STUDY OF SOIL INFILTRATIONS RATE DUE TO MIGRATION OF LEACHATE AT COLLEGE ROAD DUMPSITE KADUNA NORTH USING INAA TECHNIQUE

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Abstract- Depth wise variation of heavy metal concentration and distribution in solid waste disposal site was examined to investigate the rate of soil infiltration due to continuous disposal of solid waste in an open dumpsite. Six soil samples were collected from a hole at an interval of 0, 25, 50, 100, 120 and 150cm depth profile respectively and analyzed using instrumental neutron activation analysis technique. The results showed a varying concentration of the contaminants with depth from top soil to depth of 150cm. It is recommended that further research beyond the scope of this depth be investigated in other to elucidate the effect of ground water pollution around the dumpsite.

Keywords- Municipal Solid Waste, Instrumental Neutron Activation Analysis, Heavy Metal, Leachate, Infiltration and Dumpsite.

I. BACKGROUND

As an administrative centre of government since old northern region of Nigeria couple with activities of industries, Kaduna metropolis has received population explosion of 357,694 as at 2006 census producing 178.874 metric tons of municipal waste and refuse daily (Abdullahi, 2009). The amount of municipal solid waste in this area is expected to increase significantly in the near future as the Nigeria government strives to attain an industrialize nation status through its developmental blue print tagged vision 20:2020 (FGN, 2011). The waste in a landfill undergoes decomposition due to physical, chemical and biological processes (Abdullahi, 2010). The generation leachate is caused by precipitation, percolation through waste deposited in a landfill. Once in contact with the decomposing solid waste, the percolating water becomes contaminated and it then flows out of the waste material (Olarewaju et al., 2012). Metals are natural components of the environment including soil, but they are of great concern when they are being added continuously. Refuse dumping is one of the ways in which elements are being added into the soil (Okoyede et al., 2011). The severe problem associated with these metals containing leachate are their infiltrations when water penetrates through the waste in the landfill into the surrounding environment, subsequent, contamination of land and groundwater (Kumar et al., 2002). The geo-physical studies of the site revealed that the top soil varies in composition, color and texture and most places they are predominantly laterite and quartz grains (deep brown or reddish brown soil) (Abdullahi, 2009). Supriyo (2011) reported that laterite soil has high adsorption capacity and enhance elevated concentrations of infiltrated contaminants.

The aim of this research therefore is to use instrumental neutron activation analysis to determine rate of soil infiltration to leachate in the study site and the objective is to study the variation of contaminants across the soil profile in other to elucidate the risk of contamination to the environment and underscore the groundwater effect on the migration of heavy metals in the soil around the dumpsite at unguwar dosa in Kaduna, Nigeria.

II. STUDY AREA

The college road dumpsite consists of heterogeneous refuse and is situated within the residential areas that linked unguwar dosa to kawo, approximately lies between co-ordinate 10^0 3^{11}N and 07^0 25^{11} E. It has been in use for the past 25years. As a result of Kaduna urbanization, the dumpsite is now surrounded by residential and commercial activities. Kaduna north has a total population of 357,694 (Abdullahi, 2009).

III. METHODOLOGY.

Sample collection

The soil samples were collected through a hole at different depth profile of 0, 25, 50,100,120, and 150cm respectively with the help of an auger and parker. The collected soil samples with the help of an

auger and parker were emptied into a polyethylene bags, which were previously cleaned using nitric acid, pure water and acetone, tied and labeled with a marker on a paper each inserted in the bags showing a labeled of respective depths recorded in a record sheet to prevent interference or mix up of soil samples. The bags were double-bagged to reduce chances of cross contamination of samples.

IV. SAMPLE ANALYSIS

The samples were first dry through an open air in a room and then dried in an oven for some days at a particular temperature.

The samples were then crushed into fine powders of microns size particles in an agate mortar to make them homogenous. Some few milligram of each sample were put in a polyethylene bags labeled B1, B2, B3, B4, B5 and B6. The bags together with vials are washed in distilled water three times.

For long irradiation all the samples and standards were package together in an irradiation vial and irradiated simultaneously for six hours with a reactor power of 15kw and a thermal neutron flux of $5x10^{11}$ neutrons per cm^2 per second in a reactor at centre of energy and training of Ahmadu Bello university Zaria, Nigeria. After irradiation the activities of the irradiated samples and standards were measured.

V. RESULTS AND DISCUSSION

Table 1: Concentration of various elements in soils (in $mgkg^{-1}$) across depth (in cm)

		Detected Elements				
Code	Depth	Mg	Al	Ca	Ti	V
B1	0	BDL	32860	4847	2419	44.2
B2	25	BDL	26580	2548	BDL	56
B3	50	2210	62600	BDL	2061	59
B4	75	3668	74740	2456	3400	46
B5	100	3437	95050	2945	BDL	29
B6	130	5036	95270	6482	3065	44
Mean Concentration		3588	64517	3856	2736.3	46.4

BDL=Below Detection Limit

Table 2: Metal Contamination Factor and Geo-accumulation Index of Metal in Soil from the Dumpsite

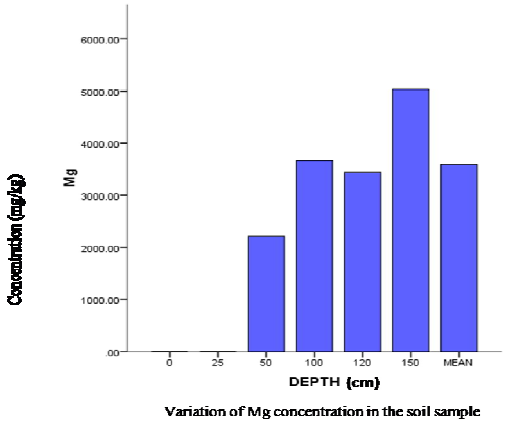
Parameter	C_m	B_m	CF	Geol	Contamination level
Mg	3588	23300	0.154	-2.28	Unpolluted
Al	64517	82300	0.784	-0.65	Unpolluted
Ca	3856	41500	0.093	-2.78	Unpolluted
Ti	2736.3	5700	0.480	-1.14	Unpolluted
V	46.4	135	0.344	-1.47	Unpolluted

CF-contamination factor; Geol: geo-accumulation index;

C_m-mean concentration of the metal in the soil;
B_m-average crustal abundance (background value) in an uncontaminated soil, adapted from (Taylor,1964).

Magnesium (Mg)
Mg was not detected in the sample B1 (top surface) and B2 respectively. The lowest and highest values for Mg are 2210$mgkg^{-1}$ and 5036 $mgkg^{-1}$ with maximum value was observed in sample B6. The range in this work is higher than range in natural soil of values (5.0 – 175mgL^{-1}) and (1.8862-42.57mgL^{-1}) in selected dumpsites in Abeokuta (Okoyede et al., 2011).

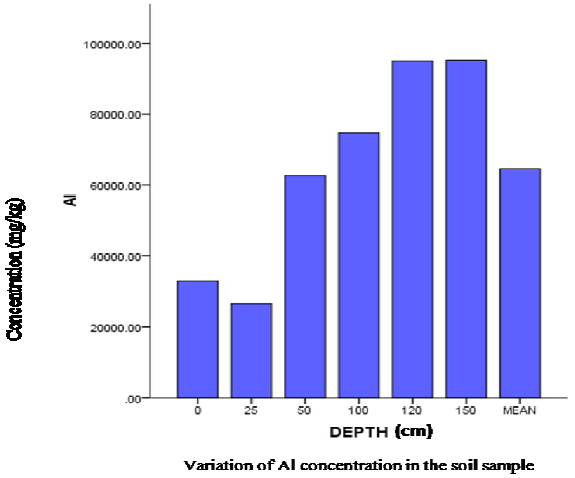
The obtained mean for Mg is 3588 $mgkg^{-1}$ which is six times lower than average crustal abundance of 23300 $mgkg^{-1}$ in an uncontaminated soil. The Geol (-2.28), shows that the soil around dumpsite was not polluted by present Mg concentrations.



Variation of Mg concentration in the soil sample

Aluminum (Al)
In the site, Al was also detected with relatively large amount in all samples. The highest concentration for Al was observed in sample B6. The lowest and highest concentrations for Al ranged from 26580 to 95270$mgkg^{-1}$. The obtained mean for Al (64517$mgkg^{-1}$) is lower than average crustal

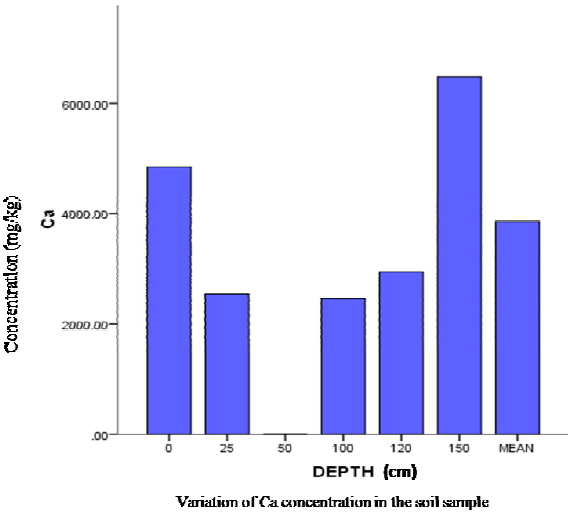
abundance of 82300mgkg^{-1} in an uncontaminated soil as estimated by Taylor, 1964. Geol (-0.65), indicated that the soil around the dumpsite was not contaminated by the present Al concentrations.



Variation of Al concentration in the soil sample

Calcium (Ca)

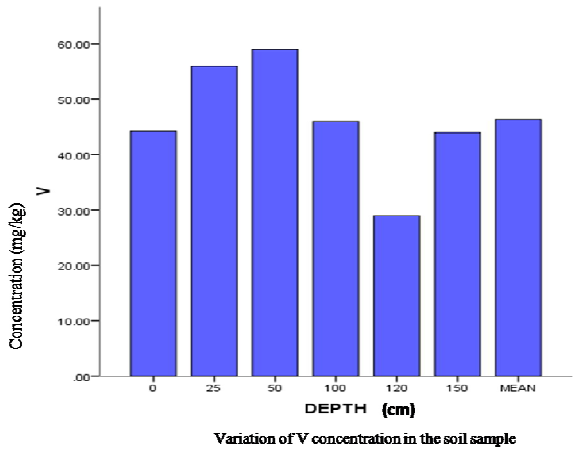
In the site, Ca fell below detection limit of 4000mgkg^{-1} in sample B3. The maximum concentration for Ca was observed in B6. The lowest and highest values for Ca ranged from 2456ppm to 6482ppm. The mean for Ca in this present work is 3856ppm which is lower than average crustal abundance of 41500ppm in an uncontaminated soil. The Geol (-2.78), shows that the soil around the dumpsite was not contaminated by present Ca concentrations.



Variation of Ca concentration in the soil sample

Vanadium (V)

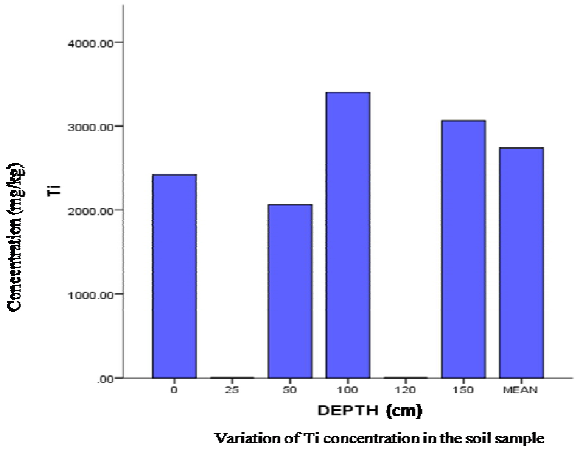
In the site, the lowest and highest values for V are 29 and 59mgkg^{-1}which falls within world range. The obtained mean for V (46.4mgkg^{-1}) is lower than world mean of 100mgkg^{-1} (Shahabuddin et al., 2010). The Geol (-1.47), shows that the soil around the dumpsite was not polluted by present vanadium concentrations.



Variation of V concentration in the soil sample

Titanium (Ti)

In the site, Ti fell below detection limit in B2 and B5 respectively. The lowest and highest concentrations for Ti was recorded in samples B3 and B4 (2061ppm and 3400ppm) respectively. Geol (-1.14), of Ti indicated that soil around the dumpsite was not contaminated by present Ti concentrations.



Variation of Ti concentration in the soil sample

Metals correlation analysis

Metals concentration correlation computed using Pearson correlation coefficient (r) values, to determine the level of association between pairs of metals along the different depth levels. Table 2 shows very strong significant correlation between Al and Mg (r = 0.957) at 0.01 levels, 2 tailed.

General discussion

Metals, Magnesium, Aluminum, Calcium, Titanium and Vanadium concentration and soil leaching varies spatially across the soil profile from the top surface up to depth of 150cm in the study areas.

This variation could be attributed to the finding of Abdullahi (2009) in the same study areas but, using geophysical approach, that the top soils varies in composition, color and texture and in most places they are predominantly late rite and quartz grains.

An evident from analytical results showed that the dumpsite soil is not polluted by Magnesium, Aluminum, Calcium Vanadium and Titanium and all elements are heterogeneously distributed.

CONCLUSION

INAA was used in the multi-elemental analysis and pollution studies in the soils around college road dumpsite at unguwar dosa area in Kaduna north of Kaduna, Nigeria. Apart from the fact that contaminants are heterogeneously and evenly distributed our results revealed evidence of leaching in the soils profile. These contaminants fluctuate in their concentrations from top soil to depth of 150cm which is in agreement with Latif et al.,(2004) that metal contamination and soil leaching varies spatially across the soil profile due to soil type, geology and PH, which is supported by similar work on same soil dumpsites but, using geo-physical techniques that the soil composition varies in composition, colour, texture and most places they are predominantly late rite and quartz grains (Abdullahi, 2009) however, Michael et al., (2011) reported that metal displayed a systematic drop in concentration with depth.

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