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Analysis of Some Clay Samples from Yauri (Kebbi State), Goronyo, Munwadata and Atokonyo (Sokoto State), Nigeria

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ABSTRACT: Analysis of some clay samples presumed to be kaolin obtained from different deposits in Yauri (kebbi state), Goronyo, Munwadata, Atokonyo (Sokoto state), Nigeria was carried out. The samples were subjected to quantitative analysis to determine major and trace constituents using gravimetric, colorimetric, titrimetric and spectroscopic methods of analysis. Results of the analysis revealed that two of the clay samples i.e Yauri and Goronyo were found to contained reasonable percentages of major and trace constituents of high-grade kaolin. The percentages were in the ranges: SiO_2(45.00-45.50%); Al_2O_3(37.00-37.20%); Fe_2O_3(0.29-0.30%); CaO (0.17-0.18%0); Na_2O(0.96-0.97%); K_2O (0.50-0.60%); MgO (0.95-0.99%); TiO_2(0.36-0.37%); P_2O_5(0.22-0.33%). Loss on ignition (16.01-17.01%) and density range (2.54-2.55g/cm^3). The two kaolin are of certain purity and can be used for industrial purposes. However, the result indicates that the remaining two samples does not agree with the standard specifications for high quality kaolin and as such are not found to be kaolin. Atokonyo has shown complete absence of one of the major constituents of kaolin i.e Al_2O_3.

Keywords: Kaolin, Yauri, Goronyo, Munwatada, Atokonyo, Industries.

INTRODUCTION

Kaolin is a fine clay formed by the decomposition of feldspar in granite and composed chiefly of the mineral kaolinite; which is a hydrated aluminum silicate ($Al_4Si_4O_4O(OH)_8$; (David, 1990; Abdullahi (1996). Kaolin also known as China clay is a white clay of high purity, though it may contain some other clay trace minerals and organic matter that may diminish its white colour and appear yellow, red, blue or brown, transparent or opaque depending upon the impurities present (Roger, 1969; Umar and Egila, 1999).

Kaolin is a mineral of widespread occurrence, well distributed through out the world. In Nigeria for instance, there is abundant deposit of it in Enugu, Kaduna, Katsina, Plateau, Ondo, Ogun, Oyo, Kebbi, Bauchi, Sokoto and Borno states (Umar and Egila, 1999). It occurs as a primary residual deposits formed by the weathering or temperature hydrothermal alteration of feldspar, muscovite and other aluminum rich silicates, quartz etc, (Deer, 1966; Paul, 1982).

Kaolin has a lot of application both locally and industrially. It is used in the manufacture of ceramics (white ware, refractory and porcelain); paper, rubber, paint, ink, plastics, pesticides, adhesives, catalysts and in the pharmaceutical industries etc. These uses could be attributed to the properties of kaolin, which includes its desirable white colour, very fine particles size, non-abrasive, chemically inert and plastic when mixed with water and can be molded into different forms. Kaolin also has a specific gravity of 2.60-2.65g/cm^3, (Roger, 1969).

As reported by Umar and Egila, (1999), little work has been done on the chemical composition of Nigerian solid minerals and is mostly unpublished (Nashuni, 1982). However, information about major and trace elemental composition of some Nigerian minerals have been reported. Egila *et, al.*(1995) used AAS to asses the quantity of ten mineral ore deposits suspected on commercial quantity along the Benue valley in Adamawa/Taraba area. The analysis revealed mineral contents such as Mg, Mn and Zn.

This work examined the constituents both major and trace in each sample with the aim of characterizing them and to evaluate their industrial potentials.

MATERIALS AND METHODS

Sample procurement and pre-treatments:

Clay samples were obtained at deposits in Yauri, Goronyo, Munwadata and Atokonyo as rock lumps from deep excavation from mines. Each sample was washed repeatedly from running water and final rinsing with distilled water to avoid surface contamination. The samples were then air-dried, after which they were crushed into fragments with hammer and ground in stages with pestle and mortar to fine powder, sieved through 120mm mesh size, dried at 110^{0}C and kept separately in polythene bags for further analysis.

Sample Treatments.

Different sample treatment was employed depending upon the analysis being made. Any method used in any case, however, was determined by nature of sample and analytical techniques in view.

Reagents used

All reagents used were of analytical grade obtained from BDH chemicals, Poole, UK.

Sample decomposition

The samples were decomposed separately using concentrated hydrochloric acid, evaporated to dryness and redissolved in dil. HCl. The resulting solution was analyzed for magnesium, calcium Aluminum and Iron.

Determination of calcium and magnesium

The determination was done by complexometric titration using Ethylenediaminetetracetate (EDTA) reagent as a complexing agent eriochrom Black T and calcon as indicators (Lanyan, 1982). Other reagents used were cyanide ions which form stable complex with interfering ions such as iron, magnesium, copper, zinc and nickel. Hydroxylamine hydrochloride reduces Fe^{+3} to Fe^{+2}.

Determination of Iron

Colorimetric method was used for the determination of total iron contents. Iron III was converted to iron II using hydroxylamine chloride solution. The Iron II react or complexed with 1,10-phenanthrolin to form an orange red complex at pH range 3-6. the pH was maintained by sodium acetate acid buffer (Alien, 1974).

Determination of Sodium & Potassium

Flame emission photometry was used for sodium and potassium determination at 589.0nm and 766.5nm respectively. 1.0g of each sample was heated with a dry mixture of calcium carbonate (5.0g) and ammonium chloride (0.5g) in a platinum crucible to convert sodium and potassium to soluble chlorides. The sintered mass was digested with hot water and the reactant calcium oxide and matrix elements- silicon, aluminum, iron, magnesium, beryllium, titanium etc that are retained in the precipitate in the form of insoluble oxide were removed by filtration. The resulting filtrate was analyzed for sodium and potassium. Interference from calcium error from the presence of small amounts of other alkali metals that may be present in the calcium carbonate and aluminum chloride used for sample decomposition was compensated for by adding identical liquors of a reagent blank solution to the calibration solution. Similar treatment was done for the mutual ionization interference from potassium in determination of sodium vice –versa (Sastri *et el.,* 1969; Umar and Egila, 1999).

Determination of total silica.

Gravimetric method was used in the total silica determination. The samples were ignited to destroy organic matter. The residue was then taken up in hydrochloric acid. These was then dehydrated to silica by continued evaporation, baking and final ignition, (Alien, 1974).

Loss on Ignition (LOI).

1.0g of the finely ground dried (105-110^{0}C) of each sample was weighed into a platinum crucible. The sample in the crucible was then ignited in a muffle furnace at 1030^{0}C for 1 hour; allowed to cool and then weighed. The difference in weight before and after ignition represents the loss on ignition.

Determination of Titanium

Atomic absorption spectrophotometry at 364.2mm was adapted in the determination of titanium. 1.0g of each sample was decomposed by sodium hydroxide fusion and dissolving in dilute hydrochloric acid. The resulting solution was used for the determination of titanium, in accordance with the method of Hunt *et al* (1974). Ionization interference which enhances titanium absorption was compensated for by adding same amount of sodium that is present in the sodium hydroxide used for fusion of the sample. Similarly, hydrochloric acid interference, which also enhances titanium absorption, was compensated for by maintaining same HCl, concentration in the sample and in the ionization solution (Umar and Egila, 1999).

Determination of Manganese

Manganese determination was done from the final filtrate in the silica determination by atomic absorption spectrophotometry at 279.5nm (Umar and Egila, 1999).

Determination of Phosphate

Phosphate was determined using Vanado-molybdo-phosphoric acid colorimetric method using ammonium molybdate which under acidic condition form molybdo-phosphoric acid. The intensity of the yellow colour was measured with spectrophotometer at 400-490nm (Ademoranti, 1996).

Determination of Density

The method employed in density analysis was based on Archimedes's principle (Nelcon, 1980). About 2.4g of prior dried sample was carefully provided into 10cm^3 of kerosene, difference in volume was recorded.

RESULT AND DISCUSSION

Table 1 shows the result of the analysis for the metals in oxides form and densities of the sample respectively. Based on the results it is evident that sample A (Yauri) and B (Goronyo) contain silica and aluminum oxide that conforms with specifications of high grade Kaolin rock ($\leq$45.50%) and ($\leq$37.20%) respectively (Umar and Egila, 1999). Their densities also closely resemble that of good quality Kaolin (2.62-2.65gcm^{-3}), (Roger, 1969). Concentration of other trace metals in the two samples is also appreciable. Little concentration of Iron and Titanium in sample A and B was recorded. That might explain why they look so very whitish compared to the other two samples C&D as high concentration of these metals may impart color to the samples, (Roger, 1969; Umar and Eigili, 1999). Generally, the samples show varying concentration of trace metals, except manganese (Mn) sodium (Na), Potassium (K) and titanium (Ti) which were not detected in some samples. Probably due to their low-level (below the determination limit of the instrument or method used).

CONCLUSION & RECOMMENDATIONS

The present study revealed that out of the four samples presumed to be Kaolin only two were found to be so (Yauri and Goronyo). The remaining two (Manuwadata and Atokonyo) were not Kaolin.

Use of sample A and B as Kaolin for industrial purpose is recommended since they are high quality grade Kaolin. More research should be devoted on our natural endowment such as solid minerals that will go a very long way to boost our national economy and reduced our over dependence on petroleum.

Table 1: Physico-chemical Analysis of *Some* Clay Samples %

Sample	Density (g/cm^3)	LOI	Al$_2$O$_3$	Fe$_2$O$_3$	CaO	Na$_2$O	K$_2$O	MgO	TiO$_2$	SiO$_2$	P$_2$O$_5$
A	2.54	16.05	37.20	0.30	0.17	0.97	0.50	0.99	0.63	45.00	0.33
B	2.55	16.03	37.00	0.29	0.18	0.98	0.60	0.95	0.37	45.50	0.22
C	1.00	16.01	2.60	0.45	5.23	ND	ND	10.00	ND	25.60	ND
D	1.50	17.01	ND	0.50	15.10	1.25	3.50	0.70	ND	17.00	ND

A = Yauri
C = Munwadata
B = Goronyo
D = Goronyo
ND = Not detected.

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