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Research Article

CHARACTERIZATION OF UGBEGUN CLAY DEPOSIT FOR ITS POTENTIAL

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Abstract

A clay deposit in Edo Central Senatorial district of Nigeria [location (Global Positioning System, GPS: 6° 13' 39.2" N; 06° 39' 05.3"E); elevation of 259m above sea level (ASL)] has been evaluated for its potential as industrial raw material. X-ray diffraction (XRD) results of the deposit analyzed with Bragg-Wulf equation, and International Center for Diffraction Data (ICDD) software has identified the deposit to contain in parts Chondrodite: ($Mg_3Fe_{½}$ SiO_4 (OH.O) , Titanian: (TiO_4 (SiO_4) (OH.O), Kaersutite: [Na Ca_2 (Mg. Fe)$_4$ Ti (Si_6 Al_2) O_{22} (O H)$_2$, which comprise of silica tetrahedral and aluminium (Mg) octahedral sheets. Mineral lattices are of 2:1 di-octahedral arrangement. The physico-chemical analysis of the deposit corroborates the xrd results and indicates a significant molecular silica-sesquioxide ratio of 2.06.

Keywords: Clay, Kaersutite, Titanian, Muscovite, Pphysico chemical.

INTRODUCTION

Clay, product derived from the weathering and hydrothermal reactions of rocks is a versatile industrial material that has amazing variety of uses and applications. It comprises of mineral groups, which contains certain hydrous aluminum, magnesium, and iron silicates in addition to sodium, potassium, calcium, and magnesium ions etc. They have found acceptance in ceramics porcelain, dinner wares, architectural tiles and enamel[1]. Important uses has also been found for clays in petroleum cracking, cosmetic base and digestive coating remedy, paper, chalk, agro-allied, and pharmaceutical industries. It has an appreciable applicability in the rubber industry where its reinforcing potential has been exploited since the early part of this century, particularly those with tolerable presence of silica (which serves as a reinforcing component in rubber compounding). The aggregate demand of filler (non-black) consumed by various industries has been estimated to be over 1,600,000 tonnes per annum, and the demand for clay is ever increased by the desire for the products of the user industries[2,3].

The applicability/acceptability of clay is however dependent on an appreciable knowledge of its mineral content and chemical composition[4,5]. In most third world countries like Nigeria non-black fillers which include clays are largely imported whereas clay deposits abound, but there is paucity of information about their potential[6].

This study therefore is to ascertain the mineralogical and chemical composition of Ugbegun clay deposit located in Edo Central Senatorial district of Nigeria so as to highlight its academic value, economic potential and encourage its immediate industrial application/uses.

EXPERIMENTAL

The clay sample was collected from the exposed faces of the deposit situated at Longitude 06° 39′ 05.3″E and Latitude 6° 13′ 39.2″N. This was air dried (49±5°C) and pulverized. Minerals were assessed using a monochromatic X-rays (MD 10 mini Diffractometer), with Ni-filter CuKα radiation and automatic slit. Elements; Si, Al, Fe, Ti, Ca, Mg, composition were determined, after acid digestion using Buch Scientific 210 VGP Atomic Absorption Spectrometer. Na and K was determined using (Jenway PF P7 Scientific Instrument) flame photometer. Loss on ignition (LOI) was by gravimetry and pH by Jenway pH meter.

RESULTS AND DISCUSSION

X-ray diffraction (XRD) (fig. 1) of Ugbegun clay reveals that the deposit comprises of two dissimilar stacks of layers of silica tetrahedra and aluminium (Mg) octahedral sheets. These layers contain in their unit cell elemental groups such as Iron (Fe), titanium (Ti), sodium (Na), calcium (Ca) at different proportions. The unit cells assembly of layers and interlayer materials making up the structure of clay comprises of: Chondrodite, ($Mg_3Fe_{½}TiO_4$) (SiO_4) (OH.O)$_2$, Titania; (TiO_4 (SiO_4) (OH.O), and Kaersutite; [Na Ca_2 (Mg. Fe)$_4$ Ti (Si_6 Al_2) O_{22} (O H)$_2$. The basal (001) d spacing, Table 1 from Braggs-Wulf equation ($n\lambda = 2d\sin\theta$) of the clay was sharp at 4.01Å and collapsed to 1.47Å during the heating processes at the corresponding glancing angles of analysis. XRD has been an invaluable tool for clay mineral identification due to its consistency and reproducibility[7,8,9].

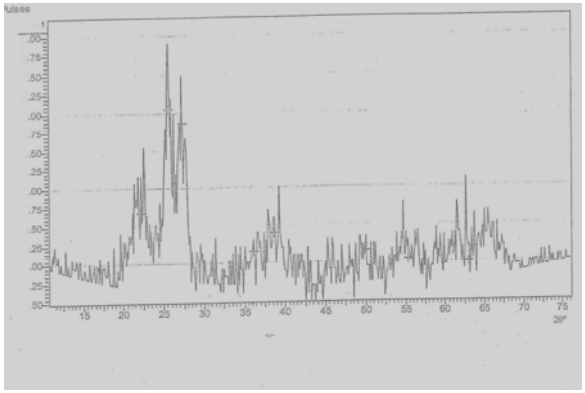

Fig. 1: X-ray diffraction spectra of Ugbegun (clay) deposit on CuKα; Ni-filter in the 2θ region of glancing angle 15-75°.

Table 1: Interplanar spacing, d of X-rays reflected from lattice of Ugbegun clay

Glancing angles (02θ)	d, (nm)
22.16	4.01
25.58	3.48
27.30	3.27
36.06	2.49
38.73	2.32
49.95	1.83
55.33	1.66
62.92	1.48
63.42	1.47

Table 2: Physical characteristics of Ugbegun deposit

Particle sizes distribution (PSA)*	**%**
Clay	83
Sand	10
Silt	7
Colour	Grayish-brown
Specific gravity	0.92
Density, gcc^{-3}	2.62

*According to the USDA[14]

The physical characteristic of Ugbegun deposit is shown in Table 2, reveals about 83% clay content, grayish-brown colour and specific gravity of 0.92 and density $2.62gcc^{-3}$. When the XRD obtained was marched with the special table for identification of mineral[10], it gave a pointer of minor phases of Mica/hydromica (muscovite & Illite) or hydrated Hallosite in the mineral distribution phases of the clay. The Ugbegun clay is suspected to be of 1:1(dimorphic) layer or 2:1 (trimorphic) layer types respectively.

The elemental composition (in their oxides) of Ugbegun deposit is shown in Table 3. This correlates with the mineralogical composition and indicates a molecular silica (SiO_2) / sesquioxide (Al_2O_3+Fe_2O_3) ratio of 2.06 also useful in characterization of clay for its applicability.

Table 3: Chemical composition of Ugbegun clay

Component	**Wt (%)**
SiO_2	38.48
Al_2O_3	12.46
Fe_2O_3	6.18
TiO_2	1.85
MgO	14.67
CaO	12.05
Na_2O	1.42
K_2O	9.57
*LOI	13.5
pH	7.43

*LOI: Loss on ignition

The chemical composition values for silica and alumina as a result of illuvial accessions of the deposit agree with the Kaersutite. The titanium oxide content (TiO_2) is justified by the presence of Titanian in the deposit. The iron enrichment in the Ugbegun clay may likely exist in ferric state, due to prolonged weathering, which has high potential to alter the oxidation state of any Fe^{2+} present. The ferro-ions are possibly derived from the ironstone and lateritic units commonly observed in sedimentary sequence which is prevalent at the Ugbegun location. This is similar to some soil of Western Nigeria origin that is known to contain about 25% of Iron oxide[11]. These ferro-ions could have been incorporated into the clay lattice structure by cation exchange involving Fe^{3+} and Al^{3+}. This process may have been facilitated by the abundance of organic matter[12&13], a condition that is easily satisfied by the Ugbegun region. The sodium, calcium and magnesium also justify the chondrodite, muscovite and Kaersutite. The presence of high level alkali and alkaline earth bases in the Ugbegun deposit could be as a result of partly reactive or exchangeable cations leading to the level of magnesium (14.67% wt).

CONCLUSION

In this study Ugbegun clay have been characterized by XRD and chemical composition analysis, so as to encourage its application. The mineralogy is dominated by Chondrodite, Titanian, and Kaersutite with localized concentrations of illite. Clays formed under humid conditions which fits the Ugbegun deposit are usually by leaching from the instability of siliceous complexes and resulting in the partial or complete degradation or decomposition of the $R_2O_3.2SiO_2.xH_2O$, which favours rapid mineralization. These clays are enriched by illuvial accumulations/podsolic reactions as shown by XRD and physical/chemical compositions (fig. 1, tables 2 and 3) which also distinguish it in possible application.

Ugbegun clay deposit could be used to make bricks, ceramic wares, sanitary wares, and other structural materials. It could also find other industrial applications in polymers, (natural / synthetic), pesticides, insecticides, cosmetics and crayon to name a few. In order to optimize its properties for specific applications, it must be beneficiated accordingly. Feasible economic activity is suggested to focus on small-scale mining and application projects.

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