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SEDIMENTOLOGY AND MATURITY OF AJALI FORMATION, BENIN FLANK ANAMBRA BASIN, NIGERIA

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ABSTRACT

The Ajali Sandstone, western flank, Anambra Basin, was studied for textural characteristics and maturity of the sediments. Grain size analysis (51 samples), thin section and heavy mineral analysis (15 samples each) and XRF fusion for metallic oxides (15 samples) were analyzed. The textural parameters show that the Ajali Sandstone are medium sand, poorly to moderately sorted, coarse to strongly coarse skewed with mesokurtic to leptokurtic grains. The thin section analysis reveals grains that are sub-angular to sub-rounded (this typifies grains that have travelled fairly long distance to the deposition site), of moderate to well sorted grains, with both monocrystalline and polycrystalline quarts-grains type, with a modal composition of $Q_{90.4,}$ $F_{2.3}$ and $L_{2.9}$. A mineralogical maturity index (MMI) of 17.04, SiO_2/Al_2O_3 ratio of 180.24, and a ZTR index of 67.96% were obtained. The values for the MMI and SiO_2/Al_2O_3 indicates mineralogical matured sediments, the ZTR index shows a chemically immature to sub-mature sandstone, and the modal composition values are consistent with a texturally and compositionally matured sands. The mineralogical maturity is indicative of high degree of chemical weathering of source area. Furthermore, the high quartz and silica content make the sandstone prospective for glass and glassware production.

Key words: Anambra Basin, Maturity, Mineralogical maturity index, Textural characteristics, Glass

INTRODUCTION

An integration of multidisciplinary tools involving particle size analysis, mineralogical and geochemical analyses provide a wealth of information on the intrinsic properties of sediments, which is important to elucidate the nature and energy flux of the multifarious agents transporting the sediments (Ramanathan *et al.*, 2009; Anithamary *et al.*, 2011). This study, investigates the textural characteristics and the maturity of the Ajali Formation, western flank of the Anambra Basin, as well as harmonized the findings from previous researchers with a view to authenticate the maturity and source area weathering that were in operation during transport and deposition of the sediments.

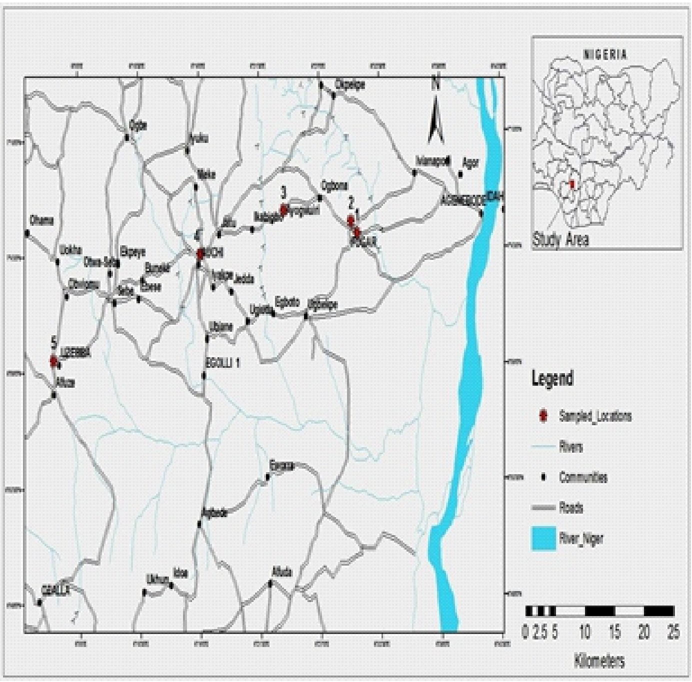

Figure 1: Location Map and Sampling Points in the Study Area

Location of Study Area

The study area and its environs are situated in Fugar, Ayogwuiri, Auchi and Uzebba all enclosed within the Ajali Formation. The area is highly accessible with major and minor roads, together with other adjoining roots. The location map (figure 1) was generated using the GPS co-ordinates obtained from the field studies.

Geologic Overview

The Anambra Basin (Figure 2) represents the sag phase of the Benue Trough evolution. It formed in response to thermal induced basin subsidence west of the Southern Benue Trough after the Santonian inversion episode (Reijers *et al.*, 1997). Its basin fill comprises of the Nkporo Group, the Mamu Formation, the Ajali Formation and the Nsukka Formation in stratigraphic order

The Ajali Formation is characteristically cross-bedded and friable with a sheet-like configuration (Ladipo 1986; Adekoya *et al.*, 2011; Odumoso *et al.*, 2015). In the western flank of the Anambra Basin, Adekoya *et al.*, (2011) identified three lithofacies, which comprises of bioturbated shale facies, tabular cross-bedded sand facies and ferruginous sand facies. Ladipo (1986) opined that the ferruginization is post-depositional. Previous studies have provided contradictory descriptions of the Ajali Formation sands. Whereas Hoque (1977), Akpofure and Etu-Efeotor (2013), Gideon *et al*. (2014), Odumoso *et al*. (2015), reported fine to coarse grained, moderately to poorly sorted, subangular to subrounded grain textures. Amajor (1987) described the Ajali sandstone as predominantly sub-rounded to well-rounded with fairly good sorting. Despite this, published data report very high amount of quartz, implying mineralogical maturity (Akaegbobi *et al.*, 2001; Akpofure and Etu-Efeotor (2013)

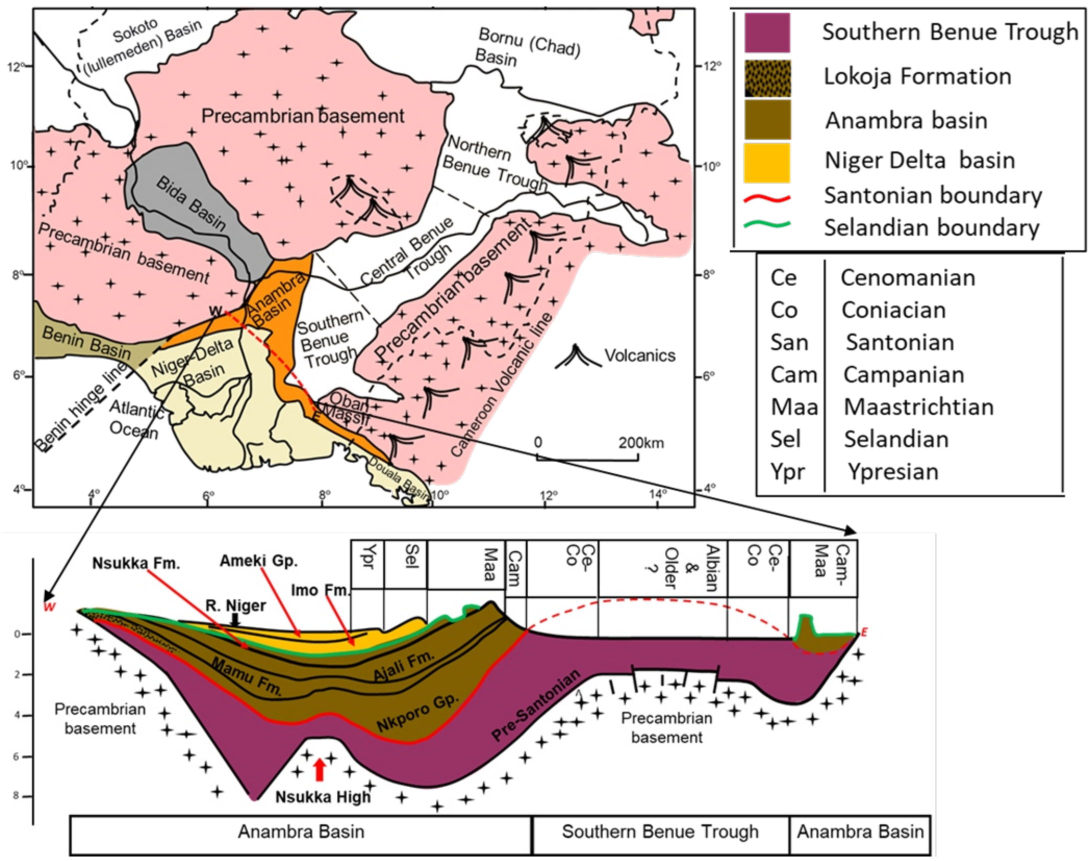

Figure 2: Map of Nigeria showing areas underlain by basement and sedimentary rocks. Below is a W-E cross-section of the Anambra Basin and Southern Benue Trough (Edegbai *et al.*, 2019)

MATERIALS AND METHOD

Sample Collection

Samples were collected at an interval of 0.6m in 5 different locations underlain by the Ajali Formation in the Benin flank. In all, 51 samples were collected. A total of 25 samples each were analysed for heavy mineral and thin section analysis (5 samples from each location), 15 samples for XRF analysis (3 samples from each location) and 51 samples for grain size analysis. The sample locations are Fugar (FG, 17 samples), Fugar II (FGB, 12 samples), Ayogwuiri (AY, 10 samples), Auchi (AU, 7 samples) and Uzebba (UZ, 5 samples).

Grain Size Analysis

50g was weighed and mechanically sieved at the Sedimentology laboratory of the Department of Geology, University of Benin, Nigeria. Mean, sorting, skewness and kurtosis (grain size parameters) were thereafter computed from the recorded weight percentages of the sieves and pan.

Mineralogical analysis

25 samples each (5 samples per location) were selected for thin section and heavy mineral analyses.

Thin Section Analysis

The samples were air dried for 24 hours, and then impregnated with epoxy and subsequently left to cure for 24 hours. The cured sample was trimmed to fit on a glass slide, and the sample smoothened using water and silicon carbide (600 grits) on a glass plate. The samples were thereafter bonded to the glass slide using epoxy on the hot plate for 24hours, trimmed to 50micron and lapped to 30 micron using silicon carbide and water. Mineral identification and textural analysis, point counting of mineral grains were carried out on the slides using a transmitted light microscope at the Sedimentology laboratory of the Department of Geology, University of Benin.

Heavy Mineral Analysis

The experimental procedure entailed pouring 5g of air-dried sample into an already mounted separating funnel filled to ¾ of its volume with bromoform. The heavy minerals contained in the samples which sunk to the bottom of the funnel was collected in a filter paper, washed with acetone to remove all the bromoform, and mounted on a clean glass slide using DPX mountant. Mineral identification and textural analysis, point counting of mineral grains were carried out on the slides using a transmitted light microscope at the Sedimentology laboratory of the Department of Geology, University of Benin

Geochemical analysis (XRF)

One gram (1.00g) of prepared samples was weighed in porcelain and placed in oven at about 110°C for 1hour in order to determine H_2O^+. It was further subjected to a temperature 1000°C in an oven for about an hour in order to determine loss of Ignition (LOI). Ten grams (10.00g) of claisse flux was added and fused in M4 Claisse fluxer for 23minutes. Furthermore, 0.2g of sodium trioxocarbonate IV (Na_2CO_3) was added to the mix; the resulting mix was pre-oxidized at 700°C and then fused

RESULTS AND DISCUSSION

The results of the particle size, mineralogical and geochemical analyses are presented in Tables 1-5.

Textural Analysis:

The grain size parameters at Fugar (Tables' 1-2), reveal the sands as dominantly moderately sorted, medium grained sandstone. Bulk of the samples are fine to coarse skewed, as well as Mesokurtic to Leptokurtic. At Fugar II (Tables' 1-2), the sandstone are mainly moderately well sorted are medium grained sandstone. Bulk of the samples are coarse to strongly coarse skewed as well as Mesokurtic to Leptokurtic. At Ayogwuiri (Tables' 1-2), the sandstone are dominantly medium grained with poor to moderate sorting, coarse to strongly coarse skewed and mesokurtic. At Uzebba (Tables' 1-2), the sandstone are fine grained, moderately well sorted to moderately sorted, strongly coarse skewed, and leptokurtic. The sandstone at Auchi (Tables' 1-2) are medium grained, moderately sorted strongly fine skewed, mesokurtic to leptokurtic. This findings agree with published data (Hoque (1977), Akpofure and Etu-Efeotor (2013), Gideon *et al.* (2014), Odumoso *et al.* (2015).

Altogether, the mean, sorting, skewness and kurtosis of Ajali Sandstone averages 1.4, 0.87, 0.104 and 1.344 respectively (Table 1), and indicates moderately sorted medium sand, near symmetry with Leptokurtic grain. Folk (1965), classified sorting values as; (1-3) ϕ for sand class; (0.25–0.5) ϕ for beach sand and (0.35-1.0) ϕ for Fluviatile / shallow marine sand. Therefore, the Ajali Sandstone, is of fluvial origin. Discriminant plots of grain size parameters (Fig. 3-5) which reflect differences in the fluid flow mechanism of sediment transportation and deposition further indicates intermediate energy of transporting and depositional medium which is typical of fluvial environment (Sutherland, 1994).

Table 1**:** Grain size, parameters of all five (5) locations, showing minimum, maximum and average values of grain size parameters.
Note: FG= Fugar, FGB =Fugar II, AY=Ayogwuiri, UZ=Uzebba and AU=Auchi

Area	Mean ϕ	Sorting ϕ	Skewness ϕ	Kurtosis ϕ
FG Max	1.7	1.5	0.464	3.280
Min	0.3	0.3	0.0625	0.801
Average	1.0	0.9	0.263	2.041
FGB Max	2.0	0.8	0.193	1.50
Min	0.7	0.5	-0.083	0.81
Average	1.35	0.65	0.055	1.155
AY Max	1.5	1.2	0.253	1.230
Min	0.4	0.8	-0.0717	0.934
Average	0.95	1.0	0.0907	1.082
UZ Max	2.3	1.5	0.14	1.639
Min	1.7	0.3	-0.06	1.03
Average	2.0	0.9	0.04	1.335
AU Max	2.3	1.1	0.216	1.27
Min	1.2	0.7	0.071	0.94
Average	1.75	0.9	0.0725	1.105

Table 2: Summary of grain size parameters in percentage of the total number of each Sector
CS- Coarse Sand, MS-Medium Sand, FS-Fine Sand, WS- Well Sorted, MWS- Moderately Well Sorted, MS-Moderately Sorted, PS- Poorly Sorted, VWS- Very Well Sorted, SFS-Strongly Coarse Skewed, PK-Platykurtic, MK- Mesokurtic, LK- Leptokurtic, VLK- Very Leptokurtic, ELK- Extremely Leptokurtic.

	FG	FGB	AY	UZ	AU
Mean ϕ					
CS	22.99	9.47	3.175	0	0
MS	77.02	78.69	96.83	16.10	78.94
FS	0	11.84	0	88.90	21.06
Sorting ϕ					
WS	6.41	0	0	0	0
MWS	13.93	78.93	0	40.66	11.17
MS	68.36	21.07	36.22	50.38	71.68
PS	11.31	0	63.78	0	17.16
VWS	0	0	0	8.96	0
Skewness ϕ					
SFS	13.10	0	16.98	0	47.37
FS	39.30	0	0	0	
NS	7.89	25.69	0	13.73	25.87
CS	37.10	52.68	30.39	17.65	0
SCS	2.49	21.61	52.62	68.63	26.75
Kurtosis ϕ					
PK	7.43	5.83	0	0	0
MK	39.24	48.30	76.47	15.26	51.04
LK	22.50	45.87	23.54	60.45	48.96
VLK	15.78	0	0	24.29	0
ELK	15.04	0	0	0	0

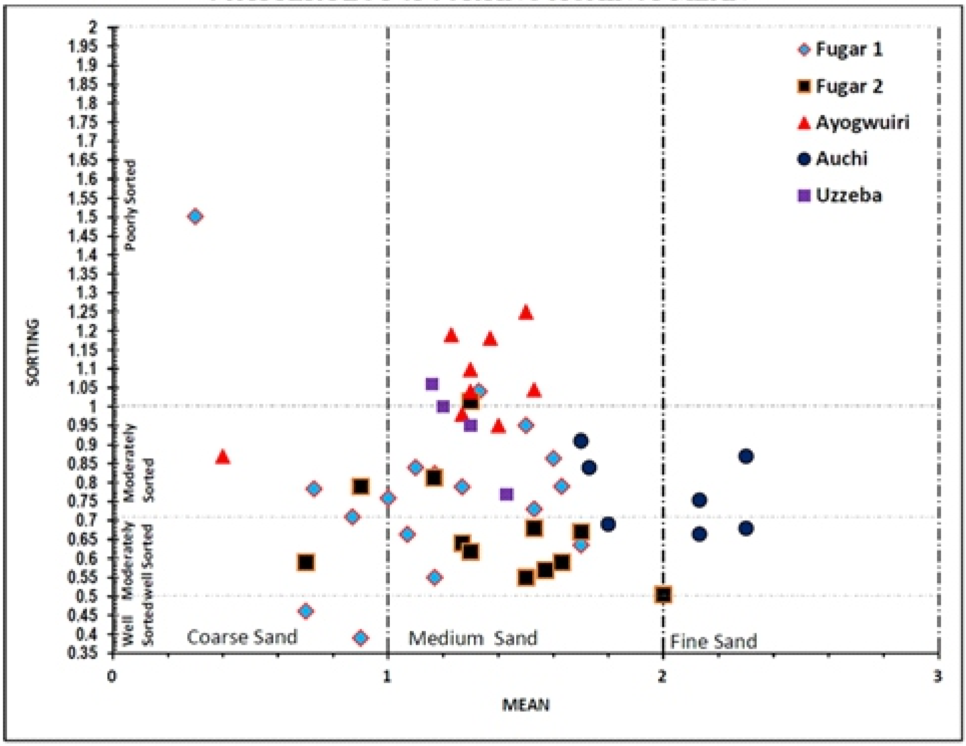

Figure 3: Bivariate relationship between the grain size (phi) and sorting

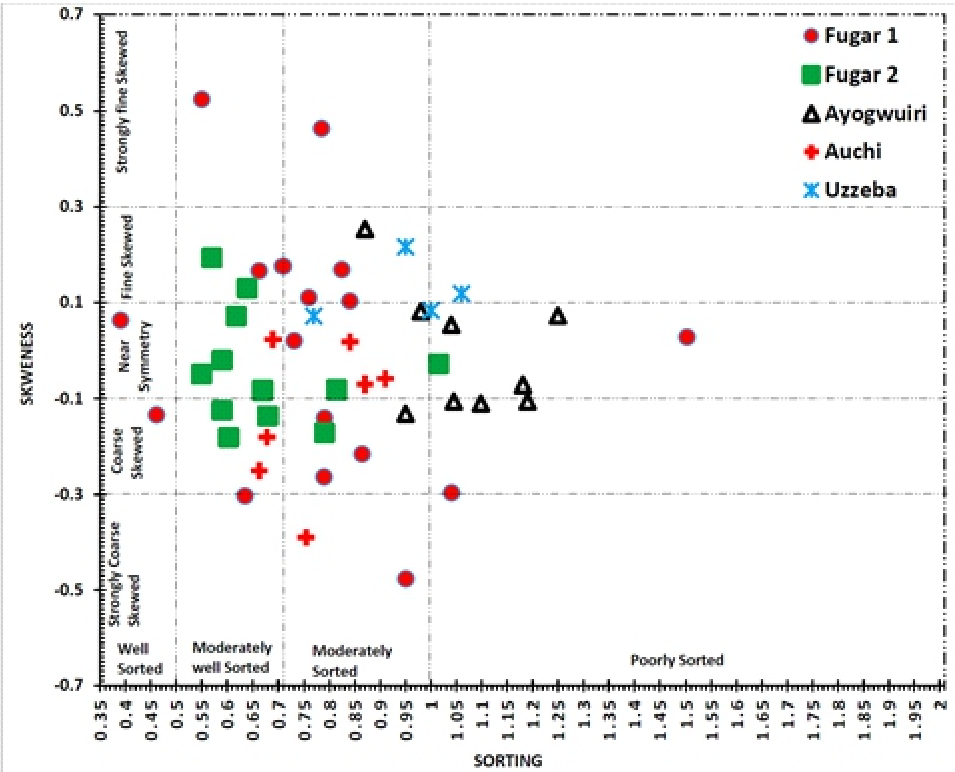

Figure 4: Bivariate relationship between skewness and sorting

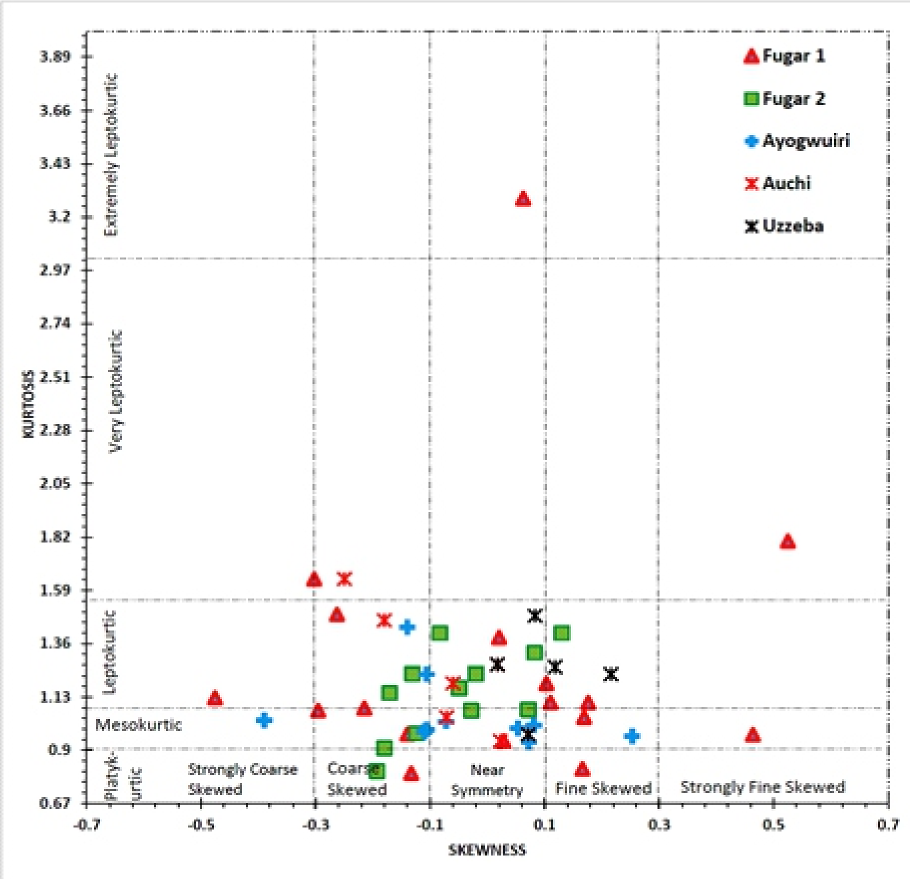

Figure 5: Bivariate relationship between kurtosis and skewness

Sediment Maturity

Extremely high or low kurtosis values is an indication of different sources for the sediment and most likely from high energy environment. The differences in the values for kurtosis (Table 2, Fig. 5) reflect the flow characteristics of the deposition medium. (Baruah *et al.*, 1997; Ray *et al.*, 2006). The dominance of the mesokurtic and leptokurtic nature of sediments reflects compositionally and mineralogically mature sand. Thin section analysis show quartz as the dominant mineral phase (quartz averages 90.4%, while mineralogical maturity index averages 17.04%) in all the samples (Plate 1-2, Table 3-4) implying that the samples are mineralogically mature arenitic sands. This is in agreement with earlier works in other parts of the Basin (Nwajide and Hoque (1985). The samples are dominated by SiO_2 which ranges from 95.0% to 99.5% (average = 98.24%), whereas the Al_2O_3 ranges from 0.2% to 3.0% (average = 0.79%). Fe_2O_3 (average 0.47%) and TiO_2 (average 0.31%) low. The high SiO_2/ Al_2O_3 further confirms the arenitic nature and the mineralogical maturity of the sandstone Potter (1978). In addition, the proportion of polycrystalline quartz is more than monocrystalline quartz (Table 4). This is suggestive of a significant detrital contribution from silica rich metamorphic rocks, thus implying less contribution from older pre-Santonian rocks. Furthermore, heavy mineral analysis reveals the presence of zircon, tourmaline, rutile, staurolite, garnet, kyanite as well as opaques. An average ZTR index of 67.96% suggests that the samples are submature (Manger and Maurer, 1992). In general, textural analysis reveal that the mineral grains have travelled some distance, implying mature to submature textural maturity (Table 4). The Auchi and Ayogwuiri samples are the exception as they are texturally immature.

Depositional Setting

Sedimentologist have attempted to use scatter graphs of grain size parameters to distinguish between different depositional setting using bivariate plot (Figure 3-5) which are based on the assumption that the statistical parameters reliability reflect differences in the fluid flow mechanism of sediment transportation and deposition (Sutherland and Lee, 1994).

Figure 3, shows that there is clustering in medium sized, moderately sorted to moderately well sorted. The result of bivariate plots indicates intermediate energy of transporting and depositional medium which is typical of fluvial environment.

Figure 4, shows the relationship between sorting and skewness for the Ajali sediments. The Sandstone is both positively and negatively skewed. Positive skewness characterizes a beach with deposition of sand, whereas negative skewness indicates erosion and non-deposition (Akofure and Akane, 2019).

The data points cluster in the near symmetry to coarse skewed region which indicates environments where the effect of erosion and deposition are almost balanced.

Friedman (1961), found that dune sand are generally positive skewed and could be barrier island, coastal lake or fluvial environment while beach sand are found to be negatively skewed.

The plot of Kurtosis against Skewness (Figure 5) is a very powerful tool for interpreting the genesis of sediment by quantifying the degree of Normality of its size distribution (Folk, 1966). The plot (Figure 5) shows that the Ajali sediments lie within the mesokurtic to leptokurtic range. Friedman, (1962) showed that most sands are leptokurtic and are either positively or negatively skewed, extreme high or low values of kurtosis indicate that some of the sediments achieved sorting elsewhere in a high energy environment. Therefore platykurtic to very platykurtic and leptokurtic to very leptokurtic sediments are due to extremely low and high energy environment respectively (Dora *et al.,* 2011). The result obtained from figure 5 is mesokurtic to leptokurtic, it therefore indicates that the Ajali sediments were deposited during intermediate to high energy environment.

Weathering of Source Area

The dominance of quartz, and low feldspar content as well as the low concentration of Fe_2O_3 (average =0.47%), Al_2O_3 (average = 0.79%) and TiO_2 (average = 0.31%) maybe attributed to sediment recycling and high degree of chemical weathering of source area. This is consistent with existing Maastrichtian paleoclimate model of Nigeria (Chumakov *et al.* in Hay and Floegel, 2012) as well as data from Mamu Formation on the Benin flank (Edegbai *et al.,* 2019).

Table 3**:** Modal composition of sandstone facies studied and mineralogical maturity

Sample ID	Quartz (Qtz)	Feldspar (FSP)	Rock (lithic) Fragment (RF)	FSP + RF	MMI	Mineralogical maturity index (MMI)
FG2	90	2	3	5	90/5	18
FG10	90	3	3	6	90/6	15
FG16	91	2	2	4	91/4	22.75
FGB3	89	3	3	6	89/6	14.83
FGB7	91	2	3	5	91/5	18.2
FGB12	92	2	3	5	92/5	18.4
UZ1	90	3	4	7	90/7	12.86
UZ3	91	2	3	5	91/5	18.2
UZ5	90	3	2	5	90/5	18
AY1	90	2	3	5	90/5	18
AY5	90	3	3	6	90/6	15
AY9	91	2	3	5	91/5	18.2
AU1	91	3	3	6	91/6	15.26
AU4	90	2	3	5	90/5	18
AU6	90	3	3	6	90/6	15
Average	90.4	2.3	2.9	5.4		17.04

Table 4: Mineral Maturity of Ajali Sandstone Studied

Nwajide and Hoque (1985)	Percentage Range (%)	This Study
Quarts	95 – 90	90.40
F + RF	5 – 10	5.40
MMI	19 – 9.0	17.04
Maturity	Mature	Mature

Therefore, Ajali Sandstone following Nwajide and Hoque (1985) mineral maturity classification scheme is mineralogically mature from the result of table 4.

Economic Potential of the Sandstone

The suitability of quartz sand for different industrial application is determined by the quality of quartz in terms of:

- Grain size distribution. Normally, unprocessed sand may be suitable for a limited range of applications, washing and sizing increases considerably the possible product range.
- Chemical analysis. The grade is determined by the impurities content of the quartz sand and the ground.
- Colour. Very low iron content result in naturally white quartz sands which are preferred for some industrial applications (BIS: 1988).

In the light of the foregoing, the geochemical analysis of the sands [SiO_2 (98.2%), TiO_2 (0.10%) and Al_2O_3 (0.63%)] from Table 7, conforms with the BIS specification for silica industries for glass making and glassware and silica related products (Table 8). The metallic oxide percentages make the Ajali sandstone suited for glass, iron and ceramic industries.

The gross rock volume of the Basin was calculated from the isopach map (figure 5) of the formation and was found to be 1.25 billion m^3 (1.25 million km^3). More so, wells with sandstone bed of 420m thick are in the Ajali Formation (sourced from Total Nigeria Ltd., 1988), this thickness is a likely "hot spot" zone for hydrocarbon, mineral exploration and hydrogeological prospecting.

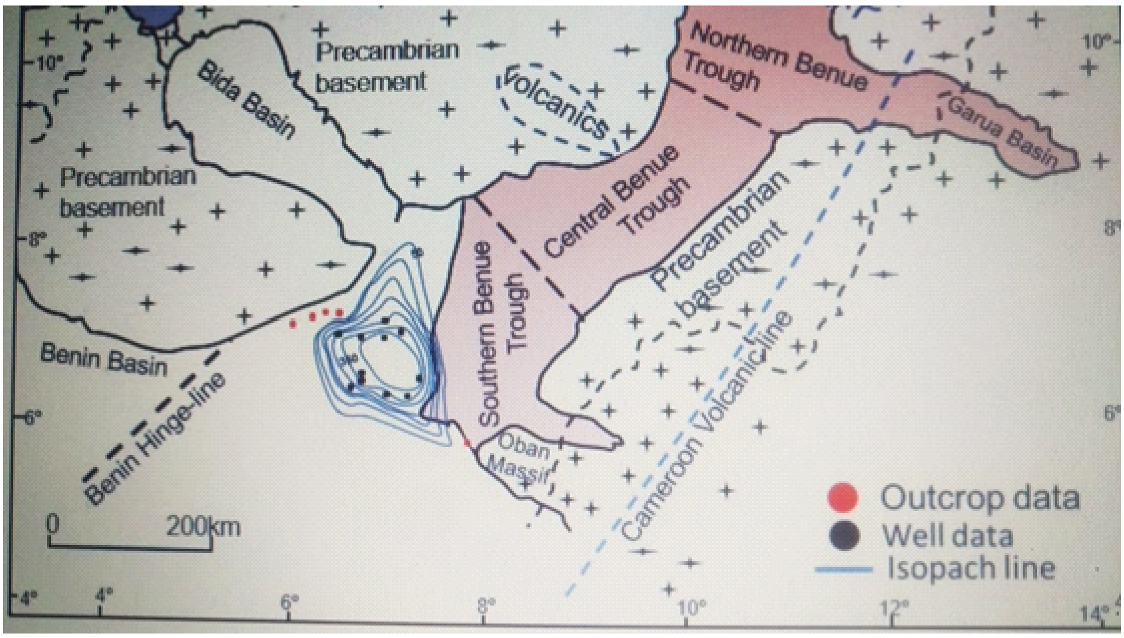

Fig. 5: Isopach map of the Ajali Formation (contour interval = 50m). Modified from Edegbai *et al.*, (2019)

Table 5**:** Compositional and textural maturity of sandstone studied

Sample ID	Quartz (Grain type)	Angular boundary	Number of count	Ratio of Polycrystalline to Monocrystalline	Textual maturity	Compositional maturity
FG2	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	55 42	55:42	Mature	Mature (=90%Qtz)
FG10	Polycrystalline Monocrystalline	Angular to sub - angular Rounded t o sub-rounded	57 49	57:49	Mature	Mature (=90%Qtz)
FG16	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	61 50	61:50	Mature	Mature (=91%Qtz)
FGB3	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	52 46	52:46	Mature	Mature (=89%Qtz)
FGB7	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	59 50	59:50	Mature	Mature (=91%Qtz)
FGB12	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	60 45	60:45	Mature	Mature (=92%Qtz)
UZ1	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	61 52	61:52	Mature	Mature (=90%Qtz)
UZ3	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	58 41	58:41	Mature	Mature (=91%Qtz)
UZ5	Polycrystalline Monocrytalline	Angular to sub - angular Rounded to sub-rounded	60 51	60:51	Mature	Mature (=90%Qtz)
AY1	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	59 43	59:43	Immature	Mature (=90%Qtz)
AY5	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	60 47	60:47	Mature	Mature (=90%Qts)
AY9	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	63 45	63:45	Immature	Mature (=91%Qtz)
AU1	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	53 44	53:44	Immature	Mature (=91%Qtz)
AU4	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	61 49	61:49	Mature	Mature (=90%Qtz)
AU6	Polycrystalline Monocrystalline	Angular to sub - angular Rounded to sub-rounded	54 46	54:46	Immature	Mature (=90%Qtz)

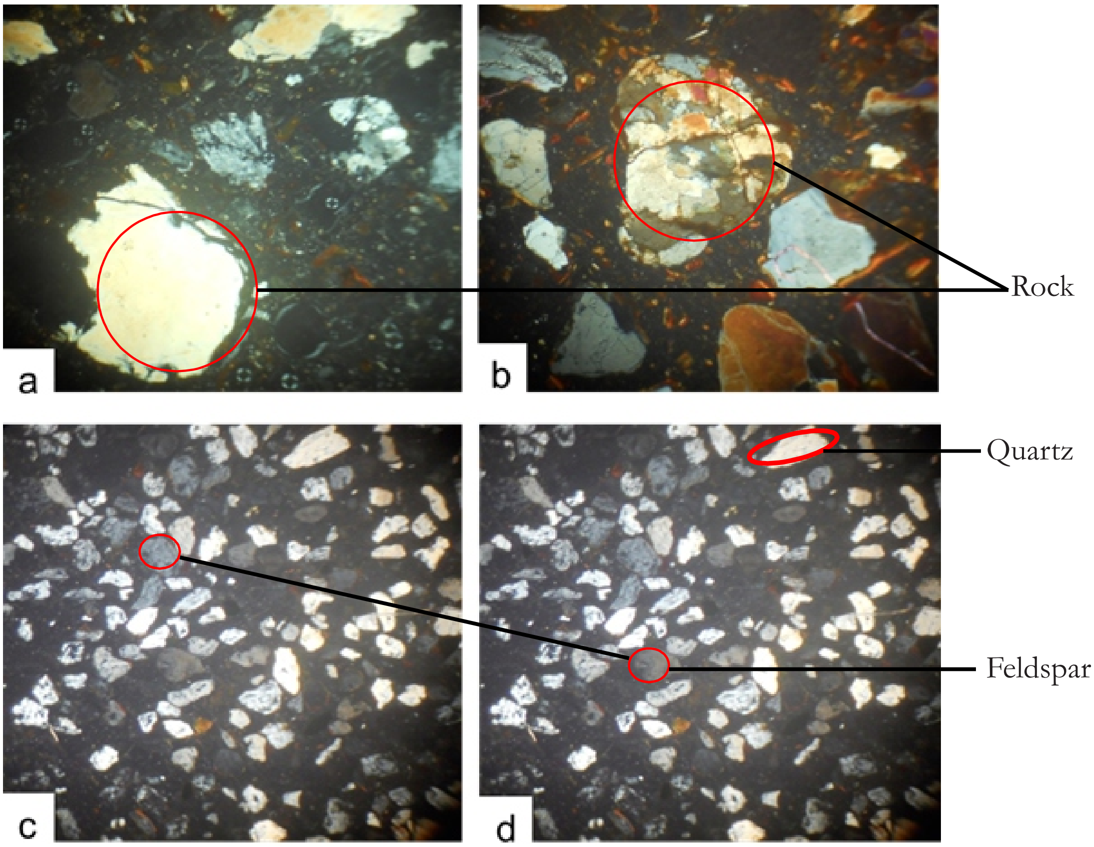

Plate 1: Photo micrograph of Sandstone at Fugar, Ayogwuiri, Auchi and Uzebba from thin section analysis under cross polarized light (30x).

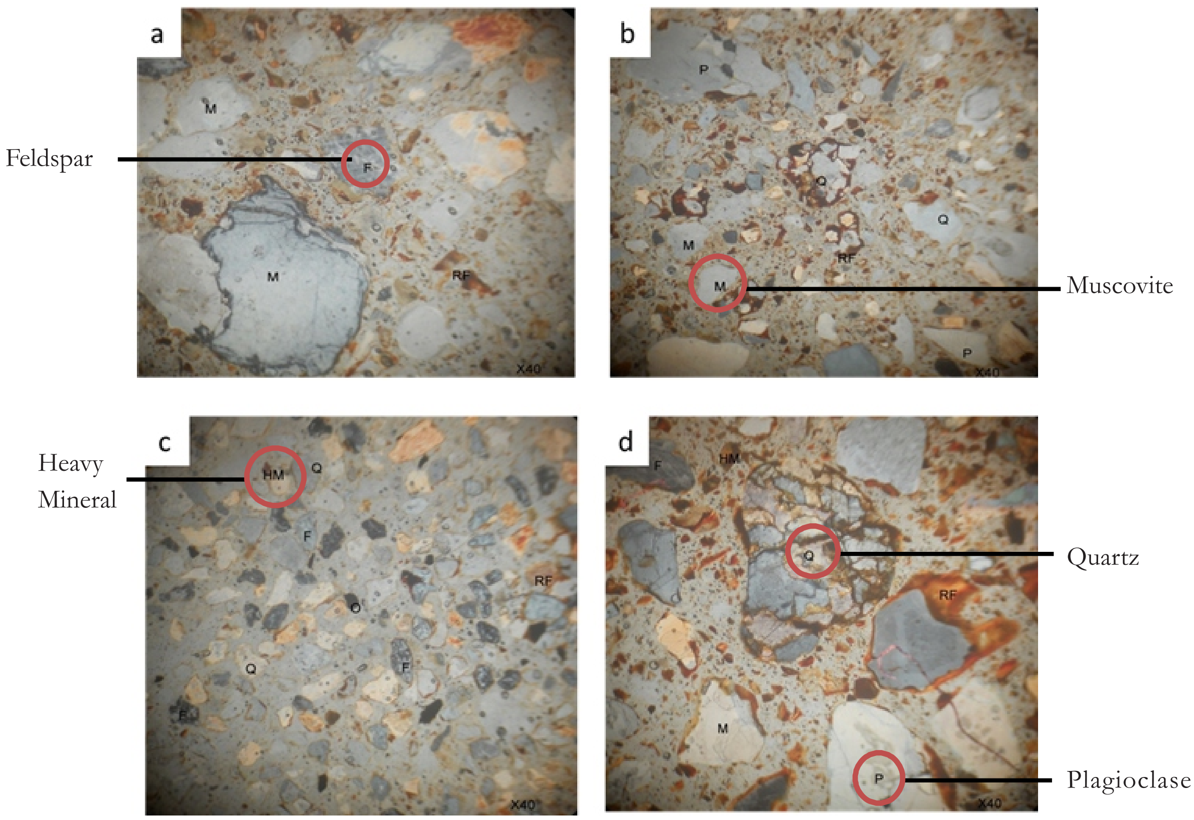

Plate 2. Photo micrograph of Fugar, Ayogwuiri, Auchi and Uzebba sands (a, b, c, d, respectively) from thin section analysis under plane polarized light (30x). M – Muscovite, RF- Rock fragments, Q – Quartz, HM - Heavy mineral, F-Feldspar, P-Plagioclase

Table 6: Heavy minerals and Zircon Tourmaline Rutile (ZTR) index.
ZTR index= Z+R+T/Total non – Opaque * 100

SAMPLE ID	ZIRCON	RUTILE	TOUMALINE	STAUROLITE	GARNET	KYANITE	OPAQUE	ZTR INDEX
FG2	6	6	7	5	3	4	24	61.29
FG10	7	5	7	4	2	4	23	65.52
FG16	8	6	8	6	5	2	28	62.86
FGB3	8	5	6	4	3	2	29	67.86
FGB7	9	8	4	5	3	4	28	63.64
FGB12	6	7	8	6	5	3	30	60.0
FG7	7	6	6	4	3	3	25	65.52
FG13	8	6	5	4	2	4	27	65.52
FGB10	8	6	9	5	3	3	28	67.65
FGB5	7	7	9	6	2	2	29	69.70
UZ1	5	6	7	4	2	1	27	72.0
UZ3	7	5	6	3	4	3	26	64.29
UZ5	5	6	5	4	4	5	29	55.17
UZ2	6	7	5	3	5	2	28	64.29
UZ4	7	7	5	5	4	4	26	59.38
AY1	9	8	10	4	3	3	29	72.97
AY5	8	6	7	5	4	2	30	65.63
AY9	9	5	8	4	2	2	27	73.33
AY4	10	6	8	3	4	2	29	72.73
AY7	8	8	9	6	4	2	26	67.57
AU1	6	5	7	4	3	3	26	64.29
AU4	7	5	6	5	4	1	25	64.29
AU6	8	6	4	3	2	3	27	69.23
AU2	7	7	8	4	3	4	28	66.67
AU5	8	7	6	5	4	3	26	63.64

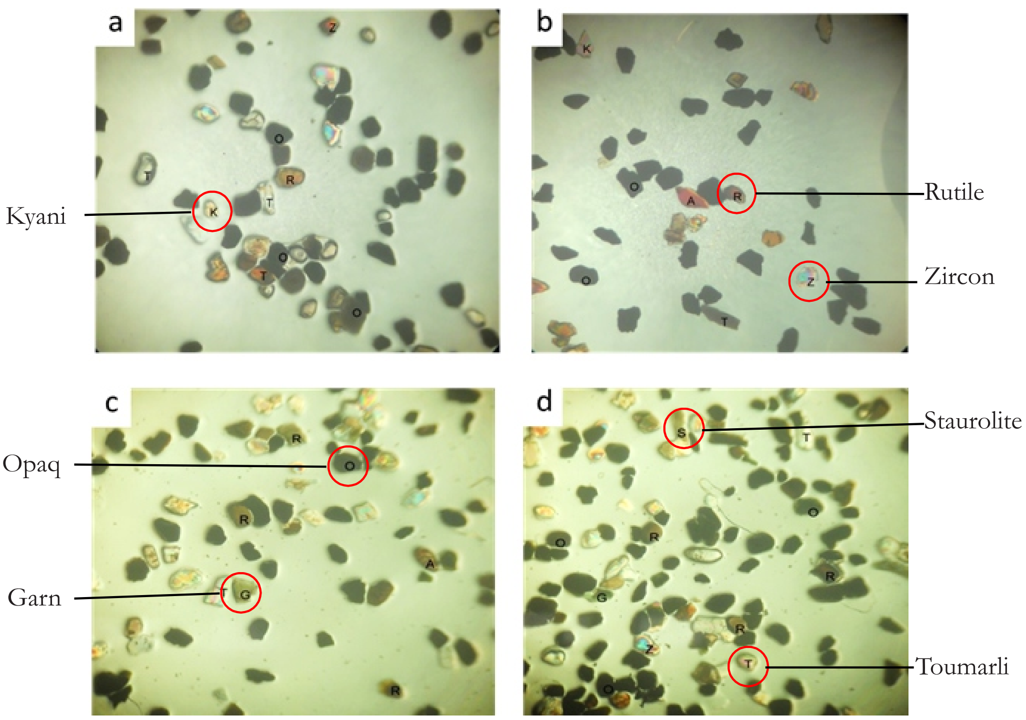

Plate 3: Photo micrograph of Heavy minerals analysis of Sandstone at Fugar, Ayowuiri, Auchi and Uzebba (a, b, c, d, respectively) under plane polarized light (30x). Z=Zircon, R=Rutile, T=Toumaline, G=Garnet, S=Staurolite, K=Kyanite, O=Opaque

Table 7: Weathering indices of oxides

Oxides	FG2	FG7	FG16	FGB3	FGB7	FGB12	AY1	AY5	AY9	AU1	AU4	AU6	UZ1	UZ3	UZ5
Al_2O_3	0.5	0.6	0.9	1.0	0.5	0.3	0.5	0.6	3.0	0.9	0.4	0.2	1.0	0.8	0.7
Fe_2O_3	0.4	0.8	0.7	0.2	0.8	0.8	0.4	0.3	0.5	0.4	0.4	0.5	0.3	0.3	0.2
SiO_2	98.8	98.1	97.8	98.3	98.3	98.9	99.1	98.6	95.0	98.2	99.2	99.5	97.6	98.2	98.0
TiO_2	0.2	0.2	0.10	0.5	0.3	<0.1	0.2	0.2	0.4	0.3	0.1	<0.1	0.8	0.4	0.9
LOI	0.11	0.13	0.37	0.41	0.05	<0.01	0.02	0.14	0.91	0.32	<0.01	<0.01	0.34	0.24	0.15
Total	100.01	98.83	99.87	100.4	99.95	100	100.2	99.8	99.8	100.1	100.1	100.2	100.4	99.94	99.95
$SiO_2/A1_2O_3$	197.6	163.5	108.7	98.3	196.6	329.7	198.2	164.3	31.7	109.1	248	497.5	97.6	122.8	140
Al_2O_3/TiO_2	2.5	3.0	9.0	2.0	1.7	-	2.5	3.0	7.5	3.0	4.0	-	1.25	2.0	0.8
Log (SiO_2/Al_2O_3)	2.3	2.21	2.04	1.99	2.29	2.52	2.30	2.22	1.50	2.40	2.40	2.70	1.99	2.09	2.15

Table 8: Specification of silica method for various industries (British International Standard 2975, 1988)

Industry mineral consumed	**Mineral consumed**	**BIS. Number**	**Chemical specifications %**						**Remarks**
			SiO_2	**Al_2O_3**	**Fe_2O_3**	**CaO**	**MgO**	**TiO_2**	
Glass	Silica Sand	IS: 488 -1980	99	0.62 (min)	–	–	–	0.1	For the manufacturer of the high grade colourless glassware, glass and decolourated ware. (special grade)
			98.0 (min)	0.04 (max)	–	–	–	0.1 (max)	For manufacturer of decolourized glass ware, container ware, lamp ware. Grade I)
			97.5 (min)	0.07 (max)	–	–	–	0.1 (max)	For the manufacture of glassware where small tint is permissible. (Grade II)
			97.0 (max)	0.2 (max)	–	–	–	–	For the manufacture of decolourzed & some coloured glasses (grade III)

CONCLUSION

Based on the textural and geochemical characteristics studied for the sandstone of Ajali Formation, western flank, Anambra Basin, the mean SiO_2/Al_2O_3 ratio of 180.24, mineralogical maturity index (MMI) of 17.4 both indicate mineralogically matured sediments while a Zircon – Tourmaline – Rutile (ZTR) index of 67.96%, indicate a chemically immature to sub - mature sandstone. The weathering index, the mineralogical maturity index, textural characteristics and modal composition of the sandstone all points to a textural, compositional and mineralogically matured sandstone. The mineralogical maturity of the Ajali Sandstone is an indication that the source area weathering was very high. The volumetric together with the textural and geochemical characteristics of the Ajali Sandstone is an indication that the formation maybe considered for economic exploration and exploitation activities of the resources within the Basin.

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