Cement Production: A Possible Menace to South-Western Part of Nigeria.

Ibitoye Taiwo Abel[1], Ayoade Peter Adebayo[2]

[1]Petroleum Training Institute, Petroleum Engineering and Geosciences Department, Effurun, Delta- State. Nigeria.
[2] Geology Department, Faculty of physical science, University of Benin,, Benin City, Nigeria

Abstract: The study involves the meticulous view to determining the level of degradation resulting from cement production on the environs. Since the area in question becomes almost inhabitable for human due to chippings, animal, and agricultural produces yielding poorly. Soil samples were taken and analyzed in order to determine some heavy metal contents and physico-chemical parameter in view to know the causative substances. From analytical result of soil samples, there are elevated values recorded (relative to control) and as compared with established regulated criteria (BOWEN'S).Meanwhile, activities of the cement production industry have seriously impaired the natural quality of the soil nutrients for the plant uptake, vibrational effects resulting from blasting exercise and eco-imbalance or the totality of the environment, thereby imperiling the human and animal health status. Therefore, it is pertinent that; treatment of effluents before final discharge into an engineered constructed waste pile, and eco- rehabilitation most especially the human and the nearby structures be relocated in a conducive, safe and environmental friendly place.
Key Words: Eco-rehabilitation, Physico-chemical parameters, Heavy metal contents, Relative to control, Chippings, eco-imbalance, blasting, and causatives.

I. Introduction

Wastes generated through human induced activities, industrially, naturally and municipally are major forms of contaminants to the eco-system, that is; soil, surfaceand ground waters within a given environment.
In exploring and excavating some natural resources, especially the raw materials for cement production; explosives are used, varieties of chemicals and toxic materials are introduced in to the geo-environment, resulting from the attempt to bring the raw materials to the surface for industrial purposes. The chemical composition of explosives used, the constituents and nature of materials being sought, determine the level or degree of pollution in the environment. Therefore, as a result of these activities, aquatic life and terrestrial habitat are exposed to environmental contamination or eco- imbalance.

Major streams and soils in industrial areas of some Nigeria's cities are already seriously polluted with industrial wastes. This is due to increase in population of about 120 million and industrial outburst, and of recent 155million (CIA World Fact Book, 2012) While soil in the industrial and densely populated areas are heavily polluted with domestic and industrial effluents. According to Riley et al (1977), most communities living around surface waters, use their banks as a dump site for their wastes, which are washed into the system during rains. These in turns leached to the top-soil and possibly percolate in to the ground waters.

Environmental contamination and degradation from industrial, domestic and natural sources, even oil spillage or activities leading to solid or crude oil excavation has become a national problem. This is more severe in oil producing areas, and areas close to industries of similar activities. Areas of high population density and those adjacent to surface waters, in cities where traditional waste disposal methods of direct discharge of solid and liquid wastes dump are also affected by environmental degradation.

Since our environment encompasses: the air, water, land and the living things contained in them, there usually is interaction among these components of the environment; that is, land-air (interaction of suspended solids in air), land-water interaction e.g moisture and soil, and water-air (Ademoroti, 1996). When the environment is left devastated, human and animal health are endangered and the environment is said to be impaired as a result of increase in industrial production and possible reduction in the quality of the component of the environment.

In a sedimentary setting, permeability and porosity are functions dependent on the distribution of various sediment types. Hence the principal factor that determines the fate of the contaminants from cement production is the nature of the ambient geology of the site, and the raw materials used for its production.

II. Limitations Of Study

Few hindrances prohibit the success of this study which includes;

-Community youths which made sampling of the study area very difficult in terms of demand prior to sampling (monetary settlement)

-Logistics; The community chief of the areas sampled were not happy with the Government negligence of their area, so expressing their dismay in an attempt to carry-out any research work on the land environs, hence set in some unusual delay.

III. Materials And Methods

Reconnaissance Survey:

Reconnaissance survey was carried out as a prelude to detailed field work. This included literature review of the available field maps, past operational history and pollution incidents. The reconnaissance survey involved four days familiarization tour to the targeted areas of the field including the locations at which samples were taken.

Detailed Studies

For effective result after few days of reconnaissance survey, detailed field procedure and strategy was adopted for ease of sampling of soils from areas marked. Composite samples were collected from the sample points. Soil samples were collected at targeted areas with the aid of auger drills, from 0-60cm.

Sampling

Sampling techniques adopted involves taking a representative of the larger lot or collection of small portion for laboratory analysis, which posed the same character with the bulk material and necessary precautionary measure were adopted.

IV. Methods Of Soil Analysis

The soil samples collected from the field were put into polyethylene bags that had been previously soaked in 0.1N HNO_3 for 1hr and then rinsed several times in deionized water to remove all traces of the acid and dried properly. The bags containing the samples were properly labelled in the field and transported to the laboratory as quickly as possible. In the laboratory, prior to the analysis, the samples were air dried, gently crushed and passed through a 2mm plastic sieve to avoid contamination. The sieve samples were stored in clean, labeled glass bottle for analysis.

Laboratory Analysis (Particle Size Determination)

Mechanical analysis was carried out by the hydrometer method of Bouyoucus as modified by Day (1965). 50g of air dried soil sample was weighed into a shaking bottle and 20mls of 20% calgon solution (Sodium hexametaphosphate) was added, followed by 50mls of distilled water. The bottle was properly stoppered and shaken on reciprocal shaker for 1 hour. The suspension was then transferred quantitatively into a Bouyaucus cylinder and brought to mark with distilled water. The suspension in the cylinder was mixed thoroughly and at 40seconds from the time mixing stopped, a hydrometer and temperature readings were taken. The suspension was left undisturbed until 2hrs had elapsed. Another hydrometer and temperature readings were then taken.

Calculation:

For every degree rise above the hydrometer calibration temperature of 20c, 0.3 was added to the hydrometer reading to correct for temperature variation.

:. % sand = 100 – [HDR + (TEMP – 20 X 0.3) X 100]

Wt of sample …………(1)

% clay = 2 hrs[HDR + TEMP – 20.03) X 100]

50 (wt of sample) ………….(2)

:. % silt = 100 (% sand + % clay) ……….(3)

Chemical Analysis

-PH DETERMINATION:

The hydrogen ion concentration of the soil was determined using a glass electrode PH meter at a soil: solution ratio of 1:1.

20g of the air dried samples was weighed into a 100ml beaker and 20ml of distilled water was added. The suspension was stirred intermittently for 30mins with a glass rod. The pH meter was standardized with buffer PH 4.01 and 7.0 before the PH of the soil suspension were taken. The reading was taken by dipping the electrodes into the liquid part of the suspension and the reading was recorded as PH (1:1) H_2O.

ELECTRICAL CONDUCTIVITY (EC)

Preparation of Soil Extract: About 200g of the air dried, 2mm sieved sample was placed in a 400ml beaker and distilled water was slowly added while stirring the paste with a spatula and occasionally tapping the beaker to consolidate the mass. At saturation, the soil surface glistened and the soil flowed slightly when the beaker was topped. The paste was then transferred into a Buchner funnel containing Whitman No1 filter paper and connected to a vacuum pump. The initial few mls of extract was discarded and the remaining extract taken for measurement of electrical conductivity using a portable El-Hamma Model 350T conductivity – meter. Values were recorded in micro semen's per square centimeter (us/cm^2).

EXCHANGEABLE ACIDITY (EA)

10g of air dried, 2mm sieved soil sample was weighed into a shaking bottle and 100ml of 1N Kcl solution was added to the sample. The bottle was tightly stoppered and shaken on a reciprocal shaker for 30mkns. The suspension was then filtered through a No1 whatman filter paper.

50ml aliquot of the extract was titrated with 0.01m Na0H solution to a permanent faint pink end point using phenolphthalein solution as indicator. The results obtained were recorded as exchangeable acidity (EA) in centimolskg-1 or meq/100g soil.

Calculation:

$$\frac{VXM100}{5} \qquad\qquad \text{…………………(4)}$$

Where
V = volume of Na0H used
M = molarity of Na0H
5 = wt of soil equivalent to 50ml aliquot of 1N KCl extract
100 = per 100g

ORGANIC CARBON DETERMINATION

This was determined by the chromic acid wet oxidation procedure of walkley and Black as described by C.A. Black (1965).

1_g of finely ground soil sample was weighed accurately into a 250ml Erlenmeyer flask. A 10ml aliquot of 1N $K_2 Cr_2 0_7$ solution was pipette into the flask using a bulb pipette and the flask was gently swirled to affect proper wetting of the soil sample.

20mls of conc. H_2S0_4 (Sp gravity 1.84) was added with a measuring cylinder rapidly to avoid dissipation of heat of reaction and the flask was allowed to stand for 30mins to enable the reaction to come to completion.

Thereafter 100ml of distilled water was added to the flask followed by 6 drops of ferrous solution. The contents of the flask was filtrated with approximately 0.5N ferrous sulphate solution to a wine end point. A blank titration was carried out without soil sample.

Calculation:

$$\% \text{ Org} = \frac{(B – T \ X \ N \ X \ 0.003 \ X \ 1.33 \ X \ 100}{\text{wt of sample}} \qquad \text{…………(5)}$$

Where
B =   Blank Titre
T =   Sample Titre
N =   Normality of ferrous sulphate
1.33 OxidizableOrgc = 78% or Org matter
0.003 Equivalent wt of carbon.

V. Results And Discussion

Textural analysis: Results of the textural analysis of soil samples from the study area are summarized in Table 3. The cumulative curve of textural analysis of one of the location samples studied are also presented in Appendix 3, using semi-log graph papers. Textural analysis results reveal that the area is composed predominantly of sand with subordinate fines (i.e. clay and silt). The particle size distribution of the sample in the study area and their percentage composition is clearly shown in Fig 1. From these results, it is clear that sand, the predominant size class of the particle spectrum ranges from 36 – 88% (with an average of 67.82%), clay which is present in moderate amounts ranges from 7 – 51% (with an average of 20.88%), while silt which is present in small proportions, ranges from 3 – 33% (with an average of 11.30%).

PHYSICO-CHEMICAL CHARACTERISTICS OF SOIL.

pH: The pH ranges between 5.62 – 7.13 with mean values of (6.33), (6.26), and (6.23) for top, middle and bottom soil respectively.

The pH for soil in reference or control site ranges from 6.95 for top soil, 6.79 for mid soil, and 6.75 for bottom soil with mean pH of 6.85. Almost all the samples were acidic to slightly acidic reflecting the lateritic nature of the soil. Significantly, the soils exhibit increasing acidity with depth.

ELECTRICAL CONDUCTIVITY (EC**):**The electrical conductivity values range from $10 – 480\mu S/cm$, mean electric conductivity for top soil is 180, mid soil is 110, and bottom soil is $100\mu S/cm$, while the average value for the study area is 130. For the control site, conductivity values of 180, 80, and 60 were recorded for top, middle and bottom soil respectively with mean value of 110.

EXCHANGEABLE ACIDITY (EA): The level of soil exchangeable acidity varies from 0.0 to 0.04Cmol/kg. The control soil value falls within non detectable level.\

TOTAL HYDROCARBON CONTENT (THC): The total hydrocarbon content varies between 0.00 and 0.54mg/kg. These values are higher in top soil and decrease with depth. Almost in nearly all cases the bottom soils had no hydrocarbon in them. The samples of the reference (control) site are characterized by very low THC which falls in range 0.12 to 0.38 mg/kg.

TOTAL ORGANIC CARBON (TOC): The organic carbon values range from 0.21 for bottom soil in location SS11, and 2.08% for top soil in location SS6; values recorded elsewhere fall within this range including those of the samples from the reference site.

EXCHANGEABLE BASES: The highest levels of exchangeable bases, i.e. Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Potassium (K^{+}) and Sodium (Na^{+}) wereobtained in SS6, SS3, SS5 and SS8 respectively. Overall, low levels of Na and K were recorded, ranging from 0.05 to 0.29 Cmol/kg. On the other hand, Ca and mg levels are relatively high. While mg values vary between 0.17 and 6.94 Cmol/kg,the Ca^{2+} concentrations are much higher, the range being 1.36 to 20.4 Cmol/kg. The results for the control (reference) samples are not significantly different from those of the project site. Also there is no discernible pattern of variation with depth.

AVAILABLE PHOSPHORUS**:**The mean value of available phosphorus in mg/kg is 6.25, while that of the reference site is 0.76. The highest available phosphorus occurs in SS10 with values as 12.45, 14.12 and 21.36mg/kg, the available phosphorus decreasing with depth at that location. This trend is characteristic of other locations. The values obtained for the control site are consistent with those of the studied area, although they are lower in some cases.

TOTAL NITROGEN : The control site total nitrogen obtained is 0.06%, 0.019% and 0.036%, from top, middle and bottom respectively with mean values of 0.038%. The total nitrogen level ranges from 0.012% – 0.114%. While the mean total nitrogen value is 0.047.

HEAVY METALS: Table 2, shows the results of heavy metals analysis of soil samples, while Fig.2and 3 shows the variation of one (Zn) trace metal concentration and distribution in all soil samples. Some of the trace metals analyzed for (Cr and Cd) both in the control samples and soils of the study area were below detection level (bdl).

Iron (Fe) values were very high in all the samples analyzed compared to other trace metals. They range between 8.29mg/kg to 5,271mg/kg. In most cases the concentration is higher in top soil and decrease downwards, particularly for the bottom soil. This simply shows an apparent decrease in vertical distribution. Cadmium and chromium are not too prominent in concentration in all the samples analyzed, but the levels of Zn (18 – 215mg/kg) are high. Environmentally significant levels of Pb (0.4 – 2.4) were recorded although not so for the control samples (0.-0.4mg/kg).

VI. Discussion

The colour of the profile pit soil samples ranged from light brown, grey to dark brown. Top soils are associated with organic matter as a result of vegetative cover and are therefore characterized by dark-grey to dark colour. Stratified random soil samples were taken for top horizon (0-15cm), second horizon (15-30cm), and third horizon (30-60cm) respectively. The size distribution of the soil particles falls mainly within fine, medium to coarse grained sand. This also depicts the fact that the soil particles ranged within poorly sorted to well sorted gains(Fig4). The particle size distribution of soils is an important parameter affecting its physical and chemical characteristics, as well as permeability which determines the ability of soil sediments to act as a mineral seal against the downward movement of fluid or leachates. Fine-grained soils generally have an affinity to all classes of contaminants. On the other hand, granular or coarse-grain materials have little attraction, if any, for toxic metals and industrial organics.(Moore and Newbry,1976). The chemical activity and high surface area of clay particle makes it the active portion of the soils. The clay has the cationic exchange property, that is; the positive ions (cations) in soil are attracted to clay particles and are held there by

electrostatic attraction. These cations during soil reactions, replace one another, and are held captive by the soil; including trace metals from leachates as they percolate through the medium. Sediments with prominent percentage of silts and clay have high concentration of trace metals. (O'Reilly Wiese et al, 1995). Consequently the clayey nature of the subsoil would prevent easy vertical infiltration and enhance near-surface retention of contaminants(Fig1).

Soils from the area studied are acidic to slightly alkaline in nature as implied from analytical result. The $_pH$ measurement is a means of determining the acidity, neutrality and alkalinity of samples. This has revealed the acidic nature of soil samples, which indirectly tells on the exchangeable cations in soil such as; zinc, copper, manganese, iron, aluminum and others in respect of their availability in the acidic soil. Acidic condition of the soil samples implies the corrosiveness of material or the leaching level in the environment, influences chemical reactions and also speeds up the biological phenomena within the area understudy (Mckee and Wolf,1972). Exchangeable acidity reveals the soil constituents with respect to its potential fertility, and minerals present in the soil. It is related to exchangeable cations as the summation of this give rise to cation exchange capacity (CEC). This means sediment has greater ability to adsorb and concentrate metals. The order of their occurrence is Fe > Zn > Cu >Pb> Cr > Cd. (Badarudeen et al 1996) The higher concentration of Fe may be due to types of waste generated, textural and mineralogical characteristics of sediments of the area.

Electrical conductivity: The electrical conductivity is generally low. This may be attributed or related to the salinity which depicts the degree of dissolved /soluble salt content of soil. The low conductivity values were due to low dissolved solids even though suspended solids were high. If there are high conductivity values of leachates, it may be due to high dissolved solids. (Reids, 1961). Low sulphate content may also account for the low conductivity. If sulphate is high, conductivity may also be high. The high values may be attributed partly to microbial conversion of organic sulphur to sulphate. (Benka-cover, 1998).

The soil of the study area is moderately rich in macronutrients that are required for plant growth. The samples showed low concentration value of mean organic carbon (0.71%), while at reference site or control a mean value of (0.59%) was obtained. According to Odu et al (1985), the lower limit of organic carbon is 1.0%. Sediments total organic carbon may influence the degree of metals enrichment in the sediment (Horowit$_3$, 1985). The organic carbon concentration level may be due to industrial effluent discharge and sewage disposal along the study area. According to Badarudeen et al (1996), organic carbon exhibited an antipathetic relationship with sand content, and sympathetic relationship with silt and clay, indicating that finer particles are more effective in trapping organic carbon and heavy metals. The results of this study support the inference that sediment contamination is governed by both physical and chemical properties.

Odu et al (1985) reported that values of available phosphorus are low, moderate, and high if they are or below 10ppm, 20ppm, and 50ppm respectively. Therefore on this basis, the phosphorus concentrations recorded range from low to moderate. Even so, the mean phosphorus concentration of the area under study is low, probably due to binding effect of nutrient ion to the organic matter present in sediments as suggested by Wali et al (1972).

VII.   Conclusions

An environmental study around the cement production company within the south-western geo-political zone of Nigeria was embarked upon with the view to justify the status of degradation within the components of the geo-environment. The study entailed the determination of the textural characteristics of soil samples both around the factory site and at some considerable distance away from the site (control samples). Additionally, selected physico-chemical parameters of soil samples in the area were measured. By comparison of the results obtained with established regulatory criteria (Bowen, FEPA,andFMEnv), and control values, the following concluding remarks emerged.

i)   Texturally, the soils in the area, which are lateritic in nature, exhibited a preponderance of sand with subordinate fines (silt Plus clay,Fig1).
The proportion of fines which is variable and may be as high as 57% in places, has enabled the soil to act as a seal or effective barrier to leachates of potential pollutants.

ii) comparison of the average values of the physico-chemical parameters and heavy metal contents of the soils with background values and tolerable limits of Bowen (1979) and FEPA (1991) showed that although elevated values (relative to control) were recorded for Fe, Cd, Cr, Cu, Ca, Mg as well as total Nitrogen, available phosphorus and organic carbon, these values were not high enough to be critical based on Bowen's classification (Tab1). The vertical distribution of these parameters showed a general decrease with depth indicating a near surface retention. However, environmentally significant levels of Zn and Pb(Fig3and Tab 3) were recorded, and this is attributable to anthropogenic factors .Hence, there is a need not only for proper handling of chemicals at the area of the industry but also proper waste management practice by the company. Also, with respect to (i) above, treatment of effluents and solid wastes from

the industry is highly recommended before final disposal in order to reduce the contaminant load to acceptable levels.

Ultimately, there should be periodic environmental audit of the area in line with the guideline and requirements stipulated by the Federal Ministry of Environment (FMEnv)

References

[1]   Adams, T.G, Atchison and Velter, R.J. (1980). "The Impact Of An Industrially Contaminated Lake On Heavy Metal Levels In Th Effluent Stream "Hydrobiology 69:187-193.

[2]   Ademoroti, C .M .A.(1996).   Environmental Chemistry and Toxicology.Folutex Press Ltd, Ibadan, Nigeria.

[3]   Badarudeen, A; Damodaran, K.T, Sajan, K.And Padmalal, D.   (1960). Texture And Geochemistry Of Sediments Of A TropicalMangrove Ecosystem, Southwest Coast Of India, Environ Geol, 27:164-169.

[4]   Benka-Coker, M.O, (1998).Textural and Chemical Characterization of Sediments of Teboga Waste Dump.Unpublished Masters. Thesis Submitted To The Dept. Of Geology, University Of Benin.

[5]   Brady, N. C. (1965). The Nature and Properties of Soil. 18th Edition, Pp 560 – 568.

[6]   Bray, R. H. And Kurtz, L. T. (145).Determination of Total Organic and Available Forms of Phosphorus in Soils. Soil Sc. Journey 101. 5pp 39-45.

[7]   Bouycos, G. H. (1951). A Calibrationof Hydrometer Method for Making Mechanical Analysis of Soils. Agronmy Journal Vol. 43, Pp 434 – 438.

[8]   Bowen, H. J. M. (1979). Environmental Chemistry Of The Elements Academic Press London In: SPDC (1996), Details Potentially Polluted Area Study By Atlantic Waste Management, Lagos. Pp 49.

[9]   Cairns, J. J., Bahns, T. K., Burton, D. T. , Dickson, K. L., Sparks, D. E. And Walter, W.T. (1973).The Effects of PH, Solubility and Temperature upon the Acute Toxicity of Zinc to the Blue Gill and Sunfish. Trans. Kansas Acad. Sci., 74(1): 81-92.

[10]   The Central Intelligence Agency 2012, CIA World Fact Book

[11]   Day, P.R. (1965). Particle Fragmentation and Particle Size Analysis in Black Et Al, Method of Soil Analysis. Pp. 545 – 566.

[12]   Department Of Petroleum Resources (DPR, 1991).Environmental Guideline and Standard fortThe Petroleum Industry In Nigeria, Lagos.

[13]   Federal Environmental Protection Agency, F.E.P.A. (1991). Guideline and Standards for Environmental Pollution Control In Nigeria, Lagos.

[14]   Gadd, G. M. And Griffiths, A. J. (1978).Micro-Organisms and Heavy Metal Toxicity.Microb, Ecol 4: 303 – 317.

[15]   Grewehug, T. And Peech, M. (1968).Chemical Soil Tests. Cornell Univ. Bul. 30:23-24.

[16]   Horowitz, A. J. (1985). United States Geological Survey Water Supply Paper 2277. A Primer son Trace Metal – Sediment Chemistry. Pp. 30 – 36.

[17]   Jones, M. J. (1974). Minerals and Environment In. Preceding Of An International Symposium By Institute Of Mining And Metallurgy, In Cooperation With Institute Of Mining Engineering. London. Pp. 37.

[18]   Mckee, J.E., andWolf, H.W (1972).Gasoline in groundwater.Jour.Water poll. Control Fed., V.44 .no.2, pp13, 293-302.

[19]   Mitchell, R. L. and Buridge, J. C. (1979). Trace Elements In Soils And Crops. Phil. Trans Res. Soc., Londn. B288:15-24.

[20]   MOORE, T. K and NEWBRY, B. W (1976)."Treatability of Dredged Material (Laboratory Study)" Technical Report   D-76-2, U.S Army Engineer Waterways Experiment Station, Vicksburg, Mississipi, 102pp.

[21]   Murphy, J. And Riley, J. P. (1962).A Modified Single Solution Method For The Determination Of Phosphorus In Antual Waters. Annual Chem... Act. 27:31-36.

[22]   Odu, C. T. I. Nwoboshi, L. C. And Esuruoso, O. F. (1985). Environmental Studies (Soil and Vegetation) Of The Nigerian Agip Oil Company Operation Areas, In: Proceedings Of International Seminar On The Petroleum Industry And The Nigerian Environment, NNPC, Lagos, Nigeria. Pp. 274-283.

[23]   O'Reilly Wise, S. B. Bubb, J. M. And Lester, J. N. (1985). The Significance Of Sediment Metal Concentration In Two Eroding Essex Salt Marshes. Mar. Pollut. Bull. 30: 190-199.

[24]   Ramirez-Munoz, J. (1968). Atomic Absorption Spectroscopy And Analysis By Atomic Absorption Flame Photometry. Elsevier. Publ. C. N. Y.

[25]   Reids, G. K. (1961). Ecology Of Inland Waters And Estyrries. Van Nostrand Reinhold Co., N. Y.

[26]   Wali M. K. Gruendling, G. K. And Blinn, D. W. (1979). Observations On The Nutrient Composition Of A Freshwater Lake Ecosystem. Arch. Hydrobiol. 69 (4): 452-464.

[27]   Walker, M. M., Miller, J. E. And Hassett, J. J. (1977). Effect Of Lead And Cadmium Upon The Calcium, Potassium, Magnesium And Phosphorus Concentration In Young Corn Plants. Soil Sci. 124:145-151.

[28]   Wood, J. M. And Wang, H. K. (1983).Microbial Resistance to Heavy Metals. Environ. Sci. Technol. 17:582a-590a.

[29]   Wycroff, B. M. (1964). Rapid Solids Determination Using Glass Fibre Filters. Water And Sewage Works III: 277.

APPENDIX 1
TABLE 1: Analytical Results of Soil Physico-Chemical Parameters

SAMPLE NO	DEPT (CM)	ORG C(%)	TOTAL N(%)	AV.P (Mg/Kg)	Ca (Cmol/Kg)	Mg Cmol /Kg	K Cmol /Kg	Na Cmol /Kg	EA Cmol/ Kg	EC (uS)	THC (Mg/Kg)
SS1	0-15	1.37	0.093	6.63	6.12	0.52	0.24	0.07	0.02	300	0.15
	15-30	0.93	0.054	5.94	5.85	1.09	0.13	0.06	0.00	120	0.04
	30-60	1.09	0.052	4.80	5.00	0.85	0.10	0.06	0.00	100	0.00
SS2	0-15	1.19	0.074	12.13	5.36	1.26	O.08	0.08	0.01	270	0.00
	30-60	0.35	0.031	3.70	5.64	2.31	0.07	0.07	0.00	180	0.00
SS3	0-15	1.32	0.094	4.96	14.00	6.94	0.10	0.10	0.00	150	0.54
	15-30	0.72	0.050	1.07	11.92	4.12	0.09	0.09	0.03	110	0.11
	30-60	0.71	0.048	0.46	10.80	3.78	0.06	0.06	0.02	120	0.00
SS4	0-15	0.22	0.023	11.72	6.05	0.94	0.07	0.07	0.00	20	0.14
	15-30	0.23	0.024	11.06	5.55	0.85	0.08	0.08	0.00	100	0.00
	30-60	0.26	0.019	7.14	4.92	0.96	0.08	0.08	0.00	70	0.00

SS5	0-15	0.59	0.038	6.00	10.72	4.78	0.06	0.06	0.00	160	0.08
	15-30	0.54	0.033	2.63	17.76	6.49	0.06	0.06	0.00	150	0.07
	30-60	0.15	0.016	1.10	17.76	6.50	0.05	0.05	0.00	110	0.00
SS6	0-15	2.08	0.114	3.88	12.06	3.66	0.09	0.09	0.00	480	0.00
	15-30	0.86	0.061	1.74	19.72	3.54	0.07	0.07	0.00	280	0.00
	30-60	0.18	0.012	0	20.40	4.19	0.06	0.06	0.00	170	0.00
SS7	0-15	0.73	0.049	724	10.16	3.72	0.08	0.08	0.00	170	0.06
	15-30	0.85	0.055	6.04	8.84	3.68	0.06	0.06	0.02	150	0.00
	30-60	0.32	0.020	4.25	7.12	2.05	0.06	0.06	0.04	90	0.00
SS8	0-15	1.76	0.104	1.08	4.52	1.82	0.12	0.12	0.01	160	0.12
	15-30	0.65	0.039	12.78	2.44	0.69	0.07	0.07	0.02	60	0.09
	30-60	0.50	0.034	3.11	2.08	0.55	0.08	0.08	0.03	40	0.00
SS9	0-15	1.27	0.087	21.36	2.20	0.85	0.09	0.09	0.00	150	0.32
	15-30	0.40	0.025	14.12	3.08	1.20	0.07	0.07	0.00	80	0.00
SS10	0-15	0.34	0.018	12.45	2.24	0.60	0.07	0.07	0.00	100	0.14
	15-30	0.73	0.052	7.07	2.88	0.72	0.05	0.05	0.00	110	0.06
	30-60	1.06	0.066	4.12	3.56	0.24	0.08	0.08	0.00	110	0.02
SS11	0-15	0.30	0.042	5.51	1.50	0.18	0.06	0.06	0.01	10	0.08
	15-30	0.22	0.021	1.08	1.36	0.17	0.05	0.05	0.01	10	0.02
	30-60	0.21	0.012	0.94	2.20	2.16	0.05	0.05	0.04	20	0.00
SS12	0-15	0.74	0.060	0.26	3.36	0.84	0.08	0.08	0.00	180	0.38
	15-30	0.37	0.019		2.24	0.88	0.07	0.07	0.00	80	0.12
	30-60	0.67	0.036		2.34		0.06	0.06	0.00	60	0.00

TABLE 2: Heavy Metals   Analytical Results for Soil (Mg/Kg)

SAMPLE	DEPT(CM)	Fe	Pb	Cu	Cr	Cd	Zn
SS1	0-15	3389	0.8	13.62	0.00	0.00	135
	15-30	1405	0.7	8.19	0.00	0.00	84
	30-60	1423	0.7	12.10	0.02	0.00	82
SS2	0-15	2485	1.4	20.71	0.03	0.00	97
	30-60	1372	0.9	7.05	0.00	0.00	52
SS3	0-15	3381	0.8	14.43	0.00	0.20	146
	15-30	2490	0.5	13.02	0.00	0.20	93
	30-60	1493	0.6	12.65	0.02	0.30	86
SS4	0-15	1276	0.7	13.00	0.03	0.00	57
	15-30	1312	0.8	13.63	0.00	0.00	31
	30-60	829	0.9	12.15	0.00	0.00	33
SS5	0-15	1888	0.7	7.84	0.00	0.00	68
	15-30	1274	0.7	5.11	0.00	0.00	65
	30-60	1285	0.6	4.93	0.00	0.00	64
SS6	0-15	3322	1.6	16.75	0.05	0.10	215
	15-30	2810	0.8	12.18	0.01	0.00	131
	30-60	2556	0.6	4.96	0.00	0.00	69
SS7	0-15	2361	0.7	8.00	0.00	0.00	89
	15-30	1413	0.5	7.48	0.02	0.00	80
	30-60	1426	0.4	8.14	0.03	0.00	22
SS8	0-15	3110	1.2	14.72	0.02	0.00	137
	15-30	3241	1.1	12.28	0.03	0.00	56
	30-60	3210	1.0	12.25	0.03	0.00	43
SS9	0-15	3466	0.9	13.09	0.01	0.30	136
	15-30	2902	0.6	8.11	0.00	0.00	44
SS10	0-15	3194	0.8	5.09	0.00	0.00	18
	15-30	3820	0.9	5.16	0.00	0.00	25
	30-60	3630	0.7	6.37	0.00	0.00	28
SS11	0-15	5271	2.4	28.04	0.02	0.00	74
	15-30	4751	1.5	16.75	0.01	0.00	51
	30-60	4820	1.6	16.02	0.00	0.00	48
SS12	0-15	2751	0.0	10.42	0.00	0.20	102
	15-30	2688	0.4	7.18	0.00	0.10	96
	30-60	3249	0.2	4.85	0.00	0.00	91

TABLE 3: Textural Analysis of Soil Samples

SAMPLE	DEPT (CM)	SAND (%)	SILT (%)	CLAY (%)
SS1	0-15	62	22	16
	15-30	72	7	21
	30-60	71	6	23
SS2	0-15	80	5	15
	30-60	66	5	29
SS3	0-15	44	11	45

|				
	15-30	44	9	47
	30-60	36	13	51
SS4	0-15	71	21	8
	15-30	71	10	19
	30-60	43	33	24
SS5	0-15	69	14	17
	15-30	66	7	27
	30-60	66	5	29
SS6	0-15	75	14	11
	15-30	77	10	13
	30-60	81	7	12
SS7	0-15	82	10	8
	15-30	86	3	11
	30-60	88	5	7
SS8	0-15	58	20	22
	15-30	63	15	22
	30-60	56	16	28
SS9	0-15	70	18	12
	15-30	56	16	28
SS10	0-15	73	5	22
	15-30	86	3	11
	30-60	70	3	27
SS11	0-15	71	17	12
	15-30	69	17	14
	30-60	65	17	18
SS12	0-15	82	4	14
	15-30	71	3	26
	30-60	66	3	31
MEAN	0-15	69	14	17
	15-30	69	10	21
	30-60	64	11	25
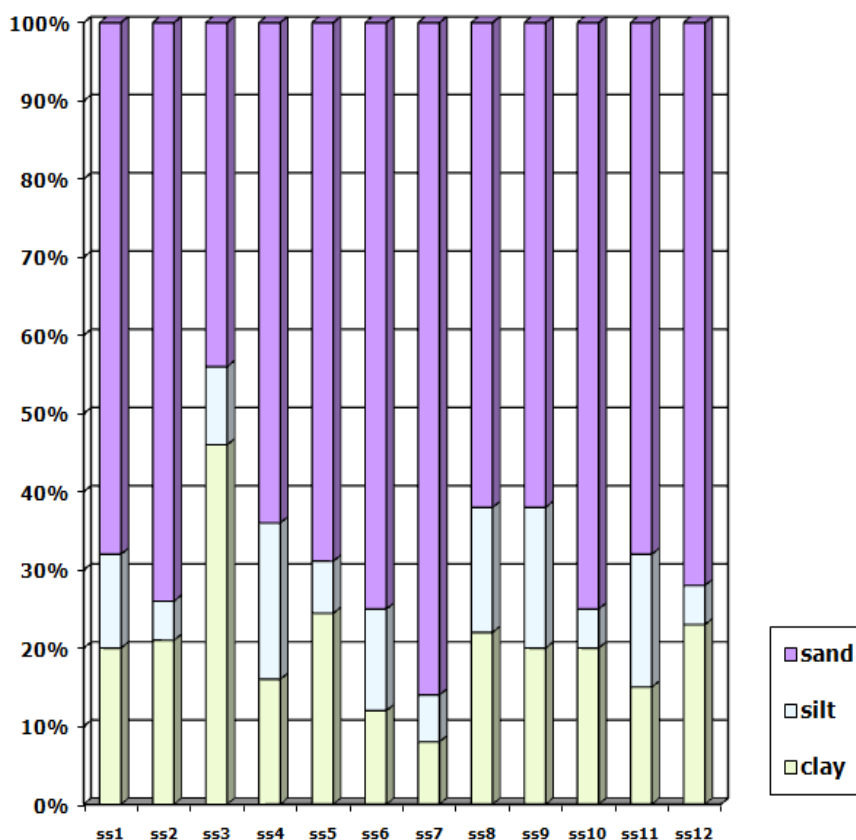
Fig 1: Textural Analysis

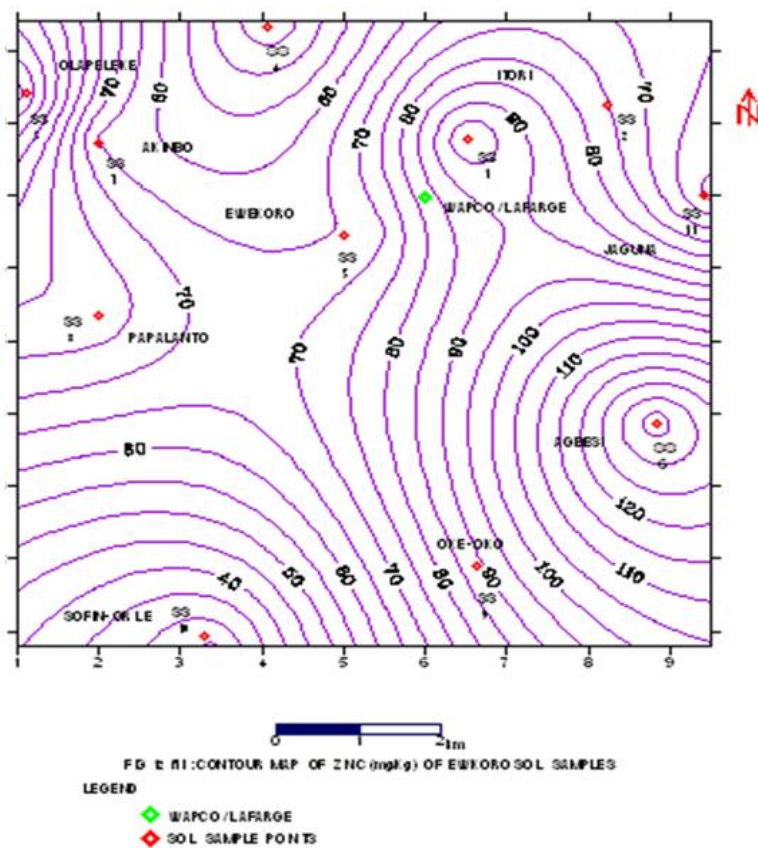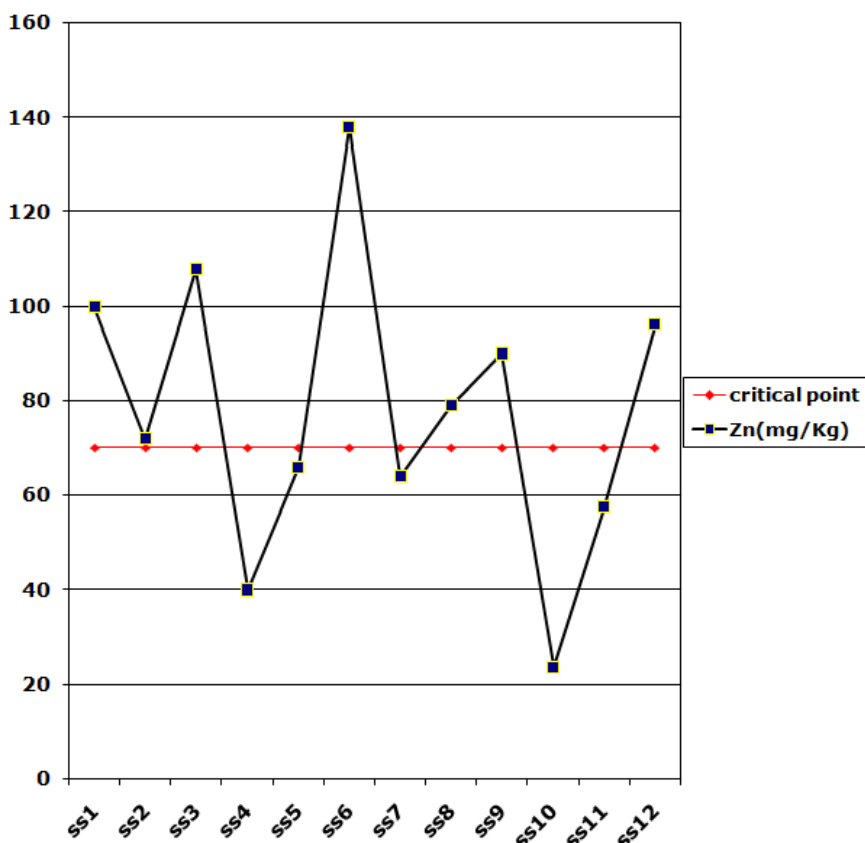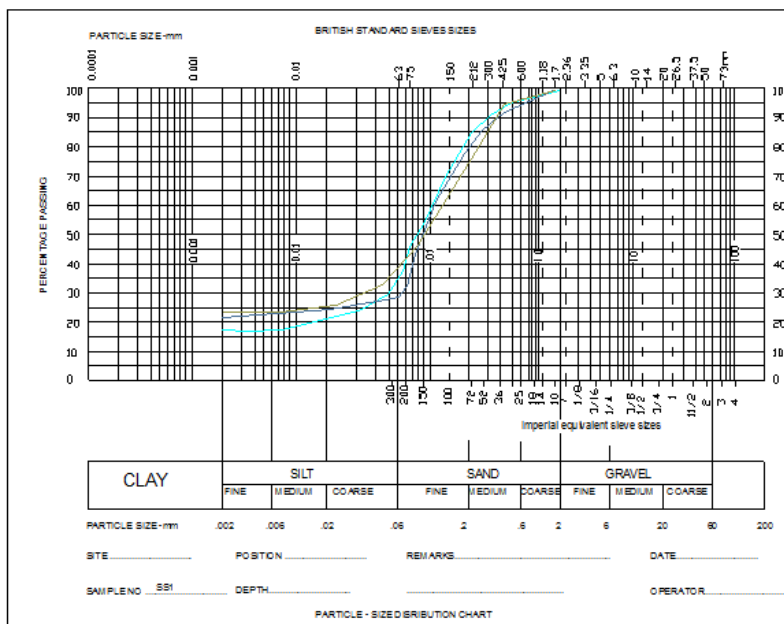**FIG 2**: Contour Map of Zn (Mg/Kg)

Fig 3: Varriations of Zn (Mg/Kg) in different soil locations.

Fig 4:SS1 Particle size distribution with respect to depth.