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A comparative analytical study of kaolin rocks from ukpor (Anambra state), ubulu-uku (Delta state) and ngwo white (Enugu state)

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ABSTRACT

Studies were conducted on the major and trace constituents of kaolin rock samples from Ukpor, Nnewi South Local Government Area of Anambra State, Ubulu-uku, Aniocha South Local Government Area of Delta State and Ngwo White, Ngwo Local Government Area of Enugu State using gravimetry, flame photometry, titrimetry and colorimetry.

The results of the analyses showed that kaolin rock samples contained percentage ranges of silica and the following metallic oxides:

$Si0_2$ (0.84-50.86), CaO (0.84-2.34), $A1_20_3$ (14.99-22.76), Mg0 (0.26-1.15), Fe_20_3(0.30-1.65), $Ti0_2$ (1.61-6.32), $Na_{2-}0$ (1.65-4.45), K_20(0.45-1.68) and loss on ignition (L01) value (12.50-15.19). Comparison with standard specifications shows that these kaolin rock samples could be effectively applied in many industrial productions

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INTRODUCTION

Since the discovery of oil at Oloibiri in 1956, Nigeria has depended solely on petroleum for revenue generation neglecting other important natural resources. This has made the economy a mono-product type vulnerable to the vagaries of international oil politics. Minerals represent natural resources that contribute to the economic and technological growth of countries. The industrial revolution in Europe in the 18th and 19th centuries was driven by the use of iron and coal for steel production and limestone for cement production[1]. The use of minerals in industry directly mirrors the technological development of nations. Presently China and India's fast economic growth is reflected in the consumption of large quantities of mineral commodities.

Minerals can be made great asset for development in Nigeria through exploration, development, application and exportation.

Kaolin is soft white clay with other names which include China clay and porcelain clay. It is a hydrous silicate of Aluminum formed by the decomposition of feldspar and other aluminum- containing minerals.

Its typical chemical composition is $A1\text{-}_2\,0_3\,2S_10_2\,2H_2\,0$. Today kaolin is mined in quantity in France, England, Germany, China and US. In addition to its use as a paste in the manufacture of table ware and other ceramics, kaolin is used extensively as a filler in rubber, extender in paints, filler and surface coating agent in paper as well as raw materials in the pharmaceutical rouge preparation.

It also finds uses in the plastic and cosmetics industries. Chemical analysis of rocks have been done using x-ray diffraction, atomic absorption spectrophotometery, flame photometry, colorimetry, fluorometry and neutron activation inductively coupled plasma-mass spectrometry[3, 4, 5, 5, 6].

The details of sampling have been documented [5, 7] and decomposition methods fully described[8, 9]. Information on the chemical composition of Nigerian solid minerals is lean.

This work highlights the chemical analysis of kaolin rocks from South -eastern Nigerian and their possible applications.

MATERIALS AND METHOD

Materials and reagents

The materials used in this work were obtained from Ukpor (Anambra State), Ubulu – uku (Delta State) and Ngwo White (Enugu State).

Surface contaminations were avoided by repeated washing of the specimens with running water and finally rinsing with distilled water.

The specimens were then air- dried. They were ground to pass through a 120 mesh silk sieve, dried at 100^0 C and stored in a sample sack (made of polythene).

The chemicals namely sodium carbonate, potassium carbonate, sodium chloride, hydrochloric acid, sulphuric acid, hydrofluoric acid, sodium hydroxide and sodium peroxide were of analytical grade (BDH) and were used without further purification.

Apparatus

Muffle furnace (Gallenkamp), over (Gallenkamp, 0 -200^0C), spectronic 20 and platinum crucible, spatula, water bath, measuring cylinder, fume cupboard and desiccators were used in the analysis.

Sample decomposition

The decomposition method used in each depended on the analytical technique.

Determination of total silica

Silica was determined gravimetrically by the method of Maxwell,1968

Loss on ignition (LOI)

0.5g of finely ground sample dried at 105- 110^0C was weighed into a platinum crucible. The crucible with its content was ignited in a muffle furnace (Gallenkamp) at 600^0C for three hours. It was allowed to cool and weighed again. The difference in weight of the crucible before and after ignition represented the loss in ignition value.

Mineral analysis

Sodium and potassium were determined by flame emission photometry at 766.5nm and 589.0nm respectively, in air-acetylene flame after extracting their chlorides with water according to the method of Beffen (1950). Calcium, magnesium and aluminum were determined by the complexomertic titration using EDTA, titanium colorimetrically by the Hydrogen peroxide Method and iron by the 0, Phenanthroline Method[12, 6].

RESULTS AND DISCUSSION

The results of the Chemical analysis of the respective samples obtained from Ukpor, Ubulu- uku and Ngwo White are given in TABLE 1 and specifications of a good quality kaolin rock are shown in TABLE 2. The silica content of kaolin from Ngwo White was found to be of high grade whereas the Ukpor and Ubulu-uku were comparatively low in silica. The alumina content of Ubulu-uku rock was also typically of high grade (14.99) whereas those of Ukpor and Ngwo White were slightly higher in alumina content (18.03% and 22.76%). The LOI values of all the rocks were in the range 12.5% - 15.19% and hence in line with the specification of high qual-

TABLE 1 : Results of chemical analysis of kaolin samples obtained from ukpor, ubulu- uku and ngwo white

Components	A_4%	B_4%	C_4%
Loss on Ignition(LOI)	13.75	15.19	12.50
Silica ($Si\ 0_2$)	2.34	0.84	50.86
Calcium (Ca 0)	2.34	0.84	0.96
Magnesium (Mg0)	1.15	0.26	0.27
Sodium (Na_20)	1.65	4.45	4.28
Potassium (K_2)	0.45	1.68	1.45
Iron (Fe_20_3)	0.34	0.30	1.65
Alumina ($AI_2 0_3$)	18.03	14.99	22.76
Manganese (Mn0)	ND	ND	ND
Titanium ($T10_2$)	2.37	1.61	6.32
Total	99.73	99.90	99.98

Note: A4, B4, C4 represent the samples obtained from the different locations respectively, ND=Not detected, %=Average of four determinations in % mass, A_4=Representative sample form Anambra State (Ukpor Kaolin), B_4= Representative sample form Delta State (Ubulu-Uku), C_4 = Representative sample form Enugu State (Ngwo white)

TABLE 2 : Typical composition of kaolin rocks from roseland (2), California (3) and Webster (4); Specifications of a good quality Kaolin (1); Kaolin for use in the paper industry as coating agent (5), as filling agent (6) and for use in the pharmaceutical industry (7)

Constituent (%)	1	2	3	4	5	6	7
SiO_2	42-45	42.8	43.1	44	47.8	48.70	48.0
$AI2O_3$	37-39	38.7	39.4	35.9	37.0	36.0	36.0
Fe_2O_3	0.8-1.8	1.10	1.4	1.1	0.58	0.82	0.10
CaO	0.4-0.6	0.1	0.1	0.8	0.40	0.60	0.10
MgO	0.4-0.6	0.3	0.1	0.6	0.16	0.25	0.20
K_2O	0.6-0.8	1.2	1.2	.1.1	1.10	1.10	1.10
Na_2O	0.1-04	13.8	13.6	14.0	0.10	0.10	0.10
TiO_2	0.2-0.6	2.20	2.0	2.20	0.03	0.05	0.02
LOI	12-15.0	-	-	-	13.10	11.90	11.90

2 = Roseland, 3 = California. 4 = Webster. 5 = Coating agent. 6 = filling agent, 7= pharmaceutical industry

ity rock. Interestingly, the rocks show varying amounts of some trace metal except manganese which was not detected in the sample analyzed. Davies (1988) showed that geochemical' circumstances lead to natural existence of trace metals in silicate -rock. Trace metals might occur through isomorphous substitution for the major constituents at the time of formation. This might possibly be responsible for the existence of some of these trace metals in the kaolin sample analyzed. However it is note worthy that all the traces were within the range of specification required for good quality kaolin except the Ukpor Kaolin which had relatively lower value of the minor element potassium in K_20. The relatively low silica content of rocks from Ukpor and Ubulu- uku suggest their being sedimentary in origin rather than residual because residual kaolin usually have more free silica as quartz than the sedimentary clay[14].

The isomorphous substitution property of kaolin is responsable for it uses as paint thickener, polish filling and coating agent. Their silica content fell short of the specifications of kaolin for paper and pharmaceutical industries but could be met through pretreatment and beneficia.

This work identified the rocks as good ones and coud be effectively applied in industrial production.

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