Advanced Journal of Science, Technology and Engineering
ISSN: 2997-5972
Volume 4, Issue 1, 2024 (pp. 135-143)
www.abjournals.org

QUALITY ASSESSMENT OF IGUE CALCITE DEPOSIT FOR INDUSTRIAL APPLICATIONS

Adakole Sunday[1], Samuel Osarenren Osaghae[2],

Yusuf Inusa[3], and Adakole Sandra[4]

[1]Department of Mineral and Petroleum Resources Engineering Technology, Auchi Polytechnic, Auchi, Edo state, Nigeria.
Email: adakolesunday@rocketmail.com

[2]Geological Technology Department, Auchi Polytechnic, Auchi, Edo, Nigeria.
Email: sammyosaghae@gmail.com

[3]Department of Mineral and Petroleum Resources Engineering Technology, Auchi Polytechnic, Auchi, Edo state Nigeria.
Email: yusufigwemi@yahoo.com

[4]Department of Mineral and Petroleum, Resources Engineering Technology, Auchi Polytechnic, Auchi, Edo state, Nigeria.
Email: orumasandra3@gmail.com

Cite this article:

Adakole S., Samuel O. O., Yusuf I., Adakole S. (2024), Quality Assessment of Igue Calcite Deposit for Industrial Applications. Advanced Journal of Science, Technology and Engineering 4(1), 135-143. DOI: 10.52589/AJSTE-2LTZKTM7

Manuscript History

Received: 11 Feb 2024

Accepted: 8 Apr 2024

Published: 18 Jun 2024

ABSTRACT: *Calcite is one of the primary components of marble and limestone, they made up a significant amount of the crust of the Earth. The goal of the study is to characterize the Igue calcite deposit. Samples were sourced from five different pits, which were homogenized and eventually weighed five kilograms. Of that amount, one kilogram was set aside for laboratory testing and analysis. The sample was first crushed to a size of 1400 µm and then further reduced to 1100 µm using a ball mill. 100 grams of the sample was riffled out for sieve analysis, the particles were classified into 1000µm, 710µm, 500µm, 355µm, 250µm, 180µm, 125µm, 90µm, 63µm, and -63µm, and 125 µm sieve size was sampled out for chemical analysis using an X-ray fluorescence spectrometer. The particle size distribution methods that were employed were the Gates Gaudin Schumann Method and the Rosin Rammler Method. The economic and actual liberation size is at sieve 180µm and 125µm respectively, according to the sieve analysis result mid points is at 49.26% which is the equilibrium point on the graph. The results of the chemical study indicate that the Igue white calcite deposit contains the following elements: Mg, Al, Si, P, S, K, Ca, Ti, V, Cr, Mn, Co, Fe, Ni, Cu, Zn, As, Pb, W, Au, Ag, and Rb with the mean concentrations of the following: 0.0000, 0.4257, 0.6757, 0.2845, 0.4199, 0.0000, 67.9587, 0.0000, 0.0009, 0.0000, 0.0000, 0.0000, 0.1958, 0.0061, 0.0090, 0.0175, 0.0000, 0.0000, 0.0000, 0.0000, 0.0005 and 0.0000 respectively and intensities of : 0.0000, 0.0014, 0.0076, 0.006, 0.0059, 0.0000, 0.6923, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0012,0.0002, 0.0005, 0.0006, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, Igue white calcite has a good calcium content and intensity, with calcium being the predominant element in the sample and having the following intensity of 0.6923 and content of 67.9587.*

Article DOI: 10.52589/AJSTE-2LTZKTM7
DOI URL: https://doi.org/10.52589/AJSTE-2LTZKTM7

INTRODUCTION

For the residents of Edo North, where Igue is located, agriculture used to be the main source of revenue and a stable economic system. But in the last 20 years, quarrying has become a major industry in these places, and most of the people who work in these quarries are illiterate men and women who don't know about the environmental repercussions of what they do because they don't know enough or don't follow safety protocols. There are many different types of quarrying businesses in these areas, ranging from manual stone-crushing operations to small- and medium-sized businesses that use massive machines to smash stones. A quarry is an open excavation used for the extraction of any desired stone for use in engineering, construction, and other fields. Actually, there are several occupational dangers associated with stone crushing (Odeyemi, 1976).

Calcite is a common mineral that can be found on earth. Its occurrences vary in shape and color depending on the region and a larger portion of the rocks on earth are its constituents. Calcite belongs to the calcite group, which is a family of minerals that naturally isomorphizes with carbonate (Thompson, 2008).

Oyawoye, (1967) and Ajibade, *et al.,* (1988) Because of their many physical similarities, calcite and other solid solution series can be used wholly or partially in place of one another. Perfect rhombohedral characteristics and a strong twofold reflection of a distinct rhombohedrous structure are evident in the cleavage of calcite. Along the trigonal system, calcite crystallizes.

Anthony *et al.,* (2003) Calcite is a mineral that produces rocks. Its chemical formula is CaCO3. Calcite is generally found in igneous, sedimentary, and metamorphic rocks worldwide. Most geologists believe it to be a "ubiquitous mineral," which means it can be found anywhere. Calcite is one of the primary components of marble and limestone. Because they were so common, they made up a significant amount of the crust of the Earth.

Calcite is the planet's main source of carbon. Calcite has more uses than any other mineral, such as an abrasive, pigment, aggregate and building material, and more (Dana, *et al.,* 2005).

When evaluating calcite's quality, it's critical to take into account a number of variables, including impurity levels, crystalline structure, and purity. Higher purity levels indicate a higher grade. Purity is important since it affects the calcite sample's overall quality and worth. Calcite's crystalline structure, which includes elements like crystal size and form, can also affect the material's quality and its uses. Furthermore, the color, clarity, and general quality of the calcite might be impacted by impurities like iron, manganese, or other minerals (Zhang & Vaksman, 2019).

According to Smith et al. (2019) it's critical to take into account a number of variables, including purity, hardness, transparency, and overall structural integrity, while evaluating the quality of white calcite. This evaluated the quality of the white calcite specimens using methods like electron microscopy and X-ray diffraction. Their results demonstrated the significance of crystal uniformity and purity in assessing the general quality of white calcite samples.

In addition, evaluating the quality of white calcite also entails looking at elements that could impact its durability and beauty, such as color uniformity, the absence of inclusions, and any

Article DOI: 10.52589/AJSTE-2LTZKTM7
DOI URL: https://doi.org/10.52589/AJSTE-2LTZKTM7

possible fractures or cleavage planes. One may ascertain the total worth and suitability of white calcite for a variety of applications in industries including manufacturing, jewelry making, and building by carrying out a thorough quality assessment based on these parameters (Smith *et al.*, 2019).

Geology and the location of the Study area

Igue, which is a component of the Igarra schist band in southwest Nigeria, is located in the northern portion of Edo and shares the same geology as Ikpeshi, which is located between latitudes 7008'N and 7010'N and longitudes 6010'E and 6015'E. It is composed of Polyphase Deformation-affected Metasedimentary rocks (marble, calc-silicate, schist, and amphibolite) invaded by Pan-African Post-Tectonic Granitic Rocks (600–150 million years old). The majority of the rocks in the area are quartz, k-feldspar, plagioclase, mica, muscovite, and calcite, with opaque minerals serving as accessory minerals, according to minerological study. More than three phases of deformational episode have been recognized in the rocks of this area. The formation of the regional foliation, which included tight, open, and close to isoclinal folds, was linked to the first phase. This was followed in an extensional tectonic environment by the heterogeneous deformation that resulted in ductile shear zones. The third step produces the dominant primary folding along an approximate NW-SE axis, whereas the fourth phase is associated with open folds added to the preexisting structures. The structural element in the analyzed area shows multidirectional orientations. The majority of the rocks in the research region follow a NNW–SSE trend, with a few deviating from N-S to NE-SW, which is suggestive of Pre-Pan-African orogeny, according to stereographic projection and rose diagrams. Plots indicate that the other, less evident patterns in the E-W and NEE-SWW orientations are remains of African orogenic episodes that occurred before Pan. (Agomuo et al. 2016).

these Global Positioning System (GPS) readings shows the location of the study area (Igue); 60 3’ 7” E longitude; 70 8’ 42” N latitude,60 12’ 37” E ,longitude (180m above sea level)Compass reading 70 8’ 42” N latitude 60 12’ 36” E longitude (150m above sea level).

METHODOLOGY

Sampling collections and analysis

Using a random sampling technique, ten (10) kilograms of the samples were taken from five (5) separate pits at the Igiue Calcite Mines Field in the Etsako West Local Government Area of Edo State, Nigeria. Using the cut and quartering process, the samples were completely combined and homogenized to produce a homogenous sample.

The lumpy calcite sample was crushed to 5000µm, then split into two parts by running it through a set of sample splitters. A portion of the sample, weighing 5 kg, was then crushed to 3000µm using a secondary crusher to reduce its size. The calcite sample was crushed until 100% of it passed through a sieve mesh of 1100µm, and 1 kg of it was ground using a ball mill. A sub sample, weighing 100 g, was then measured and poured into arrays of standard sieve sizes, including 1000µm, 710µm, 50µm, 355µm, 250µm, 180µm, 125µm, 90µm, 63µm, and -63µm. The sub sample was then placed on an automated sieve shaking machine

Article DOI: 10.52589/AJSTE-2LTZKTM7
DOI URL: https://doi.org/10.52589/AJSTE-2LTZKTM7

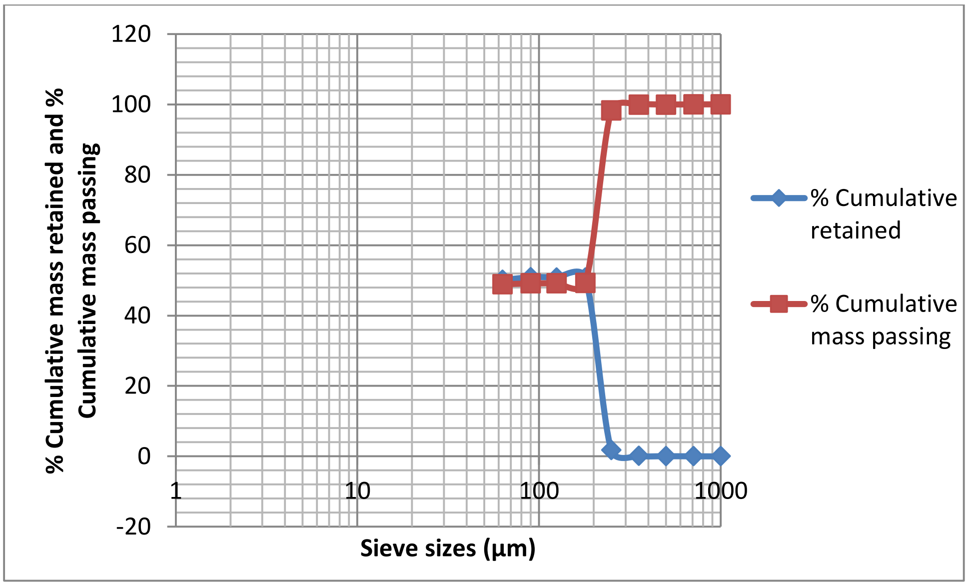
for 10 minutes, during which time the particles retained on each sieve size were weighed and recorded.

X-ray Fluorescence Spectrometer operations, Sample preparation: For non-homogeneous sample, sample will be pulverized to fine homogenous size and then pelletized. Sample testing Start, initialization (calibration), using pure silver standard, select the working curve according to the sample, test sample, output to Excel, and End.

RESULTS

Table 1: Result of Sieve size analysis of Igue calcite deposit

Sieve size (μm)	Sieve size range (μm)	Weight retained (g)	% weight retained retained	Cumulative weight retained (%)	Cumulative Weight passing (%)
1000	1000	0.00	0.00	0.00	100
-1000+710	710	0.03	0.03	0.03	99.97
-710 + 500	500	0.03	0.03	0.06	99.94
-500 +355	355	0.08	0.08	0.14	99.86
-355+ 250	250	1.60	1.61	1.75	98.25
-250 + 180	180	48.56	48.98	50.73	49.27
-180 + 125	125	0.08	0.08	50.81	49.19
-125 + 90	90	0.06	0.06	50.87	49.13
-90 +63	63	0.23	0.24	51.11	48.89
-63	Pan	48.47	48.89	100.00	0.00
Total		99.14			



Article DOI: 10.52589/AJSTE-2LTZKTM7
DOI URL: https://doi.org/10.52589/AJSTE-2LTZKTM7

Figure 1 graph of %cumulative mass retain and %cumulative mass passing against sieve sizes for Igue quarry.

Table 2: Gates Gaudin Schumann Method of Particles Size Distribution.

Sieve size (x) (µm)	Mass passing (P) (%)	$P/100$	$\text{Log}(P/100)$	Log (x)
1000	100	1.000	2.0000	3.0000
-1000+710	99.97	0.9997	-0.0001	2.8513
-710 + 500	99.94	0.9994	-0.0003	2.6990
-500 +355	99.86	0.9986	-0.0006	2.5502
-355+ 250	98.24	0.9824	-0.0077	2.3979
-250 + 180	49.26	0.4926	-0.3075	2.2553
-180 + 125	49.18	0.4918	-0.3082	2.0969
-125 + 90	49.12	0.4912	-0.3087	1.9542
-90 +63	48.89	0.4889	-0.3108	1.7993
PAN(-63)	0.00	0.0000	0.0000	0.0000

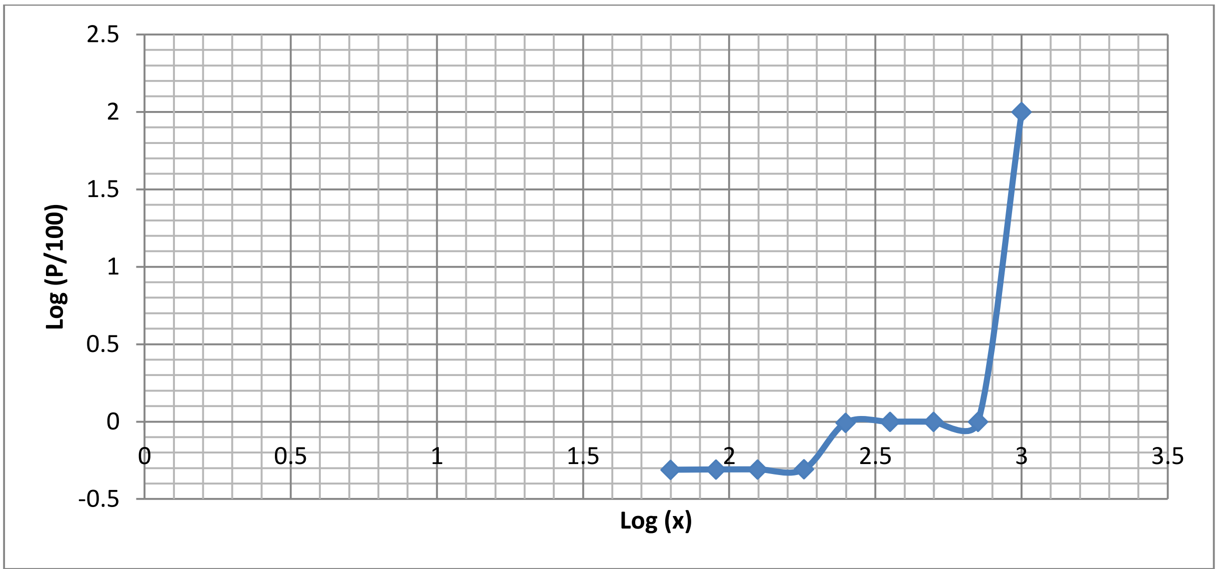


Figure 2: Showing the graph of Log $(P/100)$ on the vertical axis againt log(x) on the horizontal axis using Gates Gaudin Schumann method.

Article DOI: 10.52589/AJSTE-2LTZKTM7
DOI URL: https://doi.org/10.52589/AJSTE-2LTZKTM7

Table 3: Rosin Rammler Method of Particles Size Distribution

Sieve size (x) (µm)	Mass retained(R) (%)	$(^{100}/_{R})$	In$(^{100}/_{R})$	Log(In$^{100}/_{R}$)	Log (X)
1000	0.00	0.0000	0.0000	0.0000	3.0000
-1000+710	0.03	3333.3	8.1117	0.9091	2.8513
-710 + 500	0.06	1666.7	7.4186	0.8703	2.6990
-500 +355	0.14	714.29	6.5713	0.8177	2.5502
-355+ 250	1.76	56.818	4.0399	0.6064	2.3979
-250 + 180	50.74	1.9708	0.6784	-0.1685	2.2553
-180 + 125	50.82	1.9677	0.6769	-0.1695	2.0969
-125 + 90	50.88	1.9654	0.6757	-0.1702	1.9542
-90 +63	50.11	1.9956	0.6909	-0.1606	1.7993
PAN(-63)	100.00	1.0000	0.0000	0.0000	0.0000

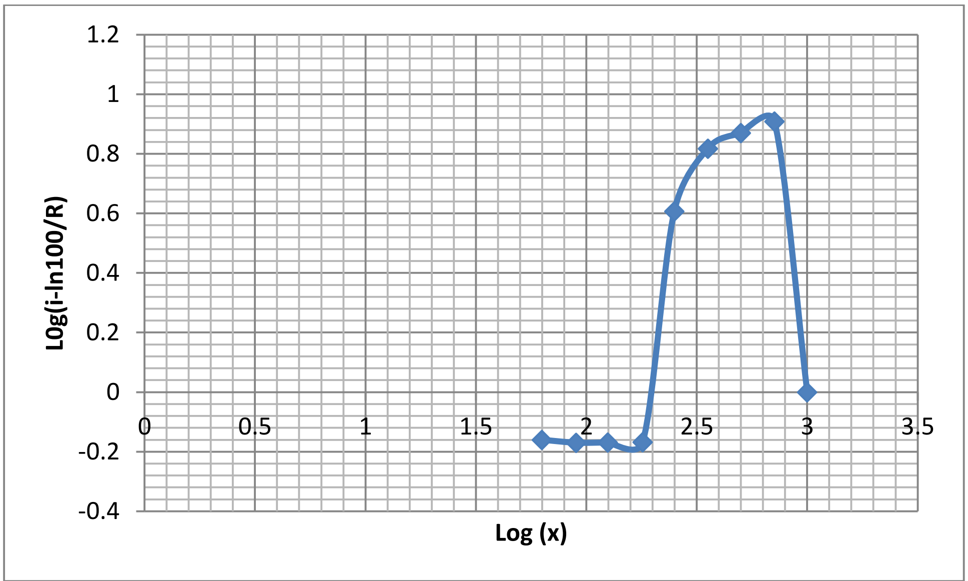


Figure 3 Showing the graph of Log(In $^{100}/_{R}$) on the vertical axis againt log(x) on the horizontal axis using Rosin Rammler method

Table 4: X-ray Fluorescence Spectrometer (Chemical) Analysis

Sample	Calcite	
Voltage(KV)	40	
Current(µA)	350	
Element	Intensity	Content
Magnesium(Mg)	0	0
Aluminum(Al)	0.0014	0.4257
Silicon(Si)	0.0076	0.6757
Phosphorous(P)	0.0060	0.2845

Article DOI: 10.52589/AJSTE-2LTZKTM7
DOI URL: https://doi.org/10.52589/AJSTE-2LTZKTM7

Sulphur(S)	0.0059	0.4199
Potassium(K)	0	0
Calcium(Ca)	0.6923	67.9587
Titanium(Ti)	0	0
Vanadium(V)	0	0.0009
Chromium(Cr)	0	0
Manganese(Mn)	0	0
Cobalt(Co)	0	0
Iron(Fe)	0.0012	0.1958
Nickel(Ni)	0.0002	0.0061
Copper(Cu)	0.0005	0.009
Zinc(Zn)	0.0006	0.0175
Arsenic(As)	0	0
Lead(Pb)	0	0
Tungsten(W)	0	0
Gold(Au)	0	0
Silver(Ag)	0	0.0005
Rubidium(Rb)	0	0

DISCUSSION

Table 1 summarizes the results of the sieve analysis on Igue white calcite. Based on the table, it was found that the economic and actual liberation size starts at 180 µm and 125 µm respectively and most of the particles are retained at these sieve sizes. The mid points, however, are 1.56% to 1.22%; this value is obtained by deducting the percentage cumulative mass passing from the percentage of cumulative mass retained from 180 µm to 63 µm.

Figure 1 show the Igue quarry's cumulative mass retained and cumulative mass passing graphs plotted against sieve sizes. This demonstrates that the cumulative mass retained and passing is at equilibrium at 49.26%, or around 50%; this suggests that the economic liberation size is 180 µm and actual liberation size is 125 µm.

Calcite, which has the chemical formula $CaCO_3$, has an intensity of 0.6923 and calcium content of 67.9587, along with other elements that are listed in table 4 above, according to the chemical analysis. This indicates that the economic liberation size ranges from 180 µm to 63 µm, with the 6.52% midpoints shown. With 50% displayed at the graph's equilibrium points. The particle distribution curve for these calcite deposits is good, and the midpoint appears to be more accurate. The following elements are shown by the chemical analysis to be present in the sample: calcium, which is the main component, and the following: Mg, Al, Si, P, S, K, Ca, Ti, V, Cr, Mn, Co, Fe, Ni, Cu, Zn, As, Pb, W, Au, Ag, and Rb.

The Igue research area's mineral and rock formations have the potential to be economically significant for the production of Portland cement, which contains less than 2% magnesium, 0.5% total alkalies, and 67.9587% calcium carbonate ($CaCO_3$). Ash Grove Cement Company in Nebraska, USA, employed cement with a calcium carbonate ($CaCO_3$) percentage as low as 69.75% (Wheeler 1999). The deposits under investigation satisfy the trace level and

Article DOI: 10.52589/AJSTE-2LTZKTM7
DOI URL: https://doi.org/10.52589/AJSTE-2LTZKTM7

acceptable lower grades of less than 98% calcium carbonate ($CaCO3$) specified by Duncan's (1963) recommendation for rock deposits utilized in the manufacturing of lime.

This deposit is appropriate for use as road base, aggregate, and concrete. Due to the high purity requirement of the calcium carbonate concentration, which should not be below 98%, the deposit in this site may not find significance in the manufacturing of glass, refractories, chemicals, sugar refining, and soda ash (Penuel et al., 2015).

CONCLUSION

This study provides a comprehensive assessment of igue calcite deposits for industries utilization, it can then be concluded that:

(i) The economic and actual liberation size starts at 180 µm and 125 µm.

(ii) The intensity of Igue calcite is 0.6923 and calcium content of 67.9587.

(iii) The particle distribution curve for these calcite deposits is good, and the midpoint appears to be more accurate.

(iv) The following elements Mg, Al, Si, P, S, K, Ca, Ti, V, Cr, Mn, Co, Fe, Ni, Cu, Zn, As, Pb, W, Au, Ag, and Rb are present in the calcite sample.

(v) The calcite deposit deposit is appropriate for use as road base, aggregate, and concrete.

(vi) Finaly, given that the percentage carbonate content of the calcite collected in the Igue research area is above normal, it can be used to produce animal feed, Portland cement, and medicinal drugs. It can be utilized to create dimension stones, ceramics, putty, vinyl flooring, carpet backing, adhesive, and asphaltic items. Additionally, according to the British Standard Institute (1983), they make good aggregate for cement. The results suggest that the sample location's composition contains the highest amount of calcite (67.9587), followed by Si > Al > Fe > other elements.

AKNOWLEDGEMENT

We, the researchers, appreciate the student of Mineral and Petroleum Department, School of Engineering, Auchi polytechnic, Auchi, Edo state, Nigeria who helped us to acquire samples for analysis, processing and as well as interpretation of the processed data. Their hard work and dedication will always be remembered.

Article DOI: 10.52589/AJSTE-2LTZKTM7
DOI URL: https://doi.org/10.52589/AJSTE-2LTZKTM7

REFERENCES

Agomuo M. S and Egesi N. (2016) Petrology and structural geology of Ikpeshi and it's environ of Igarra schist belt Southwestern Nigeria International journal of Science Inventions Today (IJSIT), 5(4): 303-319

Ajibade, A.C. and Wright J.B., (1988). Structural Relationship in the schist Belts of North Western Nigeria. *publication of Geological survey*: 103-109.

Anthony. J. W.; Bideaux, R. A.; Bladh. K. W.; Nichols. M. C. (2003). "Calcite". Handbook of Mineralogy. V (Borates, Carbonates, Sulfates). Chantilly, VA, US: Mineralogical Society of America. ISBN 978-0962209741.

Dana, J.D., Klein, C., Hurlbut, C.S. (2005) Manual of Mineralogy, ISBN 0-471-80580-7: 329.

Duncan, A. (1963). "Recommendations for Calcium Carbonate (CaCO3) Specifications in Lime Manufacturing: A Review." *Journal of Geological Resources*, 18(2): 145-156.

Odeyemi, I.B (1976). Prelimnary report on the field relationship of the Basement Complex rocks around Igarra, Midwest Nigeria, In Geology of Nigeria, edited by C.A Kogbe Elizabeth Pub Lagos: 59 – 63.

Oyawoye, M. O., (1967). The Geology of the Nigerian Basement Complex. *Journal Mining and Geology*. 1: 67-70.

Penuel, B.L., Maitera, O.N., Khan, M.E., Kefas, W.S. (2015). Quality assessment of limestone deposit found in Demsa local government area of Adamawa state, Nigeria. *Direct Research Journal of Chemistry and Material Science* (DRCMS) 3(2): 11-16.

Smith, J., Brown, A., Johnson, C. (2019). Quality Assessment of White Calcite: A Chemical and Structural Analysis. *Journal of Mineralogy and Geology*, 16(3): 112-125.

Thompson, D. W.; Devries, M. J.; Tiwald, T. E.; Woollam, J. A. (2008). "Determination of optical anisotropy in calcite and dolomite from ultraviolet to mid-infrared by generalized ellipsometry". Thin Solid Films. 313–314 (1–2): 341–346. Bibcode:1998TSF...313..341T . doi:10.1016/S0040-6090(97)00843-2.

Wheeler, R. (1999)."Utilization of Low Calcium Carbonate Content Cement by Ash Grove Cement Company: A Case Study." *Journal of Cement Research*, 27(4): 451-463.

Zhang, Y., Vaksman, Z. (2019). Quality Assessment of Calcite Samples. *Journal of Mineralogical Research*, 25(3): 102-115.

Article DOI: 10.52589/AJSTE-2LTZKTM7
DOI URL: https://doi.org/10.52589/AJSTE-2LTZKTM7