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To cite this article: A. O. Inegbenebor *et al* 2019 *J. Phys.: Conf. Ser.* **1378** 032084

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# Reconnaissance Study of Smectite ores of Lafarge- Ewekoro, Ogun State Nigeria for Industrial Applications

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**Abstract.** This work aimed to study the aluminosilicate ore contents at Lafarge Ogun State environ as a means of identification of background variation of smectite in the ore-bodied environment. Smectite clay samples (bentonite) were collected from Larfarge Ewekoro environ, while zeolite used as a standard in this work was obtained from Petroleum Department of Covenant University for comparism purpose. The samples were digested with nitric acid, HNO<sub>3</sub> and hydrochloric acid, HCl, after which the digested samples were characterized with, ultraviolet visible (UV-VIS), scanning, absorbance; and % transmittances. The results revealed similarity in ultraviolet visible for bentonite and zeolite with predominance of iron in bentonite samples. The colouration of bentonite due to the presence of transition metals in the environment under study could be of industrial uses in the manufacture of coloured wares and tiles, and magnetic ceramic, though further pre-application specific investigations are recommended. Also, the observed properties favour many aspects of industrial applications such as in pharmaceuticals, refractories, adhesives and porcelain wares. These will help in setting up small and medium-sized enterprise in this area resulting in employment creation and revenue generation.

**Key words:** Smectite, bentonite, ultraviolet visible, zeolite, FTIR, XRD

## 1. Introduction

Smectite (Montrimorillonite) are three layered lattice types of clay (Fig. 1), which have strange characteristic of shrinking and enlarging to exude or soak up water. Magnesia and calcium with up to 20% water are the major constituents of Montrimorillonite. The name bentonite is used for mud rocks containing huge amount of smectite clays. Natural accumulation of bentonite is identified by out-crop with dusty cauliflower-like outward face [1]. When solid chunk of montrimorillonite is dropped in water, it will swell and break into pieces. Bentonite is form from modified naturally occurring volcanic ash found in continental and marine environs. It usually contains broken pieces of devitrified detrital glass with small amount of heavy minerals, mica, quartz and feldspars.

The major purpose of this work was to study the aluminosilicate ore contents at Lafarge Ogun State as a means of identification of background variation of smectite in the ore-bodied environment. Bentonites are the most significant ingredient of circulating mud system employed in rotation drilling because of their peculiar



properties. Conversely, montmorillonite is a clay matrix mineral clay in an oil reservoir. This is due to the destruction of permeability during production as the clay matrix swells from the entering water [2]. The quality and amount of the elements present in the clay sample may suggest its uses including technological.

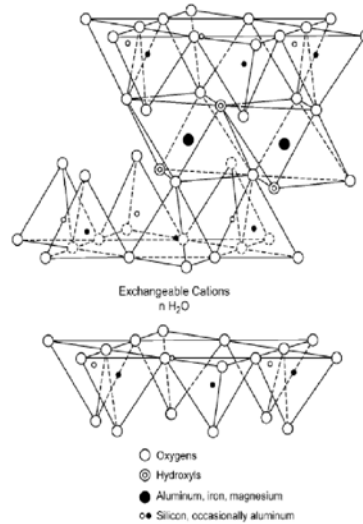


Figure 1: Diagrammatical Sketch of Montmorillonite [2]

Phyllosilicates in Deccan Volcanic Province in central and western India have been studied [3]. Eleven samples from this region were studied using Fourier Transform Infrared (FTIR) and X-ray diffraction (XRD) analysis. The study found iron oxide and smectite. Also, Abu Marawat area of Egypt mineral resources were investigated by integrating satellite, aeromagnetic and actual field data [4]. This region was found to contain minerals such as smectite, alunite, montmorillonite, kaolinite, chlorite and goethite.

## 2. Methodology

Smectite clay samples (bentonite) used in this work was collected from Lafarge Ewekoro. The study of crystal arrangement includes observation of the angle, length and depth of the aluminosilicate bodies, the purity of the ore and the connection between vegetation, water table and the ore-bearing bed [5]. Zeolite used as standard in this work was obtained from Petroleum Department of Covenant University for comparison purpose, since bentonite and zeolite exhibit few similar features, (Tables 1 and 2). The samples were digested with nitric acid,  $\text{HNO}_3$  and hydrochloric acid,  $\text{HCl}$ , after which the digested samples were characterized with, ultraviolet visible (UV-VIS), scanning, absorbance and per cent (%) transmittances (Tables 3 and Table 4).

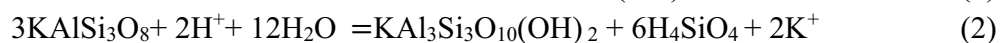
These characterizations together with microwave plasma atomic emission spectrometer (MP-AES) analysis (Fig. 5 and Fig. 6) are to know the contents of samples in order to reconnaissance the study of smectite ores of Lafarge- Ewekoro.

## 3. Results and Discussion

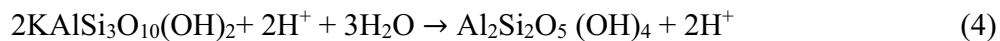
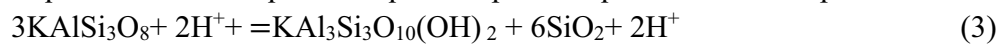
The results revealed similarity (Fig. 2 and Fig.3) in the Ultraviolet visible (UV-VIS) of smectite ore from Lafarge, Ewekoro and the Ultraviolet visible (UV-VIS) of zeolite sample used in this work.

Iron was predominant in bentonite samples (Fig. 4 and Fig. 5). The colourations of bentonite due to the presence of transition metals in the environment under study could be of industrial uses in the manufacture of coloured wares and tiles, and magnetic ceramic, though further pre-application specific investigations are recommended. Also, the observed properties like the clay expansion and the layered structure may favour many aspects of industrial applications such as in pharmaceuticals, refractories, adhesives and porcelain wares. Applications and areas of uses may also include, adsorption (elimination of ammonia, heavy metals), purification (especially waste water, sewage, air and gases), kidney dialysis, drying, production of hydrogen (from water), production of detergent, fertilizers, aquaculture, animal feeds, redox reactions, hydrogenation, dehydrogenation, and the like.

Generally, aluminum silicates as shown in Tables 1 and 2 as products of weathering practically always a clay mineral and a compound in which some of the original aluminum and silicon apparently remain combined. This is theoretically represented in equation 1 to equation 4:



Observe that eq. 1 is similar to eq. 2 except that eq. 1 is written for a slightly acid solution. Again eq. 1 and eq. 2 is similar to eq. 3 and eq. 4 except that eq. 4 is for low temperature environments.



Montrimorillonite varieties of smectite in Tables 1 and 2 may be distinguished on the bases of composition, particularly by the nature of principal cation in the octahedral sheet in Fig. 1. Some studies [1, 6-7] indicate that the clay minerals once formed, do not change character readily but persist for times at least as long as geological periods even when the environment is altered [1, 7]. These suggest that the environment in which a clay mineral is found is not as important as the original environment where they came from.

Majority of the sedimentary zeolite deposits of economic importance are produced from powdered grained volcanic ash or from further pyroclastic material which was conveyed by means of wind from volcanic eruption and placed on the surface of the land, in shallow freshwater or saline (salty) lakes or into the marines quite close to the starting place of the volcano. Significant parts of the land-deposited substance are rapidly washed into lakes where it produces beds of virtually uncontaminated ash.

Zeolites possess a few rare and vital attributes similar to bentonite, like the ability for ion-exchange and molecular sieving that create a lot of diversities of significant economic importance.

Name	Composition	Crystal System	Reference
Aliettite		Monoclinic	
Montmorillite	$(\text{Na}, \text{Ca})_{0.3} (\text{Al}, \text{Mg})_2 \text{Si}_4 \text{O}_{10} (\text{OH})_2 \cdot n\text{H}_2\text{O}$	Monoclinic	
Sauconite	$(\text{Na}_{0.3} \text{Zn}_3 (\text{Si}, \text{Al})_4 \text{O}_{10} (\text{OH})_2 \cdot 4\text{H}_2\text{O}$	Monoclinic	Flasher, 31, 411-424 (1946)
Swienfordite	$(\text{Li}, \text{Ca}, \text{Na}) (\text{Al}, \text{Li}, \text{Mg})_4 (\text{Si}, \text{Al})_8 \text{O}_{20} (\text{OH}, \text{F})_4 \cdot 4\text{H}_2\text{O}$	Monoclinic	
Beidellite	$(\text{Na}, \text{Ca}_{0.5})_{0.3} \text{Al}_2 (\text{Si}, \text{Al})_4 \text{O}_{10} (\text{OH})_2 \cdot n\text{H}_2\text{O}$	Monoclinic	
Nontronite	$\text{Na}_{0.3} \text{Fe}_2^{3+} (\text{Si}, \text{Al})_4 \text{O}_{10} (\text{OH})_2 \cdot n\text{H}_2\text{O}$	Green Monoclinic	
Sobotkite Alumuniansaponite	$(\text{K}, \text{Ca}_{1/2})_{0.3} (\text{Mg}_2 \text{Al}) (\text{Si}_3 \text{Al}) \text{O}_{10} (\text{OH})_2 \cdot 5\text{H}_2\text{O}$	Monoclinic	Flasher, 61, 177, 1976
Volkonskoite	$\text{Ca}_{0.3} (\text{Cr}^{3+}, \text{Mg}, \text{Fe}^{3+})_2 (\text{Si}, \text{Al})_4 \text{O}_{10} (\text{OH})_2 \cdot 4\text{H}_2\text{O}$	Monoclinic	
Hectorite	$\text{Na}_{0.3} (\text{Mg}, \text{Li})_3 \text{Si}_4 \text{O}_{10} (\text{F}, \text{OH})_2$	Monoclinic	
Saponite	$(\text{Ca}_{1/2}, \text{Na})_{0.3} (\text{Mg}, \text{Fe}^{2+})_3 (\text{Si}, \text{Al})_4 \text{O}_{10} (\text{OH})_2 \cdot 4\text{H}_2\text{O}$	Monoclinic	
Stevensite	$(\text{Ca}_{1/2})_{0.3} \text{Mg}_{0.3} \text{Si}_4 \text{O}_{10} (\text{OH})_2$	Monoclinic	Flasher, 38, 973-987 (1953), 44, 343-370 (1959)
Bentonite	$(\text{Na}, \text{Ca})_{0.3} (\text{Al}, \text{Mg})_2 \text{Si}_4 \text{O}_{10} (\text{OH})_2 \cdot n\text{H}_2\text{O}$ A rock forming consisting mainly of montmorillonite	Monoclinic	Fleisher Pg. 17 & Pg. 123

Table 1: Smectite Group of Minerals [8]

#### 4. Conclusion

The results revealed similarity in the Ultraviolet Visible (UV-VIS) of smectite ore from Lafarge, Ewekoro and the Ultraviolet visible (UV-VIS) of zeolite sample used in this work. These characterizations together with microwave plasma atomic emission spectrometer analysis revealed the contents in the two ores samples. Furthermore, smectite group of minerals of the environment under study can undergo chemical composition differences in terms of  $\text{Fe}^{3+}$  or  $\text{Al}^{3+}$  substitution for  $\text{Si}^{4+}$  in the tetrahedral cation sites and the substitution of  $\text{Mn}^{2+}$ ,  $\text{Fe}^{2+}$ , or  $\text{Mg}^{2+}$  for  $\text{Al}^{3+}$  in the octahedral cation locations. Iron was predominant in bentonite samples. The colouration of bentonite due to the presence of transition metals in the environment under study could be of industrial uses in the manufacture of coloured wares and tiles, and magnetic ceramic. It can also

be concluded that at Lafarge Ewekoro environs the minerals resources of clay contain aluminosilicate bentonite and zeolite. With this revelation, small scale industries can be established at Lafarge to explore these minerals for industrial application.

Table 2: Zeolite Group of Minerals [8]

Name	Composition	Crystal System	Reference
Amicite	$K_2 Na_2 Al_4 Si_4 O_{16} \cdot 5H_2O$	Monoclinic	Flasher, 65, 808 (1980)
Clinoptilotite	$(Na, K, Ca)_{2-3} Al_3 (Al, Si)_{13} O_{36} 12H_2O$	Monoclinic	45, 341-369 (1960)
Edingtonite	$Ba Al_2 Si_3 O_{10} \cdot 4H_2O$	Orthorhombic and Monoclinic	Flasher, 70,1333-1334 (1985)
Faujasite	$(Na_2, Ca) Al_2 SiO_{12} \cdot 8H_2O$	Cubic	
Cristmondine	$Ca_2 Al_4 Si_4 O_{16} \cdot 9H_2O$	Monoclinic	
Cronnardite	$Na_2 Ca Al_4 Si_6 O_{20} \cdot 7H_2O$	Orthorhombic	
Herschelite	$(Na, Ca, K) AlSi_{12}O_{16} \cdot 3H_2O$	Trigonal Compare Chabazite,	Flasher, 47, 985-987, 1962
Leoyne	$(Ca, Na_2, K_2) Al_2 Si_4 O_{12} \cdot 6H_2O$	Trigonal	Flasher, 61, 853
Mesolite	$Na_2 Ca_2 Al_6 Si_9 O_{30} \cdot 8H_2O$	Monoclinic	
Scolecite	$Ca Al_2 Si_3 O_{10} \cdot 3H_2O$	Monoclinic	
Ferrierite	$(Na, K)_2 MgAl_3 Si_{15} O_{36} (OH) \cdot 9H_2O$	Orthorhombic and Monoclinic	Flasher, 4, 90 (1919).70,619, (1985)
Wellsite (Compare Harmotome and Phillipsite),	$(Ba, Ca, K_2) Al_2 Si_6 \cdot 6H_2O$	Monoclinic	
Stilbite	$NaCa_2 Al_5 Si_{13} O_{36} \cdot 14H_2O$	Monoclinic and Trigonal	70,814-821 (1985)
Chabazite	$CaAl_2 Si_4 O_{12} \cdot 6H_2O$	Trigonal compare Herchelite	

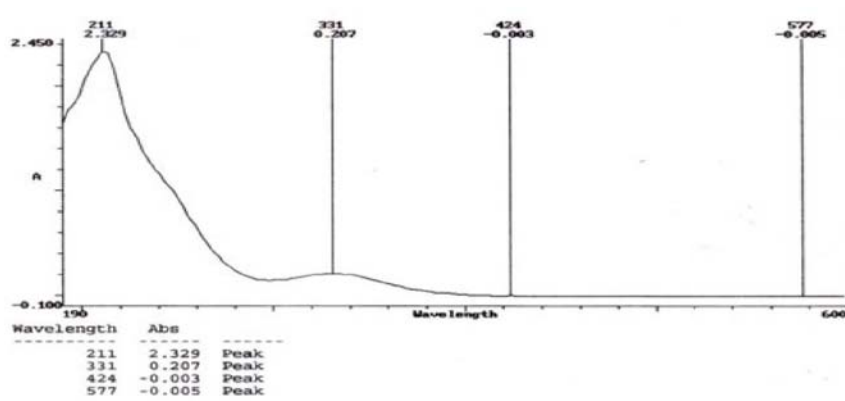


Figure 2: The Ultraviolet visible (UV-VIS) of Smectite ore from Larfarge, Ewekoro

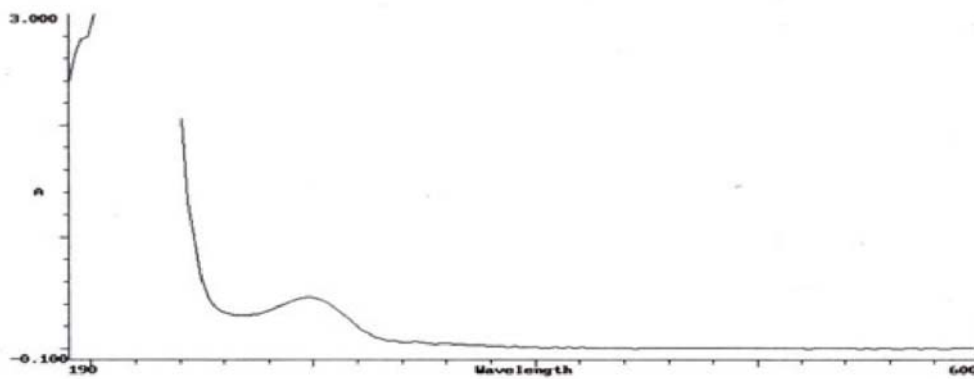


Figure 3: The Ultraviolet visible (UV-VIS) of Zeolite sample used in this work.

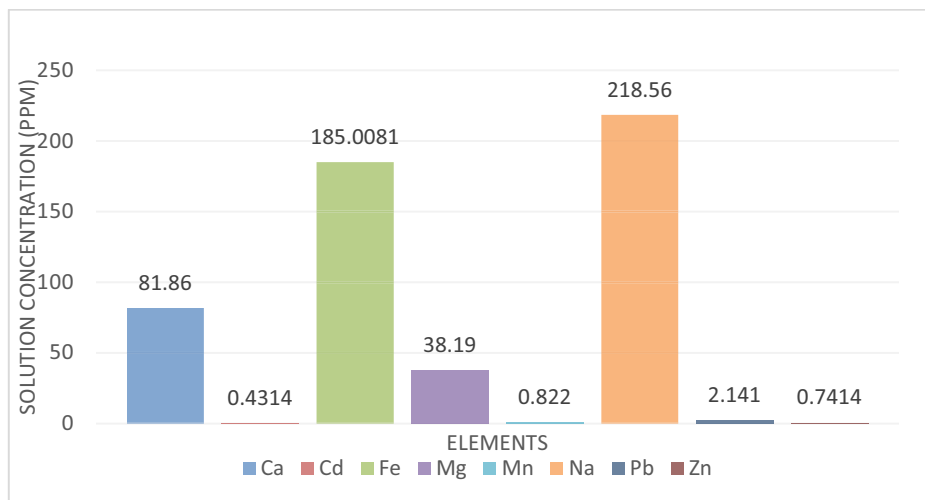
**Table 3:** The absorbance, concentration and % transmittance of bentonite

Wavelength	Absorbance (A)	Concentration	% Transmittance
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		( $\mu\text{g/L}$ )	
400 nm	0.998	994.2	10.1
600 nm	0.020	8.804	97.6

**Table 4:** The absorbance, concentration and % transmittance for zeolite

Wavelength	Absorbance (A)	Concentration ( $\mu\text{g/L}$ )	% Transmittance
400 nm	0.251	248.2	55.6
600 nm	0.013	9.31	97.7



**Figure 4:** Solution Concentration of Elements in Bentonite



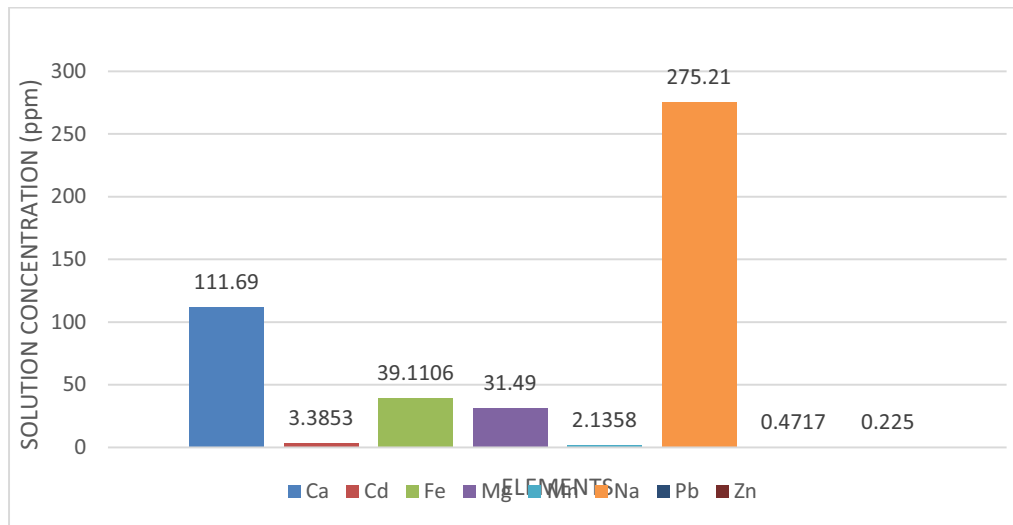


Figure 5: Solution Concentration of Elements in Zeolite

### Acknowledgements

The authors wish to acknowledge the financial assistance rendered by Covenant University for completing this research work.

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