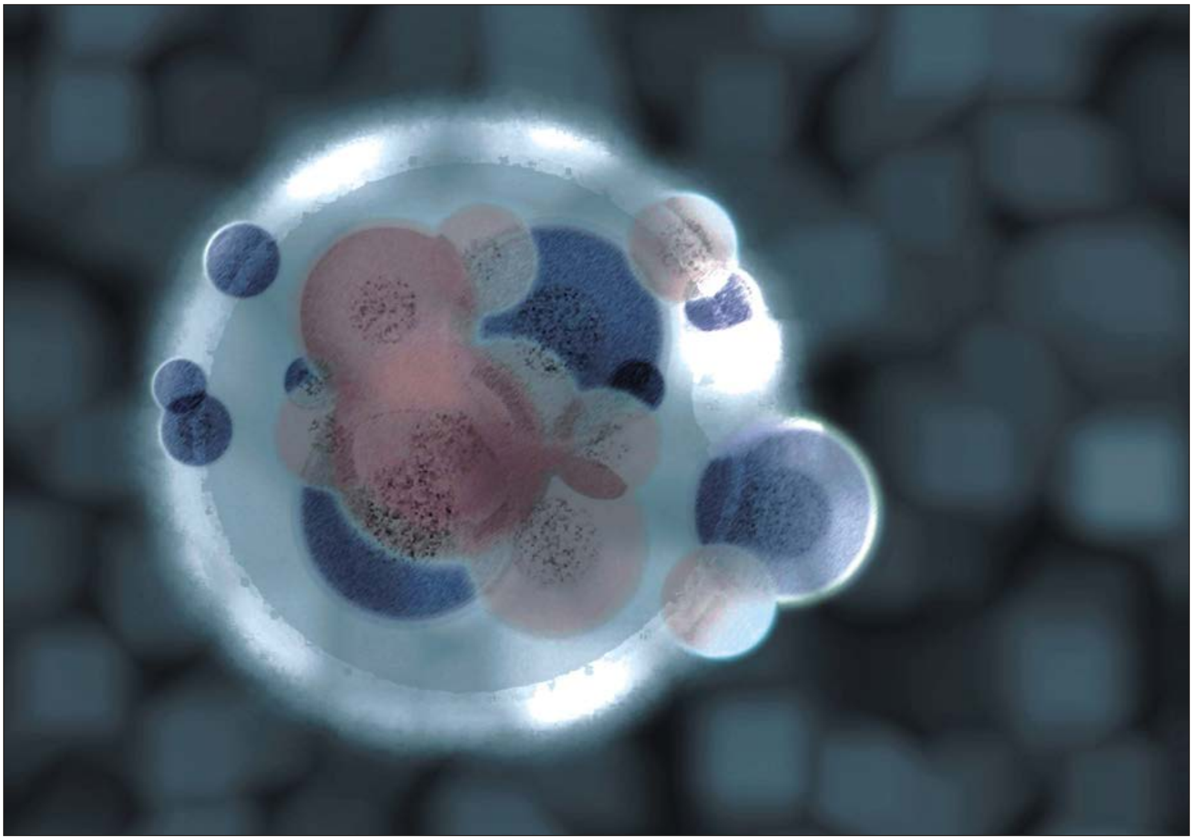

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Heavy Metals in Surface Soils under Waste Dumps from Onitsha Nigeria

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Abstract: Heavy metals in surface soils under waste dumps in Onitsha metropolis was investigated. Seven metals, namely arsenic, barium, cadmium, chromium, manganese, lead and lithium were considered. Analytical determinations were performed by atomic absorption spectrometry after sample digestion with acid mixture. Elevated concentrations of the aforementioned metals were obtained in this study. All metals were detected except for the background, soil sample from Inland town where chromium and lead were below detection limit. There were variations in the concentrations of metals in soils from various locations. Metal concentrations in soils obtained from Omagba phase II, Woliwo layout, Fegge road, Head bridge, Odoakbu layout, Awada layout and Isiafor layout were higher than those from Ozala layout and Inland town (Background soil samples). The highest concentrations of the contaminant metals found in soil located near the head bridge of River Niger. The sources of these metals were attributed to the industrial and anthropogenic wastes in various sample locations.

Key words: Industrial and urban wastes, surface soil, metal contaminants, Onitsha metropolis, river Niger

INTRODUCTION

Onitsha is a commercial/industrial town with the largest market and industries in Africa. To develop and apply strategies to reduce the already existing pollution one must know what the pollutants are, how they depend on each other and what toxic effects they have on the water, soil, air and living orgamisms, what the level of pollution is (Mihaly-Cozmuta *et al*., 2005).

Mechanism of retention and mobility of metals in soils have been studied extensively by many authors (Adriano, 1986; Kabata-Pendias and Pendias, 2001). The chemicals such as the mixture of Boiden (BIS) and zinc sulphate and Chromated Copper Arsenate (CCA) used for industrial wood preservation have contributed the toxic elements such as arsenic, copper, chromium and zinc in the soils environment (Kabata-Pendias and Pendias, 2001). The analytical results obtained by Bhattacharya *et al*. (2002) revealed a large spread of the contaminant metals in the surface soils. The highest concentrations of the contaminant metals were found in the vicinity of the platform on which the chemical treatment was carried out. Many industrial processes such as smelting, burning of fossil fuels, petroleum prospecting and mining, produce heavy metals which if not properly and carefully controlled end up in soils (Osuji and Onojake, 2004). The concentrations of heavy metals in soils are associated with biological and geochemical cycles and are influenced by anthropogenic activities, such as agricultural practices, transport, industrial activities, wastes disposal, respectively (Lund, 1990). The highest chromium and nickel content in soil from St. Manrizio Canavese was attributed to the nature of the parent material, which consists of ultramatic rocks (Alloway, 1990; McGrath and Smith, 1990).

The risk that arises in soils highly contaminated with heavy metals are primarily from the mobility (i.e., transport to water resources and bioavailability) of chemicals (Adriano *et al*., 2002). Anthropogenic inputs have resulted in elevated cadmium levels in soils, surface water and terrestrial setting, especially in Urban/suburban regions. Exposure media include soil, surface water, sediment and foods (Wren *et al*., 1995). In the transfer of cadmium from terrestrial to aquatic systems, 94-96% remains in the soil, once in the water, cadmium accumulates in the sediments more quickly than in biota (Huckabee and Blaylock, 1973). Sludge and industrial polluted soil have more cadmium and lead than soil free from sludge and industrial pollution from Hyderabad, India (Srikenin and Raja, 1991). Soil samples collected along a heavy traffic Kaduna-Zaria highway was found to contain lead, copper and zinc levels higher than the control soil samples collected some distance away from the high way (Oyewale and Funtua, 2002).

The primary aim of this research was to investigate the levels of some selected metals of toxicological interest in soils from Onitsha metropolis.

MATERIALS AND METHODS

Description of study area: Onitsha is a commercial town found in the eastern region of Nigeria. It is also located by

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the bank of the lower River Niger. It has one of the largest markets in Nigeria, which attracts people from different parts of Africa. The large market has attracted industrial locations in Onitsha and its environs. Commodities and goods that are perished are usually found in various locations in the town. These anthropogenic and industrial wastes have contributed to nuisance associated with foul odour in Onitsha. The town is liable to flood due its nearness to the River Nigeria. The poor drainage system within the area is attributed to various waste dumped in Onitsha. Dumping of refuse along culvert have eventually blocked the channel of flow into the River Niger.

Sampling and analysis: The sampling sites were selected at nine different locations within the metropolis as shown in Fig. 1. Samples 01, 02, 03, 04, 05, 06 and 07 were obtained under the waste dumped whereas samples 08 and 09 were collected as reference samples (where no dump of waste was allowed). The soils were collected by a sharp edged auger from the surface soil layer 0-15 cm (Bhattacharya *et al*., 2002). The samples were air-dried, sieved, ground to pass 2mm mesh. The samples were stored at 4°C until it is required for laboratory analysis.

(5.00 g) of the air-dried were digested in acid mixture prepared from 20 mL HNO_3, 10 mL HCL and 2 m L HF.

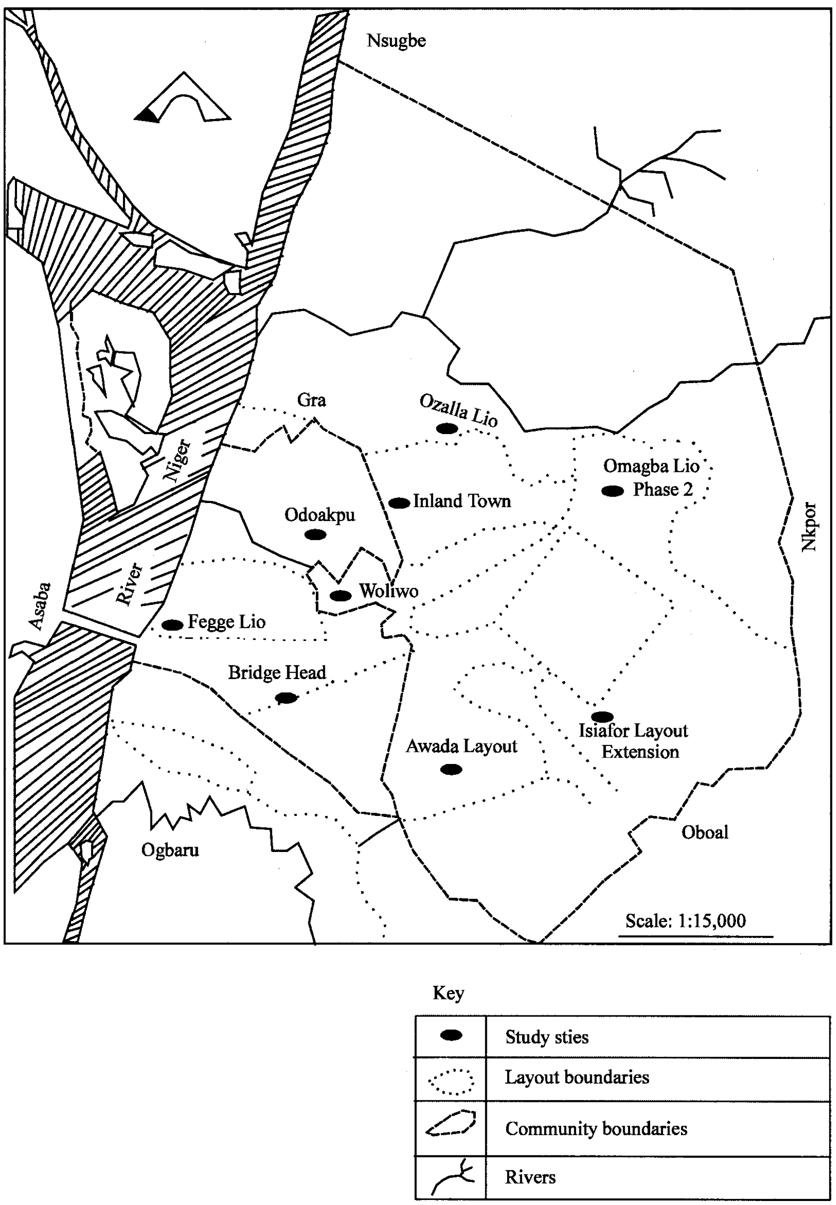

Fig. 1: Map of Onitsha showing study sites

All acids were of analytical grade (Abollino *et al*., 2002). The digests were placed on a hot plate (130°C) for 2 h with constant stirring. The digests were transferred to a fume hood overnight. The filtered solution was made up to 100 mL with doubled distilled water. The solutions was analysed for heavy metals using flame atomic absorption spectrophotometry (PYE-Unican SP 2900). Arsenic was analysed using the hydride generation technique. Recovery studies were carried out by spiking already analysed soil samples with known metals standards. The percentage recoveries for the various metals were as follows: 96% for Asernic, 91% for barium, 95% for lithium, 96% for cadmium, 89% for chromium, 98% for lead and 88% for manganese, respectively.

RESULTS AND DISCUSSION

River Niger which flows southwards through Onitsha is known to be the receiving ends of all pollution loads arising the town. The analytical results in this study reveal a large spread of the contaminant metals in the surface soils (Table 1). The highest concentrations of the metals were found near the River Niger bridge head. The high concentrations of metals in soil near the River Niger bridge head is traceable to concentrations of pollutants settled at the bridge head through run off. Metals such as arsenic, barium, cadmium, chromium, manganese, lead and lithium were detected in the soils except chromium and lead which were below detection limit in one of the background soils obtained from the Inland town. This study also revealed that metal concentrations in soils obtained from the waste dumped sites (Samples 1 to 07) exceeded those values found in background soils (Samples 08 and 09) (Table 1). The low concentrations of metals from background soils is an indication that wastes dumped have been contaminating the natural soil. The concentrations of barium and manganese in the background soils are also an indication that waste dumped is not the only contributor of these metals. The presence of metals could be traced to drainage and industrial effluent discharged on the sites. However, industrial wastes and anthropogenic wastes are the major contributors of the elevated metal concentrations in soils from Onitsha metropolis.

Highest concentrations of barium were obtained in soils from all sites when compared with other metals analysed. This high level is traceable to wastes arising from dyeing of textile fabrics, electroplating processes and metallurgical activities in Onitsha. The textile mill and metallurgical industries are located a few meters away from the River Niger. Human toxicological effects of arsenic, barium, cadmium, chromium, lead and lithium are known except for manganese which is not well characterized (Theordore and Le May, 1981).

The concentrations of chromium and cadmium in this study exceeded those obtained by Egboh *et al*. (2001) from soils around market waste dumpsite in Warri metropolis. Whereas lead and manganese concentrations in soils around market waste dumpsite in Warri were higher than those obtained in this study. The concentrations of cadmium, arsenic and lead obtained by Steinnes *et al*. (1997) in top soil from Southern most Norway were higher than those obtained in this study. However, the high concentrations of metals obtained in Onitsha metropolis are an indication of environmental pollution.

Table 1: Mean±SD and range of heavy metals in soils from Onitsha near river Niger

		Metal concentrations (mg kg^{-1} dry weight)						
Sample code	Sample location	Arsenic	Barium	Cadmium	Chromium	Manganese	Lead	Lithium
1	Omagba Phase Two	0.80±0.03	17.60±0.49	1.05±0.08	0.60±0.12	12.00±0.90	0.80±0.16	0.48±0.15
		(0.75-0.85)	(17.00-18.20)	(0.95-1.10)	(0.45-0.75)	(10.90-13.10)	(0.60-1.00)	(0.30-0.66)
02	Woliwo Layout	0.82+0.16	18.40±0.98	1.29±0.22	0.88±0.15	13.04±1.01	0.90±0.16	0.58±0.07
		(0.70-0.94)	(17.20-19.60)	(1.10-1.48)	(0.70-1.06)	(11.80-14.28)	(0.70-1.10)	(0.50-0.66)
03	Fegge Road	0.55±0.16	12.00±0.817	1.40±0.29	0.20±0.08	4.96±0.48	0.30±0.08	0.32±0.10
		(0.35-0.75)	(11.0-13.00)	(1.05-1.75)	(0.10-0.30)	(4.36-5.55)	(0.20-0.40)	(0.20-0.44)
04	Head Bridge	0.86±0.11	20.00±1.470	1.60±0.33	0.96±0.11	17.84±1.34	1.00±0.12	0.60±0.16
		(0.72-1.00)	(18.20-21.80)	(1.20-2.00)	(0.82-1.10)	(16.20-19.48)	(0.85-1.15)	(0.40-0.80)
05	Odoakbu Layout	0.30±0.09	14.40±1.306	0.57±0.09	0.32±0.05	6.96±0.74	0.50±0.08	0.42±0.10
		(0.18-0.42)	(12.80-16.00)	(0.45-0.69)	(0.26-0.38)	(6.06-7.86)	(0.40-0.60)	(0.30-0.54)
06	Awada Layout	0.80±0.16	16.00±1.633	0.89±0.16	0.48±0.13	11.20±1.14	0.60±0.16	0.44±0.11
		(0.60-1.00)	(14.00-18.00)	(0.69-1.09)	(0.32-0.64)	(9.80-12.60)	(0.40-0.80)	(0.30-0.58)
07	Isiafor Layout	0.45±0.12	16.00±0.98	0.80±0.10	0.40±0.08	8.24±0.29	0.05±0.00	0.30±0.08
		(0.30-0.60)	(14.80-17.20)	(0.68-0.92)	(0.30-0.50)	(7.88-8.60)	(0.42-0.05)	(0.20-0.40)
08	Ozala Layout	0.08±0.00	9.60±0.49	0.40±0.10	0.20±0.08	4.00±0.64	0.09±0.03	0.15±0.04
		(0.05-0.11)	(9.00-10.20)	(0.28-0.52)	(0.10-0.30)	(3.22-4.78)	(0.06-0.12)	(0.10-0.20)
09	Inland Town	0.18±0.04	6.40±0.49	0.17±0.04	ND*	9.84±0.78	ND*	0.20±0.05
		(0.13-0.23)	(5.80-7.00)	(0.12-0.22)	-	8.90-10.78	-	(0.14-0.26)

ND* = Not Detected, values in parenthesis shows minimum to maximum range

CONCLUSIONS

The results obtained in our study have revealed a large spread of the contaminant metals in the surface soils. Metal concentrations in soils from Omagba phase II, Woliwo layout, Fegge road, Head bride, Odoakbu layout, Awada layout and Isiafor layout were higher than those obtained from Ozala layout and Inland town (Background samples). The highest concentrations of the contaminant metals were found in the vicinity of the Onitsha head bridge of the River Niger. These high concentrations of metals in soils from Onitsha metropolis are attributed to industrial and anthropogenic wastes. These elevated concentrations of metal contaminant are indication of environmental pollution in Onitsha and its environs.

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