00	134.0	198.3	133.8	181.9	-
	SD	10.53	28.6	39.2	45.6	62.3	-

sites and depth showed significant higher values of cation exchange capacity, total organic matter and conductivity than the control site. The reason for the high organic matter content of the waste dumps was due to co-deposition of domestic wastes and carbon compounds present in automobile mechanic wastes.

Analysis of variance show no significant variability when samples collected from a given site and horizon are compared. However, significantly variability is found in sites 4 (at 15-30 and 30-60 cm) and 5 (at 30-60 cm depth). Significant and apparent variability exists when concentration of petroleum hydrocarbons on the various dumps sites and profiles are compared. The concentrations of total petroleum decreases with depth in all sites. This implies that most of the petroleum hydrocarbon oil accumulates at the topsoil compared to the other depths. The accumulation pattern of petroleum hydrocarbon depends on the textural and physical soil, contaminant supplies, amount that are water soluble and the hydrology the area. Surface runoff forms the major dispersing mechanism of petroleum hydrocarbon oil in these sites.

The processes of alteration of composition of hydrocarbon occur as it gets into soil. Clearly, those hydrocarbons that are most strongly sorbed onto soil organic matter will be resistant to loss or alteration by the other process. Conversely, the more volatile/soluble hydrocarbons will be the most susceptible to change by volatilization/reaction/leaching and biodegradation. The ultimate result will be weathering of hydrocarbon mixture discharged to soil, within accompanied changes in its composition and a preferential transport of certain fractions to other environmental compartment (Sadler and Connell, 2003).

As oil infiltrate the soil, it has a considerable effect on the structure and welting ability of soil. A complete breakdown in structure and dispersion of soil particulate has been noted. The rate of soil movement into and through the soil will large depend on the type oil, organic matter content, moisture content of the soil and depth to water table. As soil infiltrates the soils, it physically displaces soil air and water. This has been considered significant effect in promoting anaerobic conditions in soil (Iwegbue *et al*., 2007).

The highest concentration of petroleum hydrocarbon was recorded in site 4 (4438.7 mg kg^{-1}). The order of concentration of total petroleum in the surface horizon follows 4>5>2>3>1. In sites the subsurface horizon contained less than 450 mg kg^{-1} petroleum hydrocarbon oil. There was no significant relationship was found between total hydrocarbon concentration, age of the dump and soil physicochemical characteristics. This is a suggestive evidence that the petroleum hydrocarbon content of the soil profiles of these waste dumps is purely of anthropogenic origin. The concentration of total hydrocarbon oil found in the surface horizons are higher than concentration range reported by Onianwa and Essien (1999), Adekambi (1989) and Iwegbue *et al*. (2007) for crude oil impacted soil in the Niger Delta.

Toxicity of petroleum hydrocarbon oil in soils has been studied using a number of species including bacteria, algae, earthworms and plants and a range of lethal to sub lethal effects, such as seed germination, root elongation and reproduction. The toxicity effects have appeared over a large range

of test concentrations. However, most effects are found in concentrations range greater 1000 mg kg^{-1}. The lowest EC_{50} for germination studies (typically lettuce) are in the range of 2000-3000 mg kg^{-1} (Chaineous *et al*., 1997; Saterbak *et al*., 1999). The concentrations of total hydrocarbon recorded in the present study are within or greater than this range and therefore will produce toxicity effect on crops. Site 1 and subsurface of horizons of the other sites have concentrations low than this range.

CONCLUSION

The data obtained from this study revealed that concentration of petroleum hydrocarbon in soil profiled automobile mechanic waste dumps are relatively high and represent elevated concentrations above background levels found in unpolluted soil. The levels of petroleum hydrocarbon decreases with depth of profiles and showed no relationship with ages of dump sites and the soil physicochemical properties. The mechanic waste dumps represents a potential possible source of hydrocarbon contamination of soils, sediment, surface and groundwater in area far from oil production sites.

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