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Analysis and characterization of clay deposit in Idemili river, south eastern Nigeria

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ABSTRACT

The physical, chemical and mineralogical characterization of Idemili River clay deposit was investigated. X-ray diffraction was used in the mineralogical characterization, result obtained was analyzed using Bragg-Wolf equation and International centre for diffraction data software. The result shows that the sample contain the phyllosilicate minerals of mica group identified as Magnesia Montdorite ($KMg_{2.5}[SiO_{10}][OH]_2$), a mainly synthetic silicate. The pysico- chemical analysis of the deposit corroborates the XRD results. From the result it was concluded that this local raw material should be worked on for industrial production, rather than importing them.

Keywords: XRD, Clay, Characterization, Analysis

INTRODUCTION

Clay is an abundant fine textured earthly powder produced by the weathering and disintegration of granite and feldspathic rocks [1]. This clay occurs most abundant in soil, sedimentary rocks and hydrothermal deposits [2]. The oldest clay deposit was in Africa by archeologist some ten thousand years ago [3, 4, 5].

The history of ceramics was believed to begin with the recognition of clay as a useful material. The characteristics feature of interest include plasticity, resistance to high temperature, malleability (can be shaped to any form), and complex composite formulations (adding substances to clay with a view to improving the properties and usefulness). There are general types of clay: Expandable and Non expandable clay [6]. Expandable clay swells up when water is added to it and can be liquid when or if enough water is added to it. Non expandable clay called bentonite is used to make drilling mud in the petroleum industry. Non expandable clay is used in the ceramics industries to make bricks, tiles, pottery and porcelains.

Our work is therefore based on finding the fundamental properties of this sand sample. This is to the importance of its application in ceramics and enamel industries. Furthermore, any knowledge of clay properties would help in the process modification and development of clay refractory products, especially as it relates to foundry works [7-10]. It also supports understanding of the agricultural viability of this study.

MATERIALS AND METHODS

The sample was collected randomly from Idemili River, Anambra State, Nigeria. The sample was dried and pulverized. Physical, chemical and mineralogical characterization was done. The particle size of the sample was determined using electro-magnetic sieve shaker (Cisa Cedaceria Ind Model BA 200N) with sieve of mesh sizes 500µm, 355µm and 250µm respectively. The specific gravity and density were determined gravimetrically. The color

was also compared with standards. Elements; Si, Al, Fe, Ca, Mg, Mn, K, Na, Ti, Fe, composition were determined after acid digestion using Buch Scientific 210 VGP. Loss on ignition (LOI) was done by gravimetric method.

The mineralogical characterization was done using monochromatic X-ray (MD 10 mini diffractometer, version 2) with beta filter CuKα radiation wavelength of 1.5406Aº and automated silt. A set of 2θ angle ranging from 15º- 75º was used, this was done at Engineering Material Development Institute Akure, Ondo State, Nigeria. In the X-ray absorption analysis, the sample was exposed to a beam of X-ray of suitable energy. Diffraction occurs, the angles of deviation and relative intensities of the deviated beams were measured and from it the structural properties were determined; crystal system, crystal structure, inters planer distance and lattice constant.

RESULTS AND DISCUSSION

Table 1: Physical characterization of sand sample

Particle Size Distribution (PSD) [11]	A (%)
Clay	40
Sand	27
Silt	33
Colour	Weak red
Specific gravity	1.319
Density, gcc^{-3}	1.305

The physical characterization of Idemili River deposit is shown in Table 1 reveals about 40% clay content, weak red color and specific gravity of 1.319 with density of 1.305

The elemental composition (in oxides form) of Idemili River deposit shown is Table 2. This correlates with the mineralogical composition and indicates a molecular silica (SiO_2) and alumina (Al_2O_3) ratio 2:1, also useful in characterization of clay for its applicability.

The titanium oxide content (TiO_2) is justified by the presence of titanium in the deposit

Table 2: chemical composition of the sand sample

Component	Wt (%)
SiO_2	46
Al_2O_3	27.65
Fe_2O_3	1.2
TiO_2	0.02
MgO	1.07
MnO	0.02
CaO	0.01
K_2O	9.12
Na_2O	0.31
*LOI	11
pH	6

***LOI:** Loss On Ignition*

The iron enrichment in the clay deposit may likely exist in ferric state, due to prolonged weathering which has high potential to alter the oxidation state of any Fe^{2+} present. 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 [11 -14]. The presence of alkali and alkaline earth metal oxides in low amount, shows that the sample falls into clays recommended for refractory work [15].

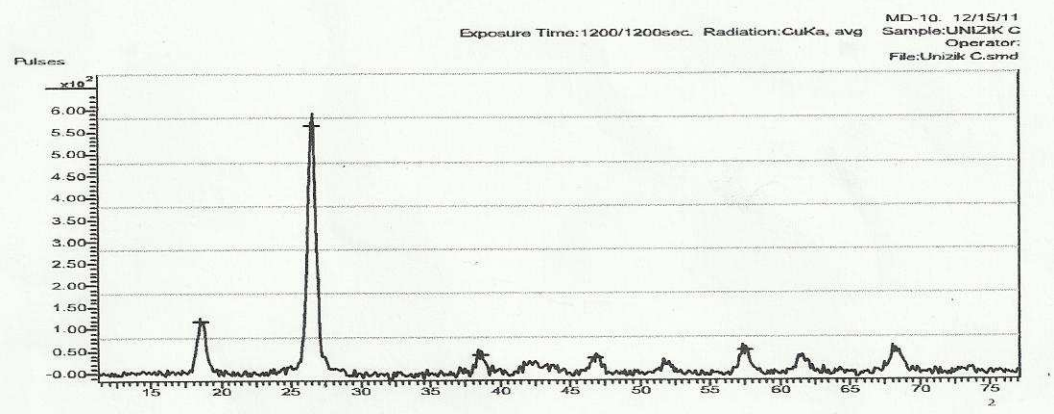
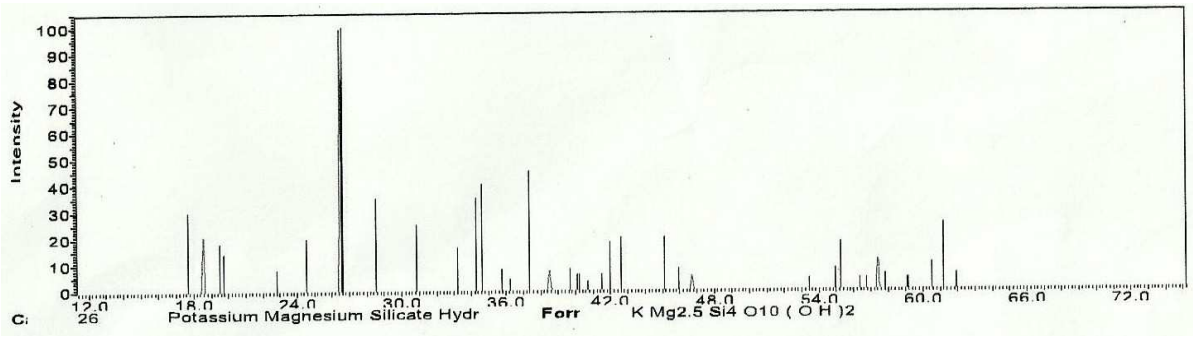


Fig. 1: X-ray diffraction of the sample on CuKα; in the 2θ region, glancing angle 15^o – 75^o



	2	d	I int	I max	I rel	I corr	FWHM
	18.53	4.78756	4834	116.8	20.8	25.4	0.73023
	26.47	3.36652	23273	563.8	100.0	100.0	0.72801
	38.49	2.33855	1678	40.3	7.2	6.4	0.68035
	46.68	1.94571	1196	30.9	5.1	4.4	0.83575
	57.39	1.60549	2656	50.8	11.4	9.4	0.80632

Fig. 2: XRD interpretation of the sample

In Fig. 1 is shown the X-ray diffraction (XRD) of Idemili River deposit which comprises of phylliosilicate minerals of mica group identified as Magnesia Mondorite ($KMg_{2.5}[SiO_{10}][OH]_2$). The basal (001) spacing of the Bragg's Wolf equation ($n\lambda = 2dSin\theta$) a the sample gave a monoclinic crystal of class space group C/m which was sharp at 4.7876A^o and collapsed to 1.60349A^o during the heating processes at a corresponding glancing angles of analysis. XRD has been an invaluable tool for clay minerals identification due to its consistency and reproducibility [16 - 19]. The chemical composition shown in Table 2 compared well with the mineralogical composition.

Magnesia Monodrite is a trioctahedral mica which was first synthesized by Seifert Schreyer [20]. Miyawaki et al[21] developed a new mineral, Yangzhumingite ($KMg_{2.5}[SiO_{10}][F]_2$), of mica group from Bayan Obo, inner Mongolia, china and obtained a lattice constant of a = 5.249A^o, monoclinic crystal of space group C2/m and (001) cleavage. Taleyama et al [22], reported the same crystal structure for Mg (IV) mica but obtained lattice constant of 3.346A^o.

CONCLUSION

In this study soil deposit from Idemili River in Anambra State, Nigeria has been characterized for its possible utilization in ceramics and enamel industries. The results showed that the sample is rich in quarz which is the major component of mica and feldspar. The level of their alkaline and alkaline earth metal oxide is an added advantage to the desired application in ceramics and enamel industries. The identified mineral, Magnesia Montdorite, mainly synthetic mineral, now found in nature in Anambra State, Nigeria is an added advantage.

Since, it has been confirmed that Idemili River deposit is suitable for refractory works, it is therefore recommended that Idemili River deposit should be channeled into possible utilization as raw materials for industrial production.

REFERENCES

[1] Idenyi. N.E., Nwajagu C.O. *Non metallic material technology*. Ist ed. Olison publication, Enugu Nigeria. **2003.**
[2] Mc Graw- Hill. *Encyclopedia of science technology*, Mc Graw – Hill book company, 8th ed. **1992.** 3, 752-761.
[3] Norton F.H. *Elements of ceramics*. Addixson weseey LTD, London, UK. **1974.** 20-28.
[4] Dinadale. A. *Pottery science, material processes and products*. Ellis Horwood LTD, London UK. **1986.** 20-28.
[5] Prudence M.R. *A source book on pottery analysis.* University press Chicago. IL. **1987.** 9-50.
[6] Ahmed K.S., Onaji P.B. *Journal of Nigerian society of Chemical Eng*. **1986.** 6(2). 119-129.
[7] Owate I.O and Edike E.N. *Journal of phy*., **1996.** 85.
[8] Yasunaga N., and Okada S. *Key Engineering Materials*. **2003.** 238 –239, 253 – 256.
[9] Ajemba R.O. *Adv. Appl. Sci. Res.*, **2012.** 3(4), 2042 – 2049
[10] Nwankwere E, Nwadiogbu J., Yilleng M, Eze K. *Adv. Appl. Sci. Res.*, **2012.** 3(2), 1122
[11] Klute A, Campbell G/S., Jackson R.D., Mortland M.M., Nielsea D.R., *Methods of soil analysis. Part 1*, 2nd ed. Madison: American Society of Agronomy Inc. **1986.** 635 – 662.
[12] Robinson G.W. *Soils – their origin, constitution and classification*, 2nd ed. Delin biotech book. **2005.** 210
[13] Barshad. I. *Chemistry of soil science*; Bear F.E, ed chemistry of soil. 2nd ed. Van Nostran Reinhold press, New York. **1990.** 2-22.
[14] Vadwel S, Manickam A,Ponnwsamy P. *Adv. Appl. Sci. Res.*, **2011.** 3(11), 219
[15] Agaly A, Palanisamy N, Swakumar P. *Adv. Appl. Sci. Res.*, **2012.** 3(3), 1220
[16] Worall W.E. *Clay and ceramics raw material*. Applied science publication, London. **1975.** 115
[17] Moore D.M. and Reynold R.C. *Diffraction and the identification/ analysis of clay minerals*. 2nd ed. Oxford university press, New York. **1997.** 145
[18] Murray H.H. *Clays in industry*. In Domiqtey E., Mas G., Gravero F. editors. A clay odyssey . 5th ed. Elsevier press, Amsterdan. **2003.** 3- 14.
[19] Omisanya N.O, Folayan C.O, Aku. S.Y., Adefila S.S. *Adv. Appl. Sci. Res.*, **2012.** 3(6), 3746 -3754
[20] Omoboriowo A.O, Okengwu K.O, Ugwueze C.U, Soronnadi-Ononiwu G.C, Acra E.J, Chiaghanam O.I, Chiadikaobi K.C. *Adv. Appl. Sci. Res.*, **2012.** 3(6), 3852 – 3657
[21] Seifert and Schreyer. *Contrib. miner. Pretrogr.* **1971.** 30. 196-215.
[22] Miyawaki R.,Shimazaki H., Shigeoka M., Yokoyama K., Matsubara S., and Yurimoto H. *Eur. J. Mineral*. **2012.** 23, 467 – 473.
[23] Taleyama H, Shimoda S, and Sudu T. *Zeitschrift Fur Kristallographic*. Bd, **1974.** 139, S, 196 – 204.