PRELIMINARY CHARACTERIZATION OF ABA-ISU LIMESTONES DEPOSIT IN AROCHUKWU LOCAL GOVERNMENT AREA OF ABIA STATE, SOUTH-EASTERN NIGERIA.

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Abstract

Geological transverse revealed the trend of the deposit to be in SE-NW direction and consists of limestone exposure of thickness of about 5-6m in some places with sand/sandstones intercalations. Petrographic studies showed that the percentage mineral grain is estimated to be 48% calcite, 43% quartz and 9% plagioclase as minor mineral. The limestone has fine to medium grained granular mosaics without any fossil. It is laminated to thinly bedded, laterally extensive and tabular. It is essentially calcite in form of grain matrix and carbonate compound which suggested to be precipitated from solution. Chemical analysis reveals that the limestone samples contain CaO_2 and SiO_2 as the major constituents. Al_2O_3 and Fe_2O_3 form the minor constituents while MgO_2 and SO_2 are present in traces. LOI of the limestone samples varies from (2.15 to 39.23%); the lime content varies from (0.1-49.15%); the LOI content is mostly contributed by the carbonate minerals. The chemical composition of the limestone reflects its mineralogical composition. The element Mg, Al, Si, S, O, Ca and Fe dominantly reflect the elastic sediment contribution. The limestone shows good qualities in the Southeast areas that can be used for cement production and low quality in other places especially in the Northwestern area of the study area which may require some form of beneficiation or enrichment before usage as raw material for cement production.

Keywords: *Limestone; petrography, geochemistry, Arochukwu, Nigeria, limestone,*

INTRODUCTION

Geological reports show that Nigeria has a strong mining potential of known major mineral deposits distributed in various locations across the country and offers considerable attraction for investors. The mineral exploitations and industrial development that are minerals based, in no small way, will contribute to the socio-economic transformation of the Nation through job creation, improved standard of living, enhance foreign exchange and increase revenues. This is made possible by taking from the environmental local resources and paying back by adding value to them through better standard of living. The role of limestone in industrialization and civilization is self-evident in every city of the world today in the new millennium, Nigerian engineers and scientists are battling to ensure the availability and utilization of this natural gift to her population, adequate knowledge of the mineral deposit and quality is essential for planning and development. It is for this purpose among others that this study undertook the petrography and characterization of Aba-Isu limestone deposit. This information will go a long way to help in the exploration and perhaps exploitation of the deposit. The study area for most part of the year is marshy and water logged, the vegetation is thick to medium forested, inter-spaced with banana plantations, cassava and (Onwuejeogwu, 1981) rice farmlands. The deposit lies essentially within latitudes 5^0 22' 29" and 5^0 23' 15".Longitudes 8^0 00' 16"and 8^0 01' 58"16"and 8^0 01' 58" (Fig. 1.).

Geology of the Study Area.

The study area is underlain by the sedimentary terrain of Southeastern Nigeria. The rocks belongs to the Calabar Flank that forms part of the Southeastern continental margin lying between the Cameroon volcanic trend on the East, Ikpe Platform on the west/Imo Formation, Oban Massif to the north and Calabar hinge line

to the South (Ehinola *et al.*, 2008). Some earlier workers classified the Calabar Flank as part of the Benue Trough sedimentary Basin (Reyment, 1963; Kogbe, 1976;

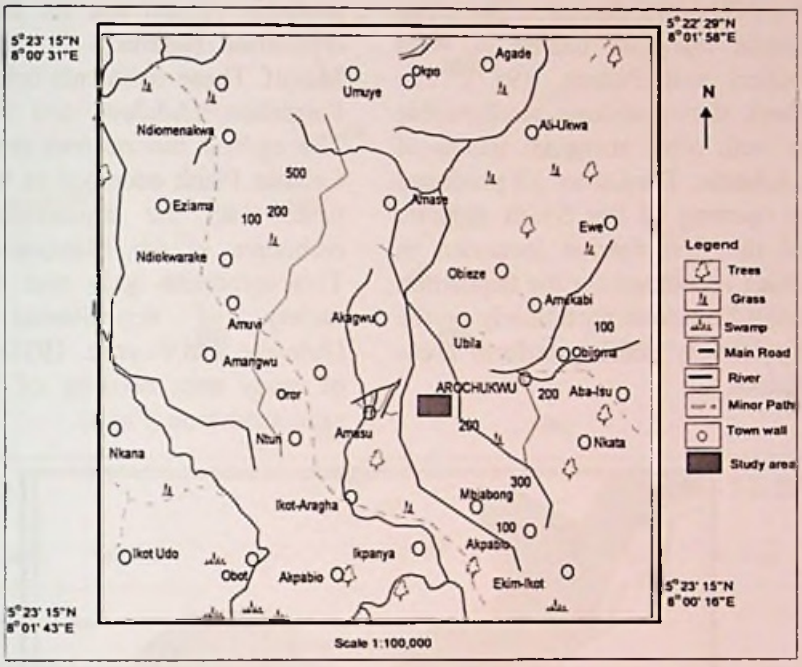


Fig. 1 Location map of the Arochukwu and Aba-Isu areas (Extracted from topographic map of Nigeria sheet 156 Federal Survey 1989)

Ramanathan and Fayoze, 1990). Further studies carried out by (Reyment (1965), Kogbe (1978), Ramanthan and Fayoze (1990) and Iwobi (1991) included biostratigraphy of deposit of Cretaceous carbonates, depositional environment and diagenesis of Abian carbonates, and Cretaceous transgressions and regressions. The Calabar Flank is believed to be part of the continental margin of Nigeria dominated by block fault with NW-SE trending horst and graben structures, such as the Ituk high and Ikang trough (Ehinola *et al.*, 2008). The Calabar Flank contains up to 4000 m of Albian to Maastrichtian marine sediments. The sedimentary succession in the study area comprises basal (Aptian arkosic) sandstone disconformably overlain by the Albian Asu River Group (Reijers, 1998). The ASU River Group consists of Awi formation (Neocomian Aptian) and the Mfamosing Limestone Formation (Albian).



Fig. 2 Geological map of Nigeria showing Aba-Isu limestone deposit (Extracted from geological map Geological Survey Agency of Nigeria GSAN 2006)

Structurally, the Calabar Flank consists of basement horsts and grabens that are aligned in a NW – SE direction like other South Atlantic marginal basins in West Africa (Reijers and Petters, 1987). The Calabar Flank shows striking stratigraphic similarities with other marginal basins of the South Atlantic. They were all produced during the opening of the South Atlantic Ocean and the first marine incursion in Middle Albian accounted for the deposition of Mfamosing limestone particularly on the horst and relatively stable platform areas and their flanks.

Sedimentation started in the Calabar Flank with deposition of fluvio-deltaic clastics of probably Aptian age on the Precambrian crystalline Basement Complex, the Oban Massif. These sediments belong to the Awi Formation (Adeleye and Fayose, 1978). The earliest marine transgression into the Calabar Flank occurred in the Mid-Albian times with the deposition of platform carbonate of the Mfamosing Limestone. This carbonate body was deposited in a variety of depositional environment (Adeleye and Fayose, 1978). The geology of study area consists of limestone and sand/sandstone (Fig.3).

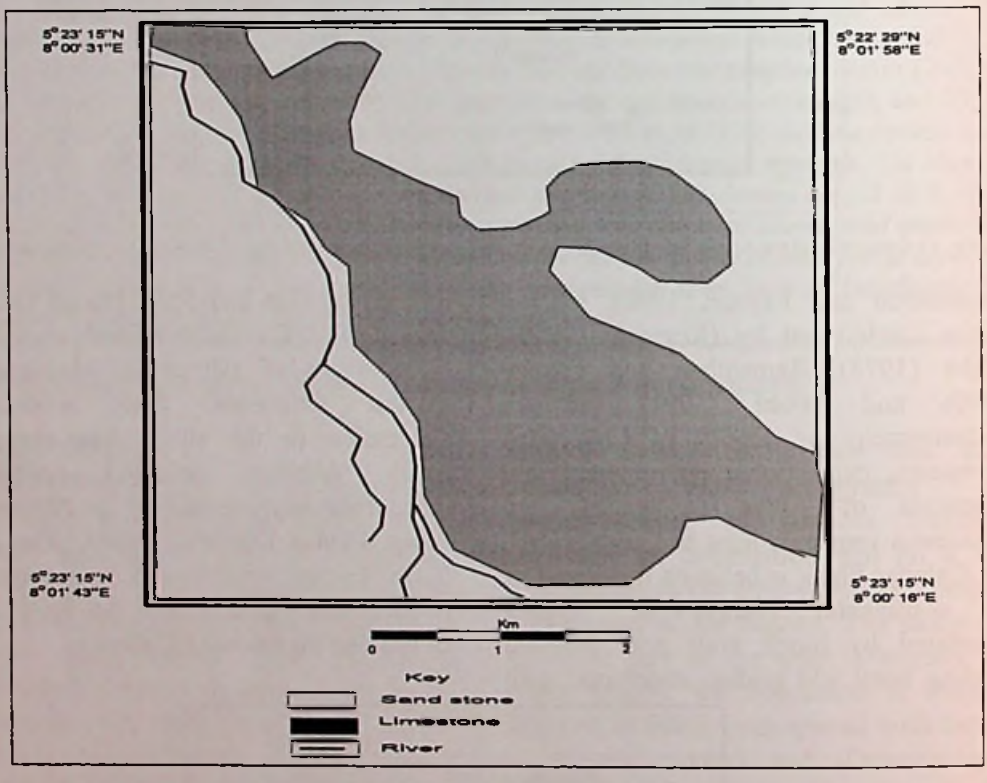


Fig. 3 Geologic map of Aba-Isu limestone deposit site.

METHODOLOGY:

A reconnaissance survey was carried out at the study area, sampling was done in a gridded pattern and samples were collected at different stratigraphic succession along the profiles at regular intervals in a systematic manner to ensure fair representation of the area. A total of twenty one 21 limestone samples were taken, 11 surface and 10 pit samples at a minimum of 1m depth. The samples were taken along profiles perpendicular to the established central line axis (CLA) which is considered to be roughly parallel to the general (regional) geological structure of the rocks in the study area. This was done to enhance the quality of the analyzed result. The samples collected were taken to laboratory for treatment and standard laboratory preparation prior to analysis. Geochemical analysis was done using an X–Ray Fluorescence Spectrophotometer and Atomic Absorption Spectrophotometer for major as well as trace element in the samples (Fig.4).

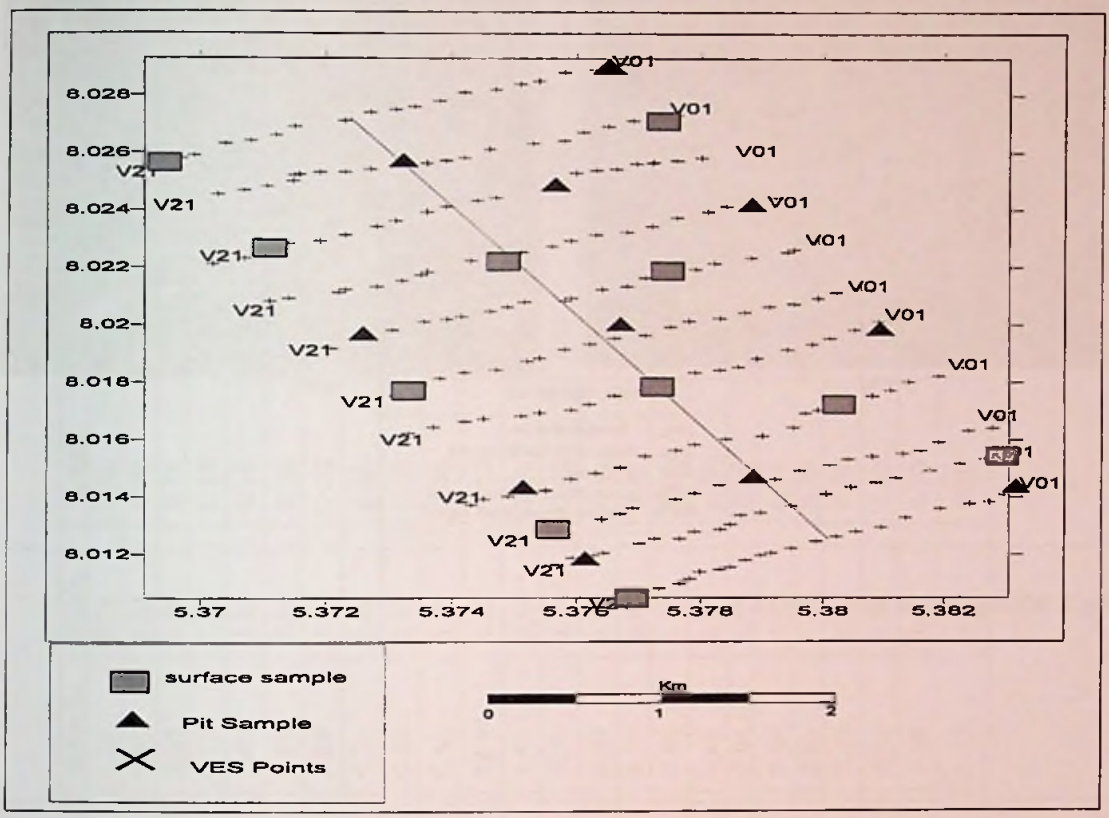


Fig.4 Schematic Map of the study area (Aba-Isu) showing sampling points.

RESULTS and DISCUSSION

A clear appearance in ppl, no cleavage, grey to white and sometimes creamy may be inferred to quartz mineral. Multiple twinning is a behavior of plagioclase minerals which was observed in the thin section. It also reveals interlocking crystals, clear to yellow and good cleavage which is an indication of calcite (Figs.5-9). The appearance of black materials in ppl as well as xpl is a reflective of opaque minerals. Further studies was enhanced by point count method for each mineral and individual percentages of modal analysis reveals that the calcite component dominate the SW portion of the deposit, while almost equal proportion of minerals were observed in the Northern portion of the deposit, the percentage mineral grain is estimated to be 48% calcite, 43% quartz and 9% plagioclase modified. This limestone rocks have fine to medium grained granular mosaics without any fossils. Calcite is generally fine grained but patches of medium to coarse grained anhedral calcite are also common, the medium to coarse grained calcite crystals are generally interlocked and contain inclusions of silicates minerals Ouartz occurs in the form of subhedral medium grained and detrital material. The calcite of this limestone deposit seems to be authigenic in origin and has been precipitated insitu. Micro fractures filled with fine grained calcite micro veins which are considered to be diagenetic clay and iron in trace amounts are present as fine grained disseminated material in many samples. The petrographic thin section reveals that the sample contains calcite as the major mineral phase while quartz and plagioclase as the minor silicate gangue mineral. No other mineral phases were observed, the limestone is fine to very fine-grained, laminated to thinly bedded, laterally extensive and tabular.

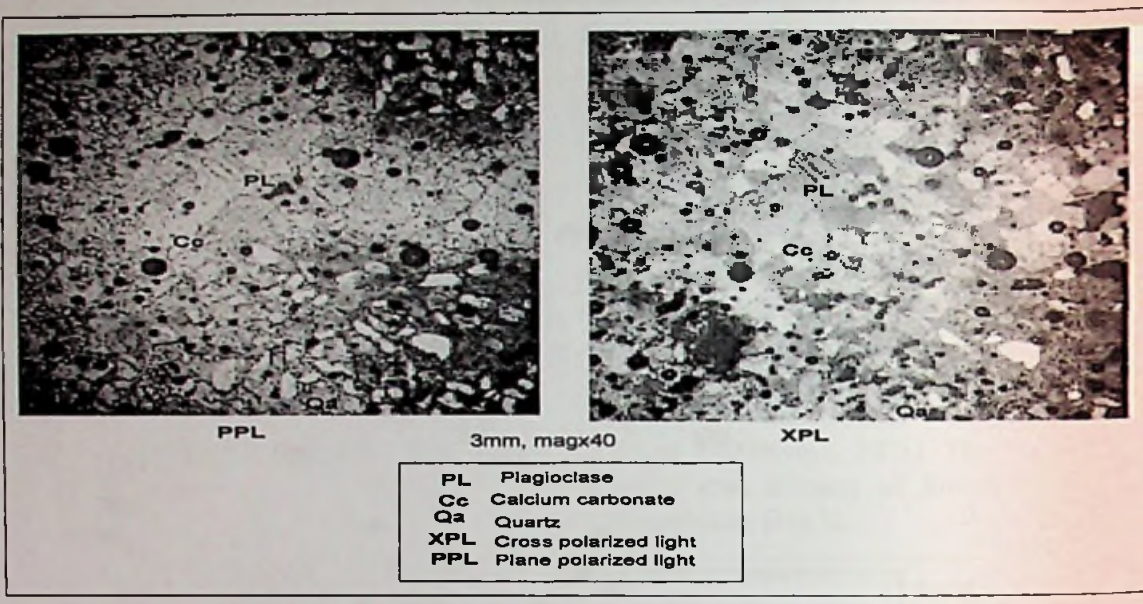


Fig.5. Micrograph of sample no. 2

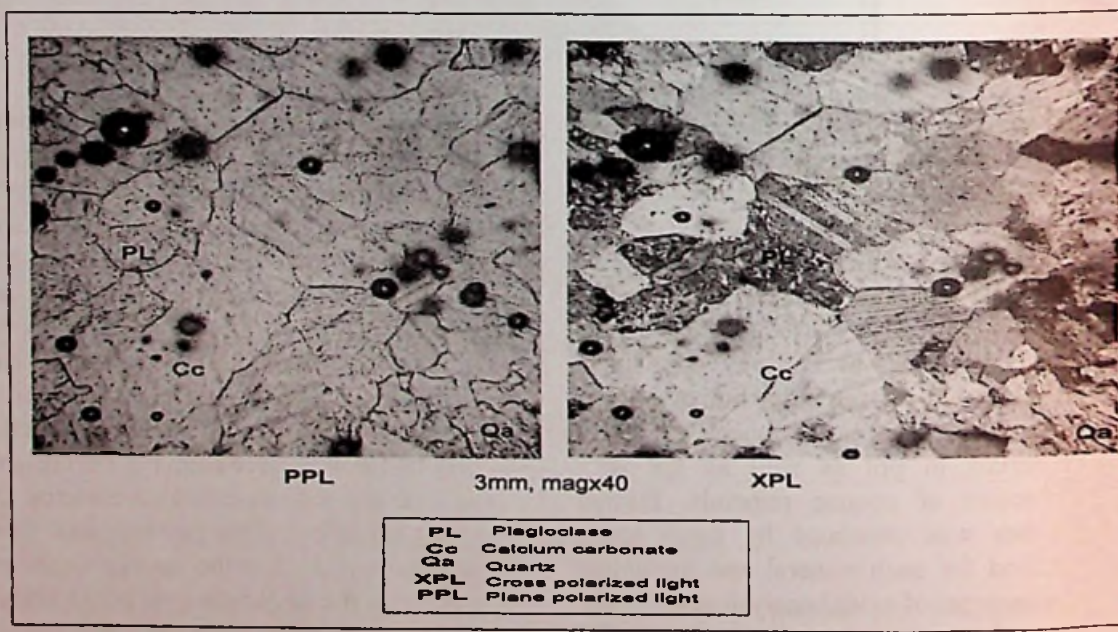


Fig 6. Micrograph of sample no. 4

Table1. Geochemical analysis of the Limestone.

/No	SAMPLE NAME	%TC	%LOI	%CaO	%SiO_2	%AL_2O_3	%Fe_2O_3	%SO_2	%MgO	%Others	%TOTAL	%S.G
	A-ISU 01	68.00	29.18	37.35	22.6	4.2	1.27	0.29	0.58	3.96	100.00	2.4747
	A-ISU3	76.75	33.34	43.22	15.21	3.2	0.55	0.22	0.75	0.91	100.00	2.5532
	A-ISU5	78.5	35.3	43.03	15.27	3.17	0.64	0.38	0.79	1.42	100.00	2.5252
	A-ISU6	75.25	33.62	42.02	14.91	3.71	0.22	0.30	0.13	4.49	100.00	2.6014
	A-ISU7	70.75	31.51	39.41	19.43	3.71	0.83	0.21	0.18	4.72	100.00	2.3877
	A-ISU12	83.25	37.43	46.51	10.65	2.43	0.45	0.16	0.10	2.34	100.00	2.5706
	A-ISU25	70.2	32.29	39.30	18.8	4.78	0.98	0.20	0.20	3.64	100.00	2.5799
	A-ISU27	0.75	5.11	0.47	66.95	16.88	4.21	0.96	0.01	6.31	100.00	2.1820
	A-ISU29	66.50	28.27	36.01	23.76	5.46	0.58	0.17	0.50	5.15	100.00	2.5687
0	A-ISU49	73.25	34.35	36.85	20.09	4.09	0.56	0.23	0.40	3.17	100.00	2..5193
1	A-ISU80	0.25	10.86	0.15	53.52	13.59	12.46	0.23	0.10	8.81	100.00	2.0778
2	B-ISU87	87.25	38.49	47.46	9.96	1.77	1.41	0.15	0.51	0.23	100.00	2.4186
3	B-ISU95A	8.75	7.62	4.36	66.98	14.91	3.31	0.45	0.40	1.92	100.00	2.3929
4	B-ISU95B	12.00	36.47	45.42	13.25	2.75	0.99	0.20	0.41	0.51	100.00	2.6350
5	B-ISU95C	76.50	35.06	35.28	7.58	3.45	5.77	3.49	3.41	5.94	100.00	2.6440
6	ABA ISU PL8-150Pit-4	47.50	30.74	26.50	35.61	8.95	0.83	0.38	0.60	6.79	100.00	2.3934
7	A-ISU PL9/ Pit (1) Sample 2	69.75	31.54	37.98	21.50	4.92	0.69	0.31	0.85	2.21	100.00	2.5763
8	A-ISU PL10/ 6	78.00	34.55	43.11	15.07	3.67	0.94	0.15	0.48	2.03	100.00	2.5344
9	PL16/+152 PL2 Sampl2 1	1.25	2.15	0.69	70.49	16.00	3.10	0.03	0.05	7.09	100.00	2.0855
20	A-ISU 5 Profile 7	88.25	39.23	49.17	6.26	1.86	0.66	0.15	0.60	2.02	100.00	2.6130
21	PL8/+200 Pit 5 Sample	5.25	2.87	2.6	79.63	10.54	3.25	0.01	0.00	0.82	100.00	2.5507
22	PL6/-100Pit 3 sample 2	0.25	9.85	0.10	58.48	17.45	8.42	0.01	0.00	5.66	100.00	1.9605
23	A-ISU PL/+100Pit 7	0.75	12.62	0.39	65.83	15.87	5.08	0.01	0.00	0.20	100.00	1.8985
24	A-ISUPL4/325/Pit sample 1 (1.5m)	1.00	10.22	0.60	67.05	16.21	4.72	0.47	0.00	0.73	100.00	2.9412

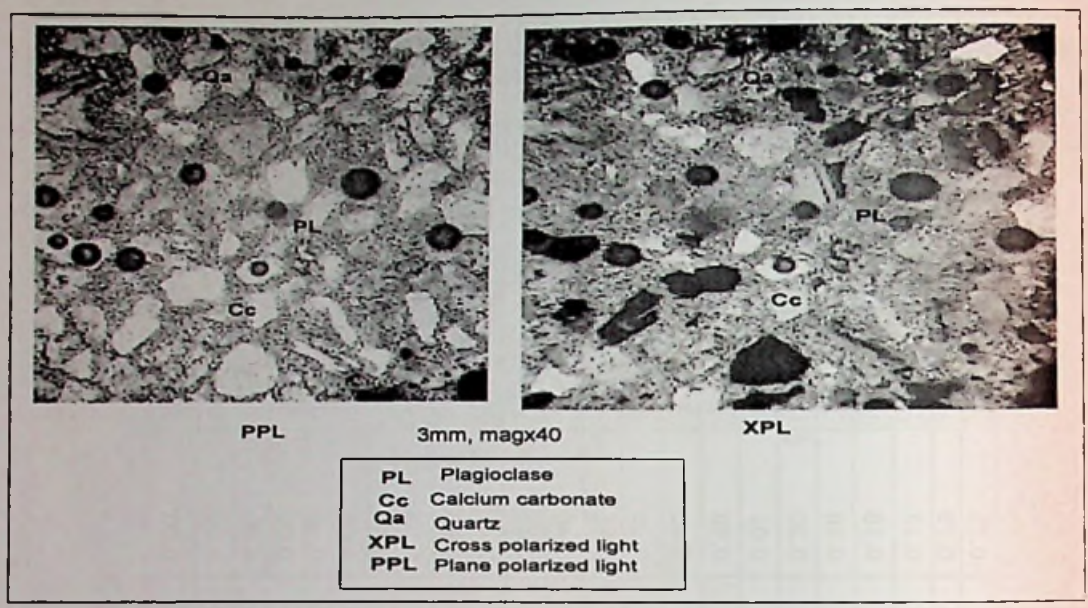


Fig.7. Micrograph of sample no.6

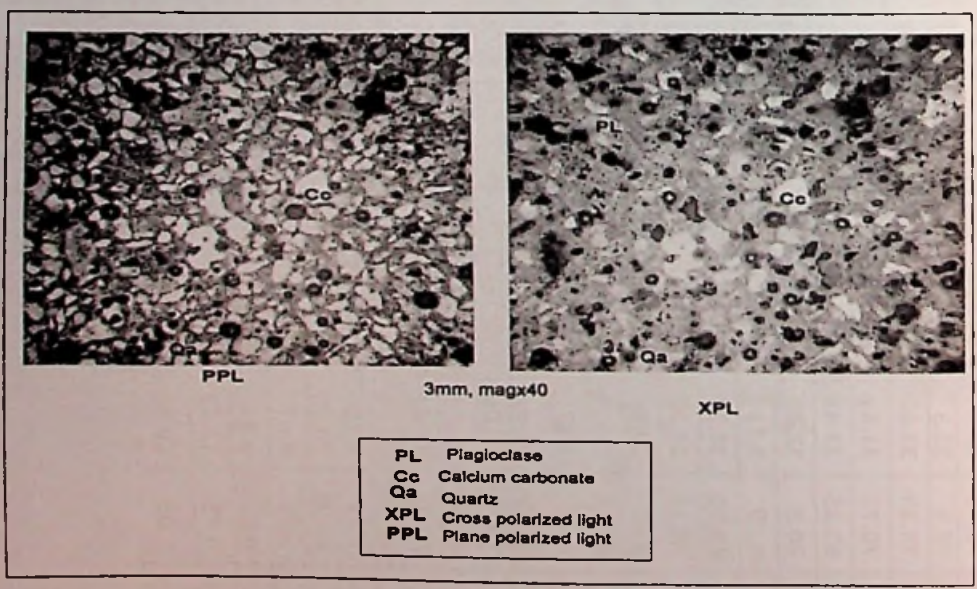


Fig. 8. Micrograph of sample no. 8

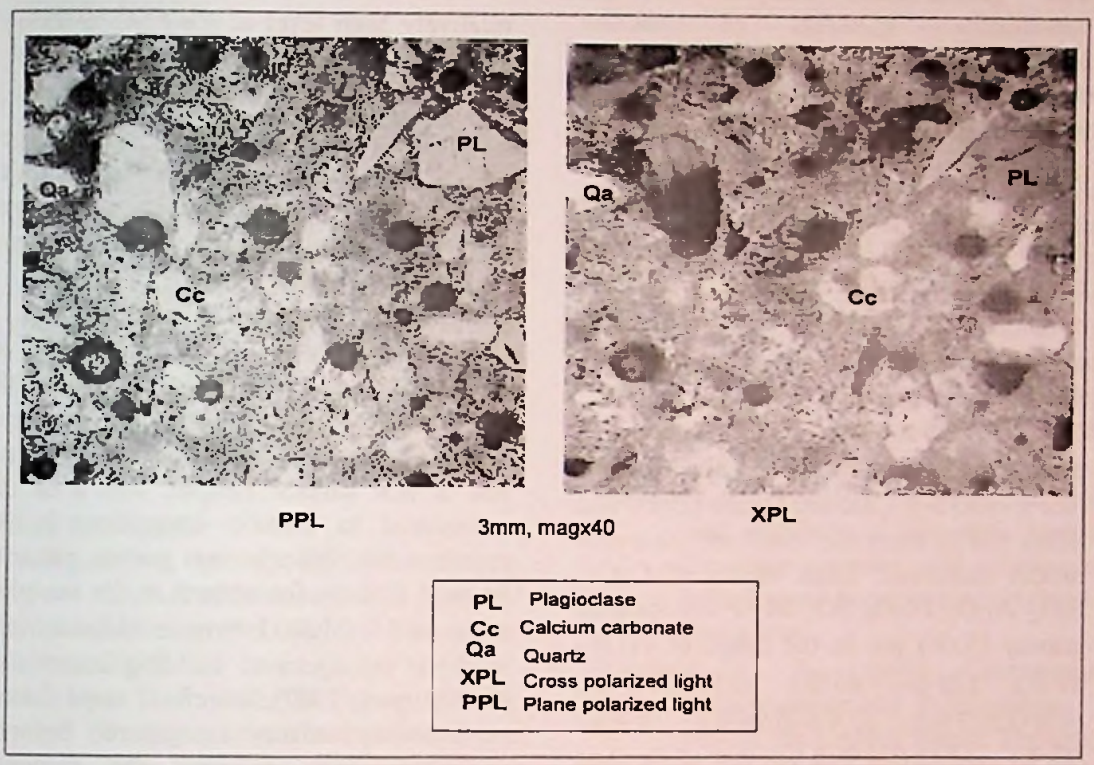


Fig. 9. Micrograph of sample no.10

Table 2: Modal composition of the mineral grains.

S/No	Mineral content	Percentage
1	Plagioclase	43%
2	Calcite	48%
3	Quartz	9%
4	Total	100%

Table 3. Required standards established by the International Industrial Market Management Building Materials Technology (2002) and Mineral (2010) of each of the elemental compound required for cement.

1	Mineral 2010	CaO >45%	MgO <3.0%	SiO_2<8%
2	IIMMBT 2002	CaO >48%	MgO <3.5%	SiO_2<5%

The geochemical analysis of the constituents' minerals of Aba-Isu limestone (Table 1) reveals that the percentage content of LOI is ranging between (2.15%-39.23%), SiO_2 content range between (6.2%-79.63%), CaCO content range from (0.1%-49.15%) and Al_2O_3 is between (1.86%-17.45%). Fe_2O_3 range is between (0.22%-12.46%). SO_2 is ranging from (0.01%-3.49%), MgO content is between (0.00%-0.85%) while the specific gravity (S.G.) is between (1.8985%-2.9412%). Other constituents present are estimated to be in the range of (0.2%-8.83%). Calcium Oxide (CaO) and Silica (SiO_2) from the result are the major oxides dominant. High values of CaCo, SiO_2, Al_2O_3, Fe_2O_3, SO_2, MgO and specific gravity (S.G.) are in the range of (43%-49%), (25%-79.63%), (5%-17.45%), (4%-12.23%), (0.4%-0.96%), (0.4%-0.8%), and (2.078%-2.941%), while their low values are between (0.1%-25%), (6.26%-20%), (1.77%-4%), (0.21%-3%), (0.01%-0.3%), (0.00%-0.3%) and (1.89%-1.96%) respectively.

The CaO content of (43%-49%) compares favorably with that of (Olaide, 1988) which is put at 45.2% but lower than that of Sagamu, Ewekoro and Ibeshe having mean values of 89.2%, 80.3% and 75.7% (Akinmosun et al., 2005) respectively, SiO_2 concentration of (6.2%-79.63%) is generally high as compared to other limestone deposit in Nigeria; such as Ewekoro (19.9%), Igunmale (13.9%), Sokoto (11.3%), (Olaide, 1988); (International industrial markets management building materials technologies, 2002) put the specifications of limestone requirement for cement production at CaO : > 48%, MgO : < 3.5% and SiO2 : < 8% respectively. (Minerals, 2010) agrees that limestone containing about 45% CaO and above is usually preferred for the manufacturing of cement. MgO content in the stone should ideally be less than 3%, although as high as 5% is used by the industry. Magnesia sulphur and phosphorus (Minerals, 2010) are regarded as most undesirable impurities. The relatively high level of CaO (43%-49%) and low values of SiO2 (6.26%-20%, MgO(0.00%-0.3%) and SO_2(0.01%-0.3%), along and around the central line axis which is within the permissible limit shows some degree of purity of the limestone hence its suitability as raw material for cement.

High percentage of SiO_2(25%-79.63%) with corresponding low values of CaO(0.1%-25%) was observed at some distance from the central line axis in pits and a few surface sample, this area is considered to contain impurities, It is apparent that this siliceous portion cannot be used directly for cement as the sample contains 8% MgO (International industrial markets management building materials technologies, 2002), therefore, some form of beneficiation may be required before usage as raw material for cement production. Chemical analyses also reveals that the limestone samples contain CaO and SiO_2 as the major constituents, Al_2O_3 and Fe_2O_3 form the minor constituents while MgO and SO_2 are present in traces. SiO_2, Al_2O_3, Fe_2O_3 along with CaO form the main ingredients that make up the Aba-Isu limestone.

LOI of the limestone sample varies from (2.15%-39.23%), the LOI content is mostly contributed by the carbonate minerals. The SiO_2 content in this limestone varies widely ranging from (6.2%-79.63%) which is contributed by quartz. The lime content varies between (0.1%-49.15%) this is due to the calcite present in the limestone. The chemical composition of the limestone reflects its mineralogical composition. These elements Mg, Al, Si, S, O, Ca and Fe dominantly reflect the elastic sediment contributions. Petrographic studies also indicate that the limestone is essentially calcite in form of grain matrix and carbonate component which suggested to be precipitated from solution (Adegoke, 2009).

CONCLUSION

Petrography and characterization of Aba-Isu limestone was carried out; the results of the elemental composition supported by petrographic analysis have given some insight about the deposit under study. The chemical and mineralogical compositions have helped to determine the quality and character of the limestone which shows good qualities in the Southeast areas that can be use for cement production and low quality in other places especially in the Northwestern area which may require some form of beneficiation or enrichment.

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