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Determination of Fe_2O_3, SiO_2, K_2O, CaO, Al_2O_3 and MgO in Ant-Hill Soil Samples within Abraka Town

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Abstract: *Analysis of SiO_2, $A1_2O_3$, Fe_2O_3, CaO, K_2O and MgO concentrations was done on soils from three different locations in Abraka Town. The soil samples collected were dried, ground and sieved using colourimetric determinations, flame photometric and Titration methods. At the different locations, the concentration of SiO_2 ranges from 448.50 – 179.40 ppm, 74.75 – 14.50 ppm and 299.00 – 29.90 ppm. $A1_2O_3$ range from 35424.42 - 16531.39ppm, 54679.07 – 23616.28 ppm and 35424.42 – 18893.02ppm. Fe_20_3 from 37.30-6.66 ppm, 19.98 – 11.32 ppm and 21.31-10.67ppm CaO from 112177.94 – 15871.18ppm, 103395.73 – 28044.49 ppm and 12339.73 – 39262.28ppm. K_2O from 5184.35 – 1135.26 ppm, 5827.62 – 1865 ppm and 4276.15-1173.10 ppm and MgO from 2800 – 9800 ppm. It is found that the concentration of CaO is higher in the three different locations followed by the concentration of $A1_2O_3$. Fe_2O_3 have the least concentration in the 3 different locations. Therefore, it can be said that the amount of CaO in ant-hill soils would support the shape and resistance of the cast to rain. It is of note that CaO is a major constituent in cement and when reacted with water forms hard stone-like mass.*

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1. Introduction

Ant-hills are piles of earth over underground nest of ants or termites. It is in most cases very hard and cone shaped. This pile of earth is widely distributed all over the earth surface but mostly found in Africa. Ant-hills are of both asthetic and cultural importance. The ant-hills have heights ranging from one metre to 4 metres depending on the age; activities of the ants or termites and human influence on the area.

The ant-hills as piles of earth contain all elements found in the soil. Some of these elements have been studied. The presence and amount of these elements in these structures is of interest to chemist, soil scientist, geologist, Agriculturist and researchers because of their significance.

The elements found in the ant-hills ranges from metals to non metals and their oxides. Their concentrations varies from one geographical location to another.

However, no effort has been made by the soil chemist to study the oxides of the elements found in ant-hills to ascertain their concentrations. Therefore some of these

oxides found in the ant-hills are selected for determination; These include silicon dioxide (SiO_2), Calcium oxide (CaO), Aluminum oxide ($A1_2O_3$), Iron (III) oxide (Fe_2O_3), Potassium oxide (K_2O) and magnesium oxide (MgO). These oxides are of great importance for example, iron (III) oxide acts as coatings on soil minerals and silicon dioxide acts as a cement binding together particle in some soil sandstone (1-5).

2. Method of Study

Fifteen ant-hills were randomly selected within Abraka for soil chemical analysis. These ant-hill soil samples were collected from three locations, these are

(1) Delta State University, Campus I labeled sample A_1 - A_5.
(2) Delta State University Campus II labeled samples B_1- B_5.
(3) Abraka Police Station labeled samples C_1 - C_5.

The samples were collected from two predetermined depths of 0-10cm and 10-30cm, using black polythene bags. These were air dried, grinded and passed through a 2mm and 1mm sieve. The following analyses were then carried out.

3. Determination of Iron(III)Oxide (Colourimetric Method) with Double – Acid Extraction. (1,2,6-10)

Procedure:

Five grams (5g) of 100-mesh soil was weighed out and placed in acid-washed 50ml conical flask. 25ml of extraction reagent was added, shaken for about 15 minutes on a reciprocating shaker at 180 oscillation per minute.

The solution was allowed to stand for sometime, and the suspension was filtered using What-man No. 42 filter paper and the filtrate was analysed for Iron (III) oxide with CE 303 Grating Spectrophotometer.

The transmission was read at 510nm for all the samples. The blank was also carried out in the same manner:

4. Determination of Silicon Dioxide (Colourimetric Methods) (3,4,5)

Procedure:

Extraction:- 1g of 2mm sieved soil was weighed into a 120ml polyethylene bottle. 100ml of distilled water was added, shaken on a reciprocating shaker for 2 hours and and allowed to stand for 5-10 hours.

The mixture was centrifuged for about 10-15 minutes at 2,000 rpm and the clear solution was filtered using whatman No. 42 filter paper into a polyethylene bottle.

Ten milliliters (10ml) of the filtered sample solution was pipette into 100ml volumetric flask, 1ml of ammonium molybdate reagent was added. Also 4ml of the tartaric acid

reagent and was added, and 1ml of the reducing solution was added. Distilled water was added to make up to 100ml. the content of the volumetric flask was mixed well and allow to stand for 30 minutes. This was analysed for silicon dioxide with CE 303 Grating Spectrophotometer. The transmission was read at 882nm for all the samples. The blank was also titrated in the same manner but in the absence of the soil.

5. Determination of Potassium Oxide (Flame Photometry) (3)

Procedure:

About 1g of soil was weighed out and put into a crucible. This was fused with 2g of sodium tetraborate and 6g of calcium carbonate in the ratio of 1:3.

The crucible and it's content was put in the muffle furnance at 650^0C. The fused sample was dissolved in 5% hydrochloric acid and made up to 100ml volume with distilled water. The solution was analysed for potassium oxide with Digital Flame Analyser.

6. Determination of Calcium Oxide (EDTA Titration) (3,11-16)

Procedure:

About 25ml of solution was pipette into a 500ml beaker and made up to 100ml with distilled water.

About 20 drops of thermipthalein indicator was added to the solution giving a light yellow colouration.

Thirteen milliliters (3ml) potassium Hydroxide was added to the solution while stirring before the addition of a few drops of calcine indicator. The solution changed from light yellow to light green. It was then titrated with EDTA solution.

7. Determination of Aluminium Oxide (EDTA Titrations)

Procedure:

About 100ml of soil solution was pipette into a 500ml beaker. 2ml Ammonium tricyanate was added to the solution and pH adjusted to 2. Ammoniuim acetate was added and then heated. While stirring, a drop of copper sulphate ($CuSO_4$) solution and 10 drops of acetate indicator were added to the solution which was then titrated against EDTA solution.

8. Determination of Magnesium Oxide (Rapid Titration)

Procedure:

One gram (1g) each of the soil sample was put into 2 conical flask; 25ml each of 1% hydrochloric acid was then added to both flask; and each solution was made up to 100ml

with distilled water. Both flasks were heated on a hot plate for 3 minutes. 5 drops of phenolthalein Indicator was added to one conical flask (designated B) and 5 drops of thermopthalein indicator was added to the other conical flask (designated C).

Each flask was titrated against 0.5% dilute sodium hydroxide (NaOH).

Flask B with phenolphthalein indicator gave a red colouration while flask C with thermopthalein indicator gave a blue colouration at the end.

After the initial titrations, flask C was boiled, cooled and further titrated against 1% barium chloride until the orginal colour (blue) was obtained.

The second titre value was taken as D. The titre value of B=D – C = MgO (Magnesium Oxide).

9. Results

Table 1: **Concentration of Fe_2O_3 in ppm;** Standard Reading at 510nm (ppm)

A_1-A_5	B_1-B_5	C_1-C_5
18.65	19.98	21.31
16.65	13.32	10.98
37.30	11.32	18.65
11.98	13.32	10.67
6.66	11.32	17.32

Table 2: **Concentration of SiO_2 in ppm;** Standard Reading at 882nm (ppm)

A_1-A_5	B_1-B_5	C_1-C_5
27.80	14.50	89.70
189.70	59.80	224.25
448.50	59.80	179.40
179.40	59.80	299.00
269.10	74.75	29.29

Table 3: Concentration of K_2O in ppm

A_1-A_5	B_1-B_5	C_1-C_5
5184.35	1865.05	4276.15
3065.20	1983.89	1437.79
3216.57	1940.73	2043.47
1135.26	5827.67	3103.04
1513.68	2951.68	1173.10

Table 4: Concentration of CaO in ppm

A_1-A_5	B_1-B_5	C_1-C_5
100960.15	67306.77	61697.87
15871.18	33653.38	39262.28
89742.36	103395.73	44871.18
67306.77	28044.49	123395.93
112177.94	72915.66	61697.87

Table 5: Concentration of $A1_2O_3$ in ppm

A_1-A_5	B_1-B_5	C_1-C_5
16531.39	23616.28	28339.53
21254.65	54679.07	35424.42
35424.42	30701.16	18893.02
33062.79	54317.44	32786.04
35424.42	47232.56	25977.91

Table 6: Concentration of MgO in ppm

A_1-A_5	B_1-B_5	C_1-C_5

25200 11200 22400 16800 28000	16800 8400 22800 7000 18200	15400 9800 11200 25800 15400

Table: 7 Showing the Range Concentrations of the Different Parameters in ppm

Parameters	A_1-A_5	B_1-B_5	C_1-C_5
Iron III Oxide (Fe_2O_3	37.30-6.66	19.98-11.32	21.31-10.67
Silicon Dioxide (SiO_3)	448.50-179.40	74.75-14.50	299.00-89.70
Potassium Oxide (K_2O)	5184.35-1135.26	5827.62-1865.05	4276.15-1173.10
Calcium Oxide (CaO)	112177.94-15871.18	103395.73-28044.49	123395.73-39262.28
Aluminium Oxide ($A1_2O_3$)	35424.42-16531.39	54679.07-23616.28	35424.42-18893.02
Magnesium Oxide (MgO).	28000-11200	22800-7000	25800-9800

10. Discussion

Considering all the parameters studied in the ant-hill soil sample within Abraka Urban, calcium oxide has the highest value, 112177.94-15871.18ppm, 103395.73-28044.49ppm and 123395.73-39262.28ppm as shown in table 7. The calcium oxide content varies considerably from one location to another. Aluminium oxide followed the same trend as

calcium oxide having a value of 35424.42 - 16531.39ppm, 54679.07 – 23616.28ppm and 35424.42 – 18893.02ppm from the different locations. Also the experimental results obtained for magnesium oxide and potassium oxide followed the same trend like the oxides mentioned above and they varied from one location to another.

It is found that the results obtained for Iron (III) oxide and silicon dioxide are smaller but varies from one location to another.

It can be said that the gradual variations of the concentrations of the different parameters in the ant-hill soil samples within the different locations in Abraka Ubrban may be attributed to the following factors:

The nature of parent materials (Rocks) in the soil from which these ant-hills are formed. In addition, the vegetation of the environment from which these ant-hill soil samples were collected and the use of fertilizers and bush burning also affect the composition of the soil (10)

11. Conclusion

Based on the results obtained, it can be concluded that Iron (III) oxide, silicon dioxide, potassium oxide, Calcium oxide, Aluminium oxide and magnesium oxide are present in ant-hill soil samples. It is therefore possible that the presence of these oxides, especially calcium oxide, silicon dioxide and Iron (III) oxide give the ant-hill it's solid shape and long resistance to rain water.

12. Recommendation

More researches should be carried out on the determination of metals and other oxides such as sodium oxide (Na_2O) and sulphur trioxide (SO_3) in ant-hill soil samples.

In addition to the above, since samples were collected from the top level of the ant-hill, more studies should be carried out to find out the concentrations of CaO, $A1_2O_3$, SiO_2, Fe_2O_3, MgO and K_2O at the base of the ant-hill to compare the different concentrations with those of the ones at the top level of the ant-hill.

It is also necessary to carry out research on the termites to find out both organic and inorganic constituents with binding properties.

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