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COMPARATIVE STUDY OF KAOLIN DEPOSITS IN SOUTHWESTERN NIGERIA

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ABSTRACT

Kaolin, a clay mineral abundantly found in the earth's crust holds significant industrial importance due to its various applications in ceramics, paper paints, and other industries. This paper investigated three kaolin deposits located in the southwestern states of Nigeria: Ekiti, Osun, and Ondo States. The paper explores the geological characteristics of these deposits, their mineral composition, physical properties, and the economic potential they offer to Nigeria's development. Kaolin samples were collected from Ijero-Ekiti, Ode-Irele, and Iwo in Ekiti, Ondo, and Osun states respectively. The samples were crushed, grounded, and screened to particle sizes below 90µm. Sieve analysis, natural moisture content, and Atterberg limit tests were carried out on the samples using the X-ray Fluorescence (XRF) technique. The results showed that the Ijero-Ekiti, Ode-Irele, and Iwo have a moisture content of 19.9%, 17.75%, and 18.86% while the kaolin values are 26%, 42%, and 47% respectively. The clay obtained from each of the deposits have the same uniformity coefficient of 1.875 while the fineness index varies at values of 36.4534, 36.4034, and 36.4042 for Iwo, Ijero - Ekiti, and Ode-Irele deposits respectively. The results imply that the moisture content is moderate across all three sites, which suggests that these clays are likely to be workable without excessive drying or wetting. The kaolin content of the deposits showed that they are suitable as ores for the production of aluminum and alumina if properly extracted. The fineness index values are very close for all three deposits and the uniformity in fineness can be beneficial in applications where consistent behavior is required, such as in ceramics or as a filler material. The study has provided the necessary data for the possible use of kaolin for the production of ceramic materials needed for foundry applications.

KEYWORDS: Clay; Kaolin; Deposits; Liquid Limit; Sieve Analysis; Atterberg Limit

INTRODUCTION

Research into mineral resources has become an important activity for the economic support of a nation. More so, the global increase in the demand for aluminium and alumina has caused the metallurgists and scientists to develop new means of getting them from low-grade ore outside the commonest bauxite ore that was known as the only process of producing aluminium by Bayer process (Olusola & Akindele, 2010). The study on Kaolin has revealed that alumina extracted from kaolin is one of the major components in the production of ceramics, paper, rubber, and cosmetics due to its fine particle size. Alumina is also fondly used as a catalyst in various chemical reactions, especially in the petroleum industry for refining and processing. Aluminium from kaolin is found among metals to be the most versatile and prospective metal that is highly demanded and the alumina derived from the kaolin plays crucial roles in industrial applications such as in pharmaceutical industries and environmental protection (Mokwa et al., 2019).

Kaolin is a clay rock formed due to weathering activities on the silicate rock. It is hydrated aluminum silicate ($Al_2Si_2O_5(OH)_4$). It is a layered silicate mineral with one tetrahedral sheet linked through oxygen atoms to one octahedral sheet alumina with a repeating layer of the mineral and hydrogen bonded. It exists as a stable α-alumina and in a variety of metastable forms (Tantawy et al., 2019). It may be white or yellowish-white in colour. It is odourless, non-porous, soft, and easily suspended in water with good plasticity and high adhesion. It exhibits high thermal stability, making it suitable for use in refractoriness, ceramics, and other high-temperature applications (Moorkah & Abolarin, 2005, Tantawy et al., 2019). It has excellent electrical insulation properties; with good acid–soluble, low cat ion exchange capacity, better fire resistance, and other physical and chemical properties.

The study of Jacobson and Webbs on the ‘Pegmatite of Central Nigeria in the Geological Survey Nigeria Bulletin 1946’ exposed the Precambrian complex minerals such as muscovite, feldspars, tourmaline, and beryl to be so much available in the pegmatite belt of Nigeria. Nigeria's pegmatite belt is concentrated in 400 kilometres from Northeast to Southwest trending (Ale et al., 2014). Olusola and Akindele (2010) examined the geology and geotechnical appraisal of some clay deposits around Ijero in Ekiti State southwestern Nigeria.

The Precambrian basement complex minerals including granites, gneisses, and schists are the source of the kaolin deposits in southwestern Nigeria. The process of weathering, in particular chemical weathering, is responsible for converting feldspar-rich rocks into kaolinite (Afolagboye et al., 2023; Olatunji et al., 2023). The region's tropical climate plays a major role in intensifying chemical weathering. The continuous action of acidic groundwater on feldspar-bearing rocks, like granites and granodiorites, results in the leaching of alkali and silica, leaving behind a residue rich in alumina, which eventually forms kaolinite. This process is more effective in areas with high rainfall, where the weathering process is prevalent (Adebowale & Anthony, 2022).

The qualities of kaolin that make it so versatile are its brightness, high surface area, tiny particle size, and chemical inertness. Kaolin is mostly used in Southwestern Nigeria's ceramics sector, where it is an essential ingredient in the creation of a range of ceramic goods, such as refractory bricks, tiles, and sanitary ware. The strength, longevity, and heat resistance of these products are enhanced by the high alumina content of kaolin (Mgbemere & Oluigbo, 2024; Olatunji et al., 2023). Kaolin is widely utilized as a coating and filling agent in the paper industry (Buyondo et al., 2024). The smoothness, opacity, and printability of paper are enhanced by its high brightness and tiny particle size. However, beneficiation is frequently needed to improve the brightness and purity of kaolin for use in the production of high-quality paper (Devisetti et al., 2023). The Ijero-Ekiti deposit in Southwestern Nigeria has demonstrated potential for utilization in the paper industry through suitable beneficiation procedures (Fatoye, 2022). Kaolin is used as an extender and filler in the paint industry, where it increases the paint's longevity, opacity, and viscosity. Kaolin is a perfect material for this because of its small particle size and chemical inertness (Ayalew, 2023; Buyondo et al., 2024). Similar to this, kaolin is used as a filler in the rubber and plastics sectors to improve mechanical qualities and lower manufacturing costs (Anam et al., 2023; Feriancová et al., 2023). Kaolin also finds application in the cosmetics sector, where its mildly abrasive and absorbent qualities render it appropriate for usage in powders, facial masks, and other skincare products (Dissanayake et al., 2022; Dwiani et al., 2023).

Considering the growing demand for kaolin across a range of industries worldwide, the kaolin resources in Southwest Nigeria hold significant economic potential. By supplying raw materials for the manufacturing sector, offering employment possibilities, and earning cash through exports, the exploitation of these resources might considerably contribute to the economic growth of the region

(Olatunji et al., 2023; Abu et al., 2023; Mgbemere & Oluigbo, 2024). Still, a few obstacles need to be overcome to reach this potential. The absence of suitable infrastructure for kaolin mining and processing is one of the major problems. Due to their remote locations and inadequate access routes, many of the deposits have a limited production scale and higher transportation costs. Furthermore, the beneficiation procedures needed to raise the caliber of kaolin for high-value applications are frequently absent or inadequate, which results in the export of raw or minimally processed kaolin at lower prices.

MATERIALS AND METHOD

Extraction of Kaolin

In this study, three states samples of crude kaolin deposits were visited (Plate 1) in the western states of Nigeria. They are Ijero-Ekiti in Ekiti State, Ode-Irele in Ondo State, and Iwo in Osun State. Ijero-Ekiti is situated at longitude $5^{o}\,4^{'}\,4^{''}$ E and latitude $7^{o}\,48^{'}\,43^{''}$ N. It is about 120 kilometers Northwest away from Ado Ekiti the State capital of Ekiti State, Ode-Irele is situated at longitudes $4^{o}\,52^{'}\,0^{''}$ E and latitudes $6^{o}\,29^{'}\,0^{''}$ N. It is about 200 Kilometres Northwest of Akure; the State capital of Ondo State, while Iwo is situated at longitude $4^{o}\,10^{'}\,37^{''}$ E and latitudes $7^{o}\,38^{'}\,24^{''}$ N. Iwo town is about 35 Kilometers northwest of Oshogbo; the State capital of Osun State. The geological studies revealed that all these deposits are pegmatite occurrence centered which are within the schist belt that lies within the Precambrian Basement Complex rocks of South Western Nigeria. They are associated with the cretaceous sedimentary rocks of the Ewekoro formation. The locations where the kaolin clays were collected are shown in Plate 1.

a) Ijero, Ekiti State b) Iwo, Osun State c) Ode-Irele, Ondo State

Plate 1: The Kaolin Sites in the southwestern states of Nigeria

Test on the materials

The samples collected were crushed, grounded, and screened to particle sizes below 90µm. Physical tests and chemical composition analysis using the X-ray fluorescence (XRF) technique were carried out on the obtained kaolin samples to verify their suitability. The tests are the natural moisture content test, sieve analysis, and Atterberg Limit tests.

The moisture content of the Kaolin

19.22 grams of each kaolin sample were measured and heated in an oven for 24 hours at 110 ^{o}C as shown in Plate 2. It was heated and measured until a constant average obtained mass of 114.4 grams of the samples with an indication that the water content had been removed. The difference in values gave the moisture content value of the kaolin as recorded in Table 1. The moisture content was obtained using Eq. 1

$$Water\ content\ (\%) = \frac{M_3 - M_5}{M_5} \times 100 \ldots..Eq.1$$


Plate 2: Determination of the moisture content of Kaolin.

Sieve analysis test

The sieve analysis determines the particle size distribution of a given soil sample and hence helps in the easy identification of soil's mechanical properties. These mechanical properties determine whether a given soil can support the proposed engineering structure. It is interpreted by analyzing the retention of particles throughout a sieve stack or the amount of material that passes through each sieve. Eight various sieve sizes ranging from 9.5mm at the top to 75 µm were arranged on the Condecotts Test Sieve Shaker (E.F.L.2 MK11). 500g of dried kaolin from each sample were grounded in the mortal and put on the coarsest (topmost) sieve as shown in Plate 3. The machine was switched on to vibrate and shake the sieves for 15 minutes to distribute the granular materials through the series of mesh sieves with progressively smaller openings. The material retained on each sieve is calculated by measuring the weight of the soil retained on each sieve subtracting the weight of the empty sieve from the recorded weight of the sieve and multiplying with the British standard sieve mesh number of the previous mesh. The total product weight of the particles retained is added and compared to the initial weight of the soil samples to produce the fineness number which is the American Foundry Society Number (AFS). The data collected is then used to create a particle size distribution curve and deduce the gradient of the curve which is known as the Uniformity Coefficient (Cu). The uniformity coefficient (Cu) expresses the variety in particle sizes of soil and is defined as the ratio of D60 to D10 from the graph Figure 1 to 3. The value D60 is the grain diameter at which 60% of soil particles are finer and 40% of soil particles are coarser, while D10 is the grain diameter at which 10% of particles are finer and 90% of the particles are coarser. Therefore, Cu is estimated as shown in Eq. 2.

$$C_u = \frac{D_{60}}{D_{10}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..Eq.2$$

Atterberg limits test on Kaolin

This limit test is a method used to classify fine-grained soils, lie silts, and clay, based on their plasticity. It determines the liquid limit, plastic limit, and shrinkage limit of the soil sample. It establishes the moisture contents at which fine-grained clay and silt soil transition between solid, semi-solid, plastic, and liquid states. The limits relate the determined moisture contents to empirically defined boundaries between states of consistency (liquid, plastic, and solid. The test aims to obtain empirical information on the reaction of its friendliness to water.

Liquid limit test

200 grams of the dried samples were put on the glass plate and water was gradually added using distilled water and mixed until the sample transformed into a uniform slurry. The cone penetrometer apparatus was

used by filling the ring with the slurry and allowing the cone ring to penetrate through the slurry in the ring as shown in Plate 4. Taking the reading and using equation 2 to calculate the liquid limit of soil.

Plate 4: Liquid limit, Using Cone-Penetrometer

Average plastic limit test for Ijero Kaolin

33.18 grams of the slurry samples were rolled into threads about 3 mm in diameter and kept rolling the samples into thread until they crumbled, the moisture content at which the thread started to crumble is the plastic limit as shown in Plate 5. To determine the Liquid limit on the graph, at 20mm penetration value, the value of the moisture content is the limit: which is equal to 52.6%.

Plate 5: Determination of Plastic limit of the Kaolin Clay

Average plastic limit test for Ode Irele Kaolin

33.18 grams of the slurry samples were rolled into threads about 3 mm in diameter and kept rolling the samples into thread until they crumbled, the moisture content at which the thread started to crumble is the plastic limit as shown in Plate 6.

Plate 6: Determination of plastic limit of the Kaolin Clay

Shrinkage limit test on Kaolin

Part of the slurry samples used for plastic were filled into the shrinkage cone as shown in Plate 3.7 and allowed to dry naturally the length of the internal interval minus the final length. The shrinkage limit is the moisture content at which the samples no longer undergo any significant volume/length change using the formula.

$$SH_{limit} = \frac{L_1 - L_2}{L_1} * 100 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots Eq.3$$

(3)

Before shrinkage After shrinkage

Plate 7: Determination of Shrinkage limit on Kaolin

Chemical analysis of the Kaolin

X-ray fluorescence (XRF) machine were used to analyse the chemical composition of the materials used as shown in Plate 8.

Plate 8: XRF Machine

RESULT AND DISCUSSION

Kaolin content of the extracted clay from the three sites

The kaolin excavated in these three sites are typically white and fine-grained as shown in Plates 9a-c. The kaolin collected from the three states showed that they are all kaolinite ore but with different values of kaolin with the Iwo at the greatest value of 47%, Irele at 42%, and Ijero-Ekiti at the least value of 26%. This is depicted in the results of the chemical analysis of the samples as shown in Figures 1, 2, and 3. The high kaolin content makes them more suitable for applications where low plasticity and high thermal stability are desired. These values are within the ranges of kaolin as deduced in Tantawy (2019).

a) Ijero, Ekiti State b) Iwo, Osun State c) Ode-Irele, Ondo State

Plate 9: Kaolin collected from each site

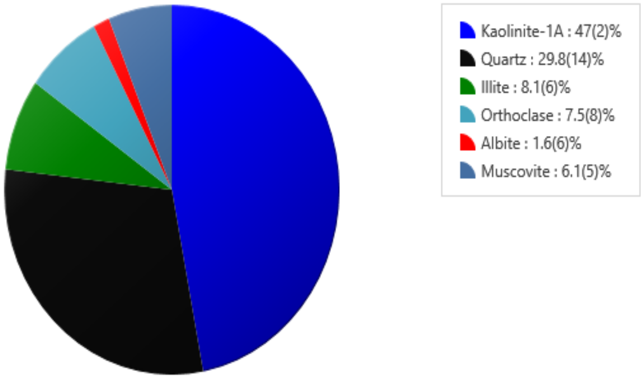

Figure 1: Iwo Kaolin

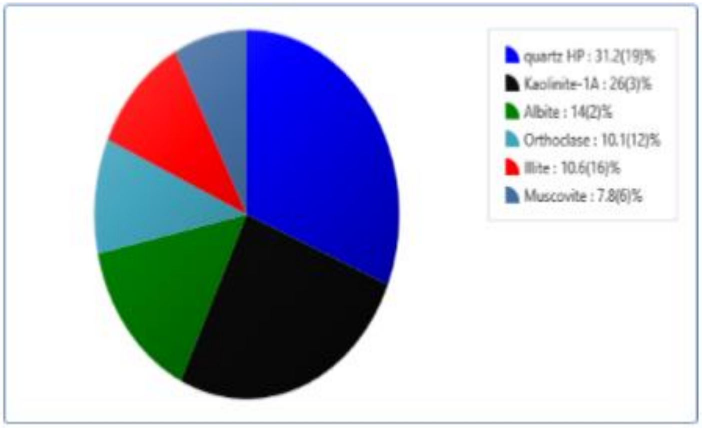

Figure 2: Ijero Kaolin

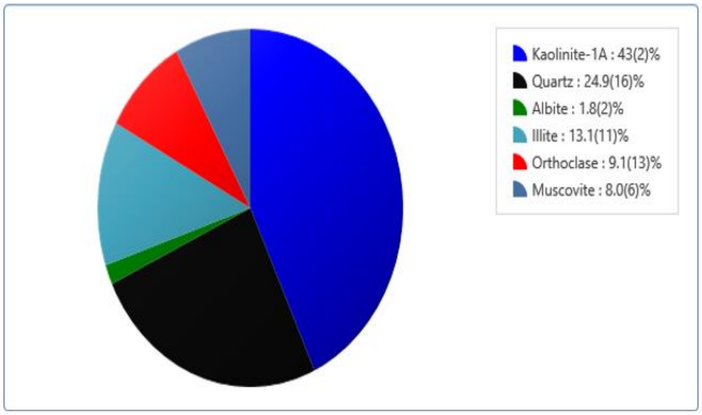

Figure 3: Irele Kaolin

Moisture content and plasticity index of clay from the three sites

The analysis of kaolin clay samples from Ijero-Ekiti, Ode-Irele, and Iwo reveals high plasticity, as indicated by the Atterberg limits in Tables 1-3. This property enhances their suitability for industries such as ceramics, paper production, rubber manufacturing, and pharmaceuticals. High plasticity clays are valued in these sectors for their ability to be shaped and molded into various forms. The kaolin samples were subjected to processes to remove or reduce organic and other impurities, ensuring their suitability for ceramic production. The moisture content of the samples was measured as follows: Ijero-Ekiti (19.9%), Ode-Irele (17.75%), and Iwo (18.86%), as shown in Table 4. Moisture content plays a critical role in the clay's plasticity, workability, and compaction characteristics. Moderate moisture levels across the samples suggest that the clays are generally workable and do not require excessive adjustments for drying or wetting. However, depending on the specific application, some fine-tuning of moisture content may still be necessary to achieve optimal performance.

Recent studies corroborate these findings, indicating that moderate moisture content can enhance the plasticity and usability of clays for industrial applications while maintaining their structural integrity (Biederman & Tan, 2021; Kumar et al., 2022). Additionally, effective impurity removal is crucial for ensuring the quality of kaolin used in high-precision industries (Siddiqui et al., 2023).

Table 1: Average Atterberg Result for Iwo kaolin clay

Test	Liquid limit				Plastic limit		SL
TRIAL	1	2	3	4			
Initial Penetration	7.2	5.5	6.6	7.0			
Final Penetration	24.1	25.3	33.5	36.1			
Actual Penetration (mm)	16.9	19.8	26.9	29.1	A	B	
Can weight (g)	11.04	11.75	16.96	15.93	7.84	14.83	**3.57%**
Can + Wet Soil (g)	33.87	29.50	35.26	38.46	18.16	33.18	
can + Dry Soil (g)	26.06	23.31	28.67	30.17	15.26	27.95	
Moisture Content (%)	52.00	53.55	56.28	58.22	39.08	39.86	
					39.47		

Table 2: Average Atterberg Result for Ode Irele kaolin clay

Test	Liquid limit				Plastic limit		SL
TRIAL	1	2	3	4			
Initial Penetration	5.5	6.2	7.0	6.6			
Final Penetration	21.9	24.9	31.5	36.0			
Actual Penetration (mm)	16.4	18.7	24.5	29.4	A	B	**2.86%**
Can weight (g) = M_1	9.42	13.80	13.09	12.07	9.76	15.82	
Can + Wet Soil (g) = M_2	24.87	31.20	33.30	32.42	28.44	38.77	
can + Dry Soil (g) = M_3	19.67	25.22	26.17	25.07	23.48	32.53	
Moisture Content (%) =	50.73	52.36	54.51	56.54	36.15	37.34	
					36.75		

Note: At 20mm penetration value, the value of the moisture content is the limit value and it is equal to 52.6% as shown in Figure 4 below.

Table 3: Average Atterberg Result for Ode Irele kaolin clay

Test	Liquid limit				Plastic limit		SL
TRIAL	1	2	3	4			
Initial Penetration	5.5	6.2	7.0	6.6			
Final Penetration	21.9	24.9	31.5	36.0			
Actual Penetration (mm)	16.4	18.7	24.5	29.4	A	B	
Can weight (g) = M_1	9.42	13.80	13.09	12.07	9.76	15.82	**2.86%**
Can + Wet Soil (g) = M_2	24.87	31.20	33.30	32.42	28.44	38.77	
can + Dry Soil (g) = M_3	19.67	25.22	26.17	25.07	23.48	32.53	
Moisture Content (%) =	50.73	52.36	54.51	56.54	36.15	37.34	
					36.75		

Table 4: Moisture Content of the Kaolinite Clay

	Ijero sample D	Ode Irele Sample E	Iwo sample B
Mass of the pan = M_1	5g	5g	5g
Weight of the sample+ pan = M_2	24.22g	24.22g	24.22g
Initial weight of sand $M_3 = ((M_2-M_1)$	19.22g	19.22g	19.22g
Final weight of the sample +pan =M_4	19.40g	19.92g	19.65g
Final weight of sand $M_5 = (M_4-M_1)$	14.40g	14.92g	14.65g
Water content $= M_3 - M_5$	4.82g	4.30g	4.57g
Water content percentage $= \frac{M_3 - M_5}{M_3} * 100$	19.90%	17.75%	18.86%

The uniformity coefficient of clay from the three sites

The sieve analysis results for kaolin clay samples from Ijero, Ode-Irele, and Iwo deposits are presented in Tables 5, 6, and 7 and depicted in Figures 4, 5, and 6. These graphs, along with the chemical analysis data in Figures 1, 2, and 3, indicate that the clay samples exhibit similar particle size distribution and chemical composition across the three locations. The uniformity coefficient (Cu), which measures the range of particle sizes, was found to be 1.875 for all samples. A Cu value this low indicates that the soils are poorly graded, meaning they consist largely of particles of similar size. Poorly graded soils, like those found in these kaolin samples, tend to exhibit lower shear strength and may not perform well in foundation or load-bearing applications without proper treatment, such as stabilization techniques. Studies such as those by Singh & Mittal (2020) have shown that poorly graded soils with narrow particle size distributions require additional measures for structural applications to enhance their mechanical properties.

The fineness index for the kaolin deposits was 36.4534 for Iwo, 36.4034 for Ijero-Ekiti, and 36.4042 for Ode-Irele, demonstrating a high level of consistency in particle fineness across the deposits. This uniformity is beneficial in applications where consistent particle size is crucial, such as in the ceramics industry, where fine particles contribute to smoother textures and higher-quality finished products (Ma & Li, 2019). However, finer clays also exhibit higher plasticity and lower permeability, which can pose challenges in geotechnical applications requiring high drainage capabilities (Sridharan & Prakash, 2021). This makes the material potentially unsuitable for drainage-heavy environments unless further treated or modified.

Furthermore, the Atterberg limits confirm that the kaolin samples have a moderate plasticity index, indicating that the clays will have workable moldability but could shrink or expand when exposed to moisture. This plasticity makes the kaolin samples suitable for ceramic and filler applications, where plastic deformation is desired during shaping but controlled shrinkage is necessary during drying and firing (Chauhan & Shukla, 2019). These clays may not be ideal for structural foundation applications due to their low shear strength and poor grading, but their uniformity and fineness make them suitable for ceramic production, as well as other industrial applications where consistent particle behavior is essential. The study aligns with contemporary research emphasizing the importance of particle size distribution and plasticity in determining the usability of clays for various industrial purposes (Sridharan & Prakash, 2021; Ma & Li, 2019).

Table 5: Result of the Sieve Analysis of Ijero Kaolin Clay

Sieve numbers (BS)	Sieve Size (mm)	Sieve Weight (g)	Sieve + soil Weight (g)	Weight of soil Retained (g)	% Retained (%)	Cumulative percent retained	Retained Multiplied by previous sieve number	product
1	9.50	549	0.00	0.00	0.00	0.00	-	-
4	4.75	521	527	6.90	1.38	1.38	6.90*1	6.90
8	2.36	491	528.6	37.60	7.52	8.9	37.60*4	150.4
16	1.18	426	436.9	54.50	10.90	19.80	54.50*8	436
30	0.60	401.3	465.2	63.90	12.78	32.58	63.90*16	1022.4
50	0.30	376	415.7	39.70	7.94	40.52	38.70*30	1161
100	0.15	355	600.2	245.20	49.04	89.56	246.30*50	12315
200	0.075	351.2	378.1	26.90	5.38	94.94	0.15*100	15
	Pan			15.60	3.12		15.6*200	3120
								18226.7

AFS fineness number = Product/ weight of sample

AFS fineness number = 18226.7/ 500

AFS fineness = 36.4534

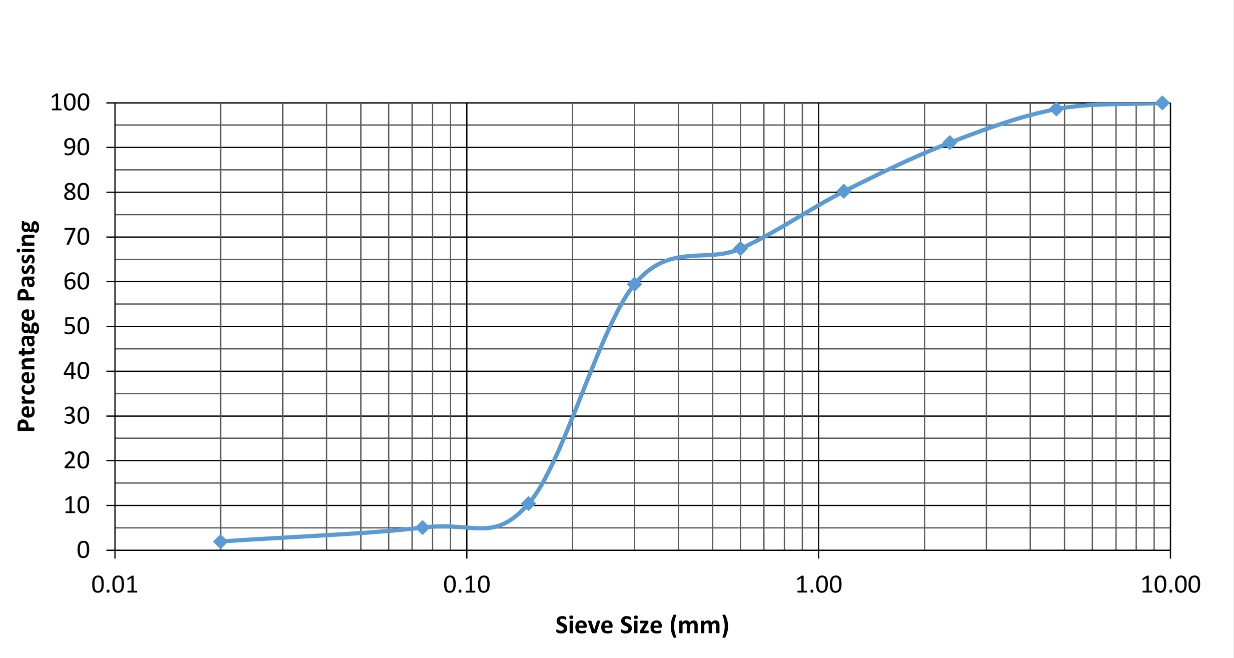

Figure 4: Graph for Sieve Analysis on Ijero Kaolin clay

$$C_u = \frac{D_{60}}{D_{10}} = \frac{0.30}{0.16} = 1.875$$

Table 6: Result of the sieve analysis of Iwo Kaolin Clay

Sieve numbers (BS)	Sieve Size (mm)	Sieve Weight (g)	Sieve + soil Weight (g)	Weight of soil Retained (g)	Retained Multiplied by previous sieve number	Product	% Retained (%)
1	9.50	549	0.00	Nil	-	-	0.00
4	4.75	521	527.9	6.90	6.90*1	6.90	1.38
8	2.36	491	528.6	37.60	37.60*4	150.4	7.52
16	1.18	426	480.5	54.50	54.50*8	436	10.90
30	0.60	401.3	465.2	63.90	63.90*16	1022.4	12.78
50	0.30	376	415.7	39.70	39.70*30	1191	7.94
100	0.15	355	600.2	245.20	245.20*50	12260	49.04
200	0.075	351.2	378.1	26.90	0.15*100	15	5.38
	Pan			15.60	15.6*200	3120	3.12
					Product	18201.7	

AFS fineness number = Product/ weight of sample

AFS fineness number = 18201.7/ 500

AFS fineness = 36.4034

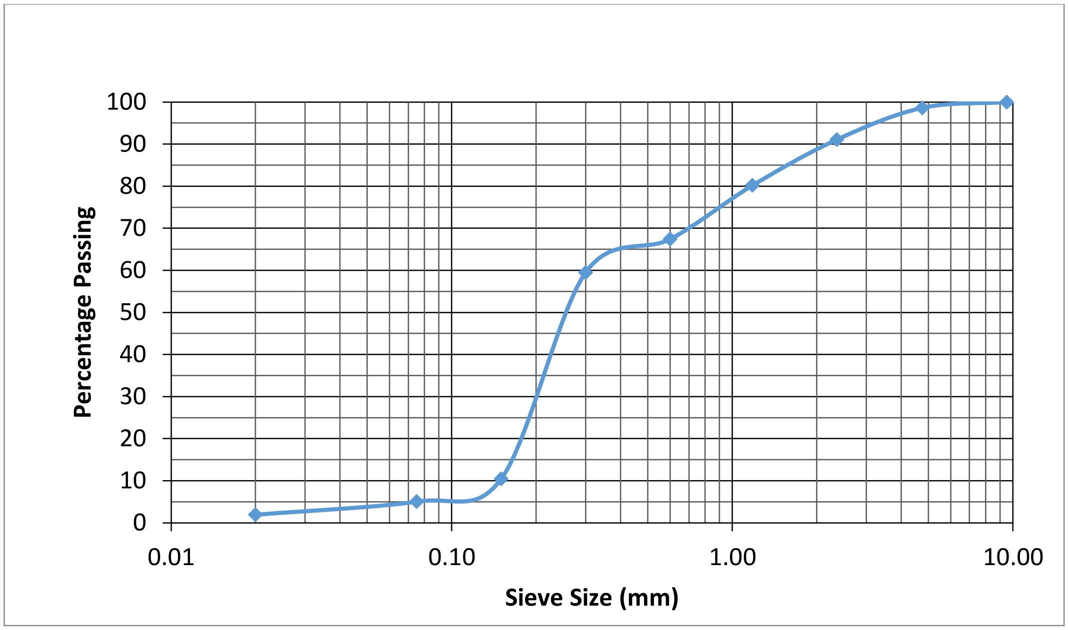

Figure 5: Graph for sieve analysis on Iwo Kaolin clay

$$C_u = \frac{D_{60}}{D_{10}} = \frac{0.30}{0.16} = 1.875$$

Table 7: Result of the sieve analysis of Ode Irele Kaolin Clay

Sieve numbers (BS)	Opening (mm)	Sieve Weight (g)	Sieve + soil Weight (g)	Weight Retained (g)	Retained Multiplied by previous sieve number	product	% Retained (%)
1	9.50	549	0.00	0.00	-	-	0.00
4	4.75	521	527	6.90	6.90*1	6.90	1.38
8	2.36	491	528.6	37.60	37.60*4	150.4	7.52
16	1.18	426	436.9	54.55	54.55*8	436.4	10.90
30	0.60	401.3	465.2	63.90	63.90*16	1022.4	12.78
50	0.30	376	415.7	39.70	39.70*30	1191	7.94
100	0.15	355	600.2	245.20	245.20*50	12260	49.04
200	0.075	351.2	378.1	26.90	0.15*100	15	5.38
Pan	Pan			15.62	15.6*200	3120	3.12
					Product	18202.1	

AFS fineness number = Product/ weight of sample
AFS fineness number = 18202.1/500
AFS fineness = 36.402

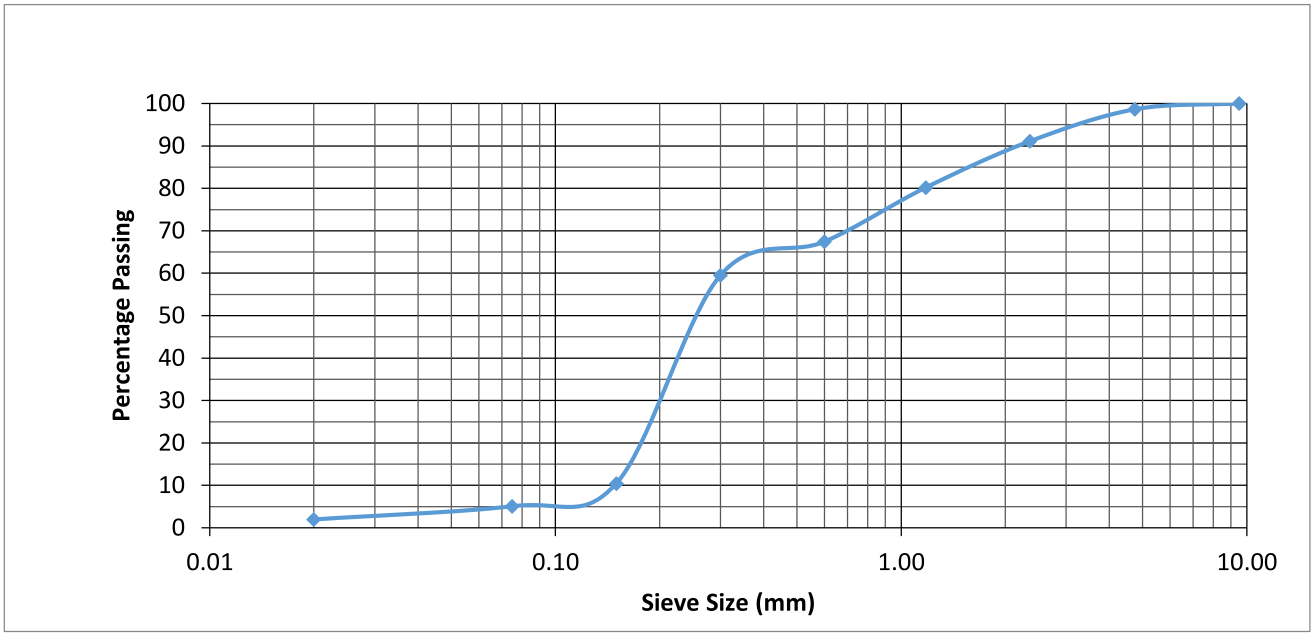

Figure 6: sieve analysis of Ode-Irele Kaolin

$$\boldsymbol{C_u} = \frac{D_{60}}{D_{10}} = \frac{0.30}{0.16} = 1.875$$

CONCLUSIONS AND RECOMMENDATIONS

This comparative study of kaolin deposits in Southwestern Nigeria, specifically from Ijero-Ekiti (Ekiti State), Ode-Irele (Ondo State), and Iwo (Osun State), investigated the mineralogical and physical properties of these deposits, as well as their potential industrial applications. The chemical analysis showed varying kaolin content, with Iwo having the highest kaolin percentage at 47%, Ode-Irele at 42%, and Ijero-Ekiti at 26%. The study also shows that the moisture content across all three sites is moderate, making these clays workable without significant need for additional drying or wetting processes. The kaolin content is notably higher in the Iwo and Ode-Irele deposits compared to Ijero, suggesting that these deposits might be more suitable for industries requiring low plasticity and high thermal stability, such as ceramics, refractories, and high-quality paper production. The fineness index values, which are very close for all three deposits, indicate uniformity in particle size distribution—a critical factor for applications in ceramics and as filler materials in industries like paint and rubber. The uniformity coefficient for all samples is consistent, which further supports their potential to produce materials with predictable and reliable behavior. Despite the promising results, there is a need for better infrastructure and beneficiation processes to enhance the quality and economic viability of these kaolin deposits. Addressing these challenges could significantly contribute to the region's economic development by supporting the manufacturing sector, creating employment, and generating revenue from both domestic and export markets.

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