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Research Article

Sedimentological characteristics of Ajali sandstone at Okigwe, Anambra basin, SE Nigeria

Uzoegbu, M.U[1]. and Ikwuagwu, C.S[2].

[1*,2] Department of Geology, College of Physical and Applied Sciences, Michael Okpara University of Agriculture, Umudike, PMB 7267, Umuahia, Abia State.

The Ajali sandstones exposed along Enugu-Port Harcourt Express Road at Okigwe, Imo State, Nigeria were studied to evaluate textural parameters, mineralogy, and statistical measures to depict the depositional pattern of sediments. A total of eleven samples were collected for this study from five locations based on their stratigraphic position (i.e. from top to bottom). Results of grain size analysis reveal a unimodal frequency distribution which indicates a single provenance for the sandstones. Statistics reveals a graphic mean range from 1.5 to 2.8, sorting range from 0.45 to 1.58, skewness range from -0.58 to 0.32, and kurtosis between 0.38 and 2. The sandstones are false bedded and burrowed, medium to fine grained, poorly to moderately sorted, strongly coarsely skewed and platykurtic. The sandstones generally lack of microfauna and macrofossils. Mineralogically, the sandstones contain, on the average, 32.56% monocrystalline quartz, 9.33% polycrystalline quartz, 16.09% plagioclase, 25.91% potassium feldspar, 4.88% clay matrix and 14.27% opaque. The major framework composition classifies the sandstones as sub-feldspathicarenite. Bivariate and multivariate results reveal shallow the Ajali sandstones may have been deposited at fluvial deltaic to marine environments

Keywords: Sandstone, grain-sizes, structures, depositional environment, Okigwe, Anambra basin, Nigeria

INTRODUCTION

The Anambra Basin became the site of major deposition following the Santonian folding in southeastern Nigeria (Fig. 1). Compressional uplift of the Lower Benue Trough succession (Albian to Coniacian) along a NE-SW axis was accompanied by tectonic inversion and down warping of the Anambra platform.

The Mamu Formation is overlain by the Ajali Sandstones (Reyment, 1964) [quoted “Falsebedded Sandstones” of Tattam (1944), Simpson (1954), de Swardt and Casey (1961)] which has an overall blanket-like geometry (Ladipo, 1986; Allix, 1987). Its maximum thickness, in the central part of the Anambra Basin, is some 500-600m (Simpson, 1954; Allix, 1987) (Fig. 1). According to Simpson (1954), to the south it thins to about 200m where it is exposed crosses the axis of the Abakaliki anticlinorium, though only a few tens of metres were reported from this area (Ladipo, 1986). The formation comprises of mainly friable, clean, medium to coarse-grained, subangular to subrounded, poorly sorted, white to grey sometimes iron-stained quartz-arenites [in contrast to the feldspathic nature of pre-Santonian sandstones, those of Campano-Maastrichtian age are quartz - arenites (Hoque, 1977)]. Cross-bedding is virtually ubiquitous; small-scale cross-bedding with sets usually ≤ 5cm, occurs but tabular varieties are predominant.

***Corresponding Author:** Dr. Uzoegbu M. Uche, Department of Geology, College of Physical and Applied Sciences, Michael Okpara University of Agriculture, Umudike, PMB 7267, Umuahia, Abia State, Nigeria.
Co-author: Tel: +2349037459505, E-mail: muuzoegbu@gmail.com

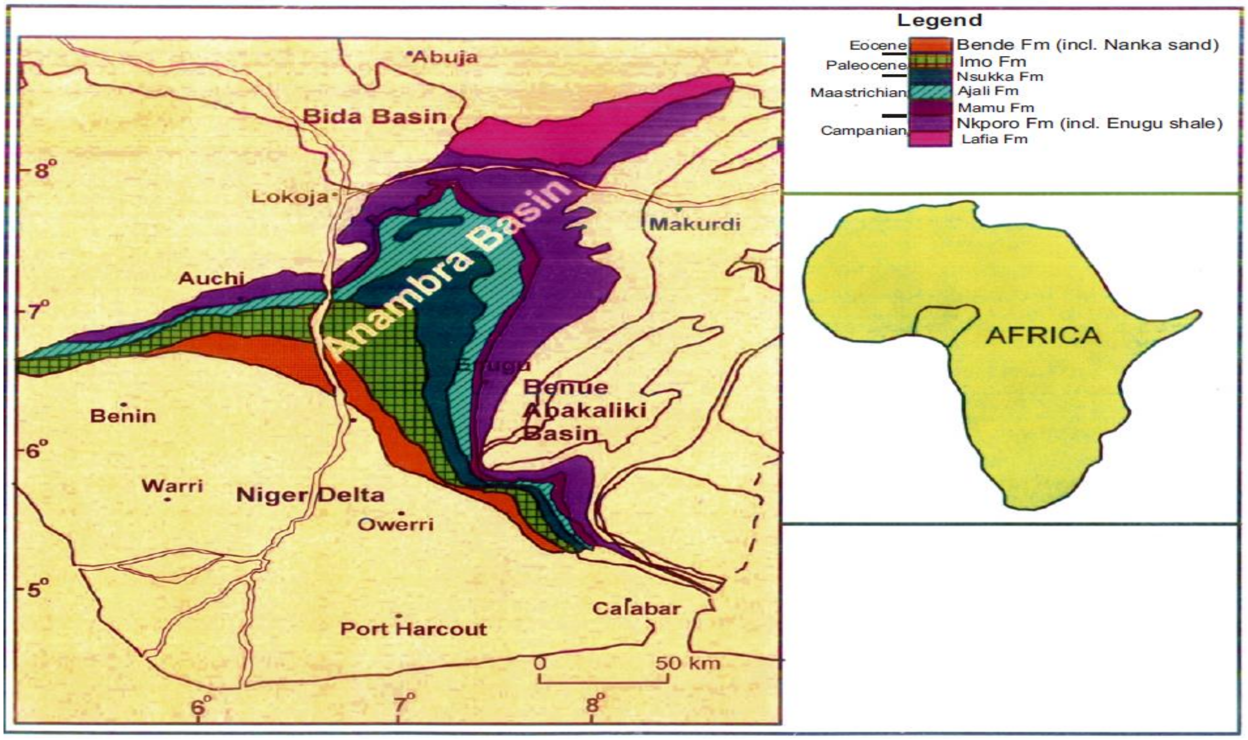

Figure 1. Anambra Basin Showing the Extension of Ajali Sandstone (Drawn from Geological Map of Nigeria, GSN, 1994).

Simpson (1954), Reyment (1965), Hogue and Ezepue (1977) and Ladipo (1986) have discussed the environment of deposition.

Simpson (1954) described the litho-stratigraphic units as false bedded sandstone; Reyment (1965) studied its type environs and named it the Ajali Sandstone; Hogue and Ezepue (1977) evaluated its textural characteristics and inferred a fluvial deltaic depositional setting while Ladipo (1986) on the contrary argued for a tidally influenced regime in a shelf/shoreline environment.
Furthermore, Adekoya et al. (2011) studied the Sedimentological characteristics of Ajali sandstone in the Benin flank of Anambra basin and reported deposition in shallow marine (littoral) environment as indicated by the shale facie as well as in fluvial environments as indicated in the attributes of the overlying tabular and ferruginous upper sandstone facie.

Hogue and Ezepue (1977) have classified the Ajali sandstone as a quartz arenite on the basis of field work, petrographic and mineralogy using four parameters: quartz (Q), feldspar (F), rock fragment (R) and matrix element (M). But, Ibe and Akaolisa (2009) reported that, using the classification scheme of Herron (1988) which involves geochemical data, the Ajali sandstone in Ohafia, southeastern Nigeria has two distinct units: the quartz-rich lower unit and the overlying iron-rich variety which was contrary to the general classification of the sandstone as quartz arenite.

Odigi and Amajor (2008) also argued that, the high mineralogical maturity association with the Ajali sandstone as opined by Hogue and Ezepue (1977) can only be upheld if supported by geochemical data. However, the present work encompasses studies on the basis of mineralogy (using the four parameters as earlier mentioned), geochemical data and log plots of Fe_2O_3/K_2O against SiO_2/Al_2O_3. The Fe_2O_3 separates lithic fragments from feldspars in sandstone while the SiO_2/Al_2O_3 ratio is used to distinguish between quartz-rich (high ratio) sandstone from other components as found by Herron (1988). This study focuses on the sediments characteristics of Ajali sandstone exposed at Okigwe and environs in Imo State.

Regional Geological Setting

The tectonism in Southern Nigeria probably started in Early Cretaceous, with the separation of Africa from South America due to the opening of the Atlantic. This resulted in the development of the Benue Trough which stretched in a NE-SW direction (Fig. 1), resting unconformably upon the Pre-Cambrian basement complex. It extends from the Gulf of Guinea to the Chad Basin and is thought to have been formed by the Y-shaped (RRR) triple junction ridge system that initiated the breaking up and dispersion of the Afro-Brazilian plates in Early Cretaceous (Kogbe, 1989).
After the evolution of the Benue Trough, sediments started depositing in the Trough. Stages of

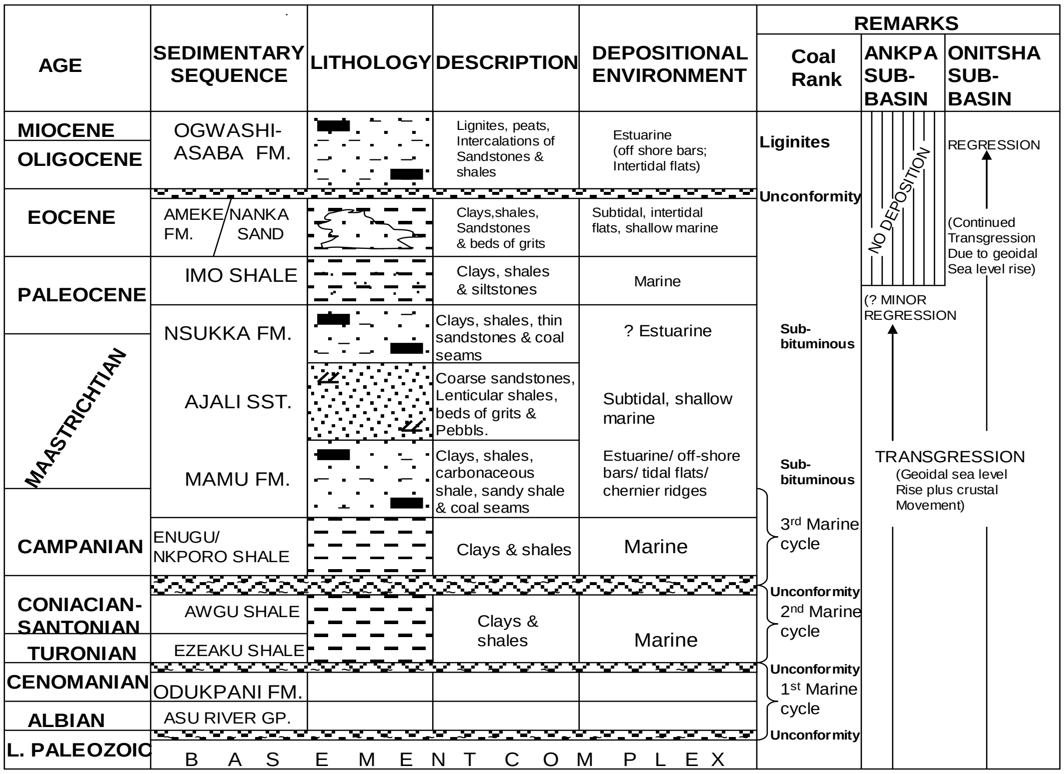

Figure 2. The stratigraphy and environment of deposition of sediments in the Anambra Basin southeastern Nigeria (after Uzoegbu et al., 2014).

sedimentations in the trough were in three cycles; the Pre-Cenomanian deposit of Asu River Group followed by the Cenomanian-Santonian sedimentation. According to Hogue (1977) the inversion tectonics of the Abakaliki anticlinoria which led to the evolution of both Afikpo Syncline and Anambra basin, represented the third cycle of sedimentation which produced the incipient Nkporo shale, Enugu shale and Owelli sandstone. The Nkporo group is overlain conformably by the Coal Group consisting of the Mamu, Ajali and Nsukka Formations that form the terminal units of the Cretaceous series.

Stratigraphic Setting

The sandstones which is about 330 m thick is an extensive stratigraphic unit conformably overlying the Lower Coal Measure (Mamu Formation) and Nkporo Formations that are 400 and 200 m thick, respectively and underlying the Upper Coal Measure (Nsukka Formation) in the Maastrichtian (Reyment, 1965 and Nwajide, 1990) (Fig. 2). The Ajali Formation is typically characterized by white coloured sandstone (Reyment, 1965) while the Mamu Formation is essentially composed of sandy shale and some coal seams; the Nkporo Formation consists mainly of grey - blue mudstone and shale with lenses of sandstone (Obaje, 2009). According to Reyment (1965), the prevailing unit of Ajali Formation consists of thick, friable, poorly sorted sandstone. The Ajali sandstone at Okigwe and environs in Imo State of Anambra basin is the object of this study.

MATERIALS AND METHODS

Intensive field study covered a total of five localities from where samples were taken. Eleven representative sandstone samples were retrieved from the field survey along road cut at Milliken Hills at approximately 100m apart from each location. At each location, samples were collected from the top of the exposed formation, middle part and bottom. The distances from top to middle and bottom were approximately 10 meters apart. In locations where the top of the formation was inaccessible, samples were collected from the middle and bottom part of the formation. All the samples of varying weights were used for granulometric and petrographic analyses. Grain size analysis was carried with the aim of determining the depositional pattern and environment of deposition for the Ajali sandstones, while petrographic analysis was necessary in the determination of the mineralogical composition of the sandstones.
In the laboratory, the samples were later disaggregated and dried for at least 24 hours in an oven at 60^0 C to remove the moisture before analysis. Afterwards, sieve analysis was carried out for each of the samples. Lumped samples were disintegrated so that the sieve analysis

Figure 3. The Ajali sandstone exposure at Location 1 (Magnification X 50).

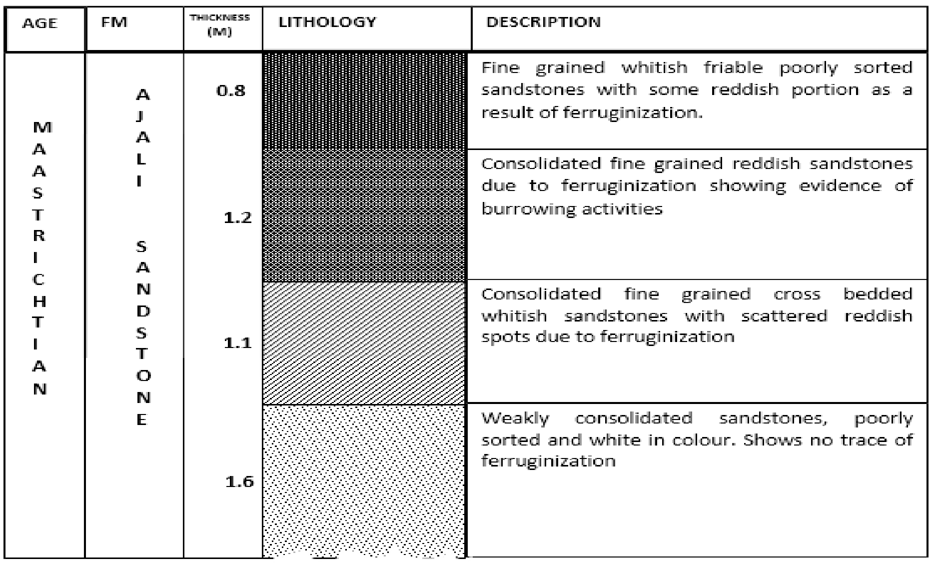

Figure 4. Lithostratigraphic description of Ajali sandstones exposed at location 1.

Figure 5. The Ajali sandstone exposure at Location 2 (Maginification X 50).

result can be authentic. Sieving technique is applied to separating the grains of various size-classes, as proposed by Ingram (1971). British Standards were employed with a sieve set in the order of mesh sizes: 2 mm, 1mm, 500 µm, 250 µm, 150 µm and 75 µm respectively. The sieves were arranged in such a way that the one with the highest opening was placed at the top while the one with the smallest opening was placed at the bottom with the base pan at the base. The dried samples were placed at the top sieve, covered up and placed on a mechanical shaker. The amplifier was used to operate the shaker at a medium frequency. The sieve

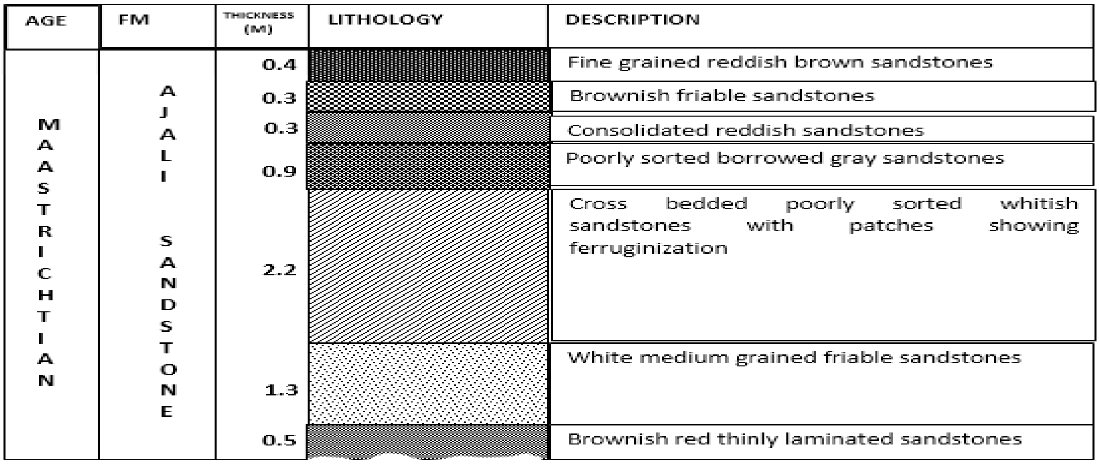

Figure 6. Lithostratigraphic description of Ajali sandstones exposed at location 2.

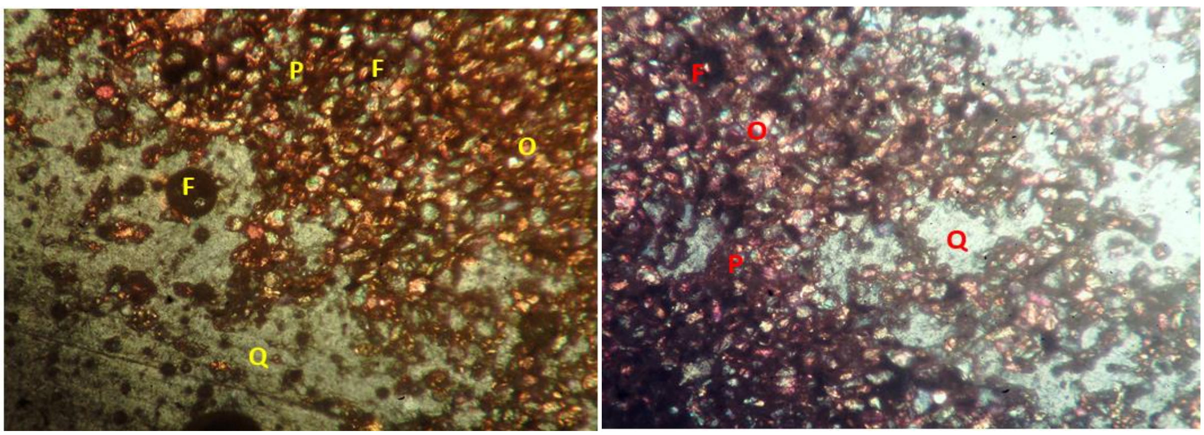

Plate 1. Photomicrograph of sandstones exposed at Location 1. O – Orthoclase feldspar; Q – Quartz; P – Plagioclase feldspar; F – Iron oxide (image on Left = Location 1 middle; Right = Location 1 bottom). Magnification X 200.

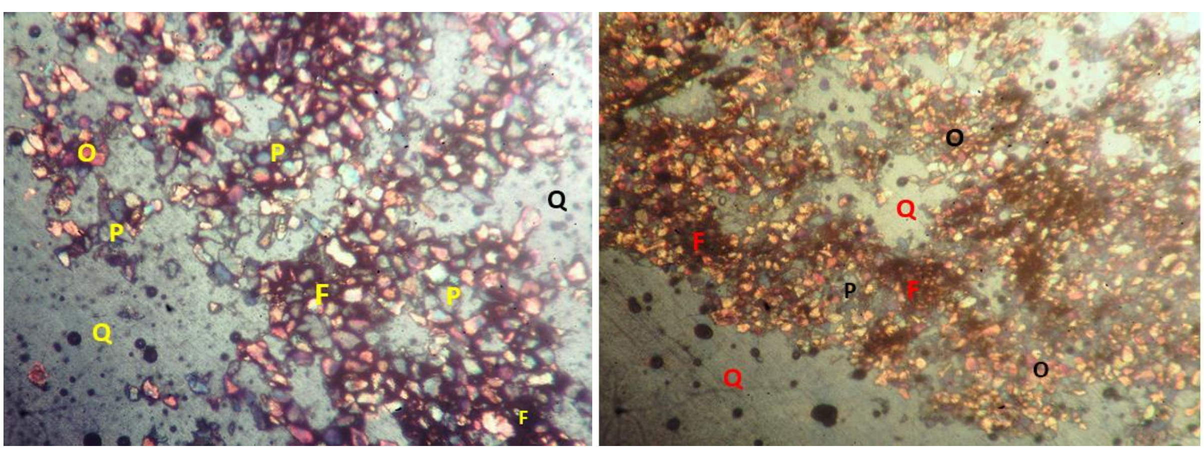

Plate 2. Photomicrograph of sandstones exposed at Location 2. O – Orthoclase feldspar; Q – Quartz; P – Plagioclase feldspar; F – Iron oxide (image on Left = Location 2 middle; Right = Location 2 bottom). Magnification X 200.

analysis was carried for about five minutes while checking at intervals. After the sieve analyses have been completed, the sediment in each sieve was weighed and recorded. These procedures were carried out for each of the eleven samples.

Thin sections of representative samples of sandstones were prepared for petrographic studies of the minerals and textures of the grains using a polarizing microscope (Plates 1, 2, 3 and 4). Both friable and consolidated samples were used. The friable sandstone samples were

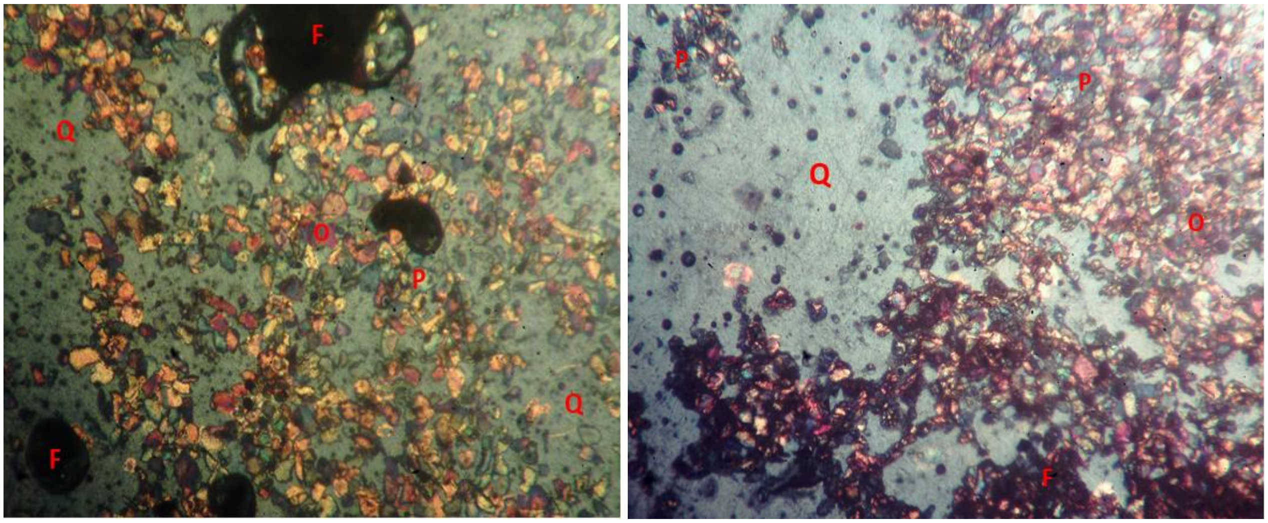

Plate 3. Photomicrograph of sandstones exposed at Location 4. O – Orthoclase feldspar; Q – Quartz; P – Plagioclase feldspar; F – Iron oxide (image on Left = Location 4 Top; Right = Location 4 bottom). Magnification X 200.

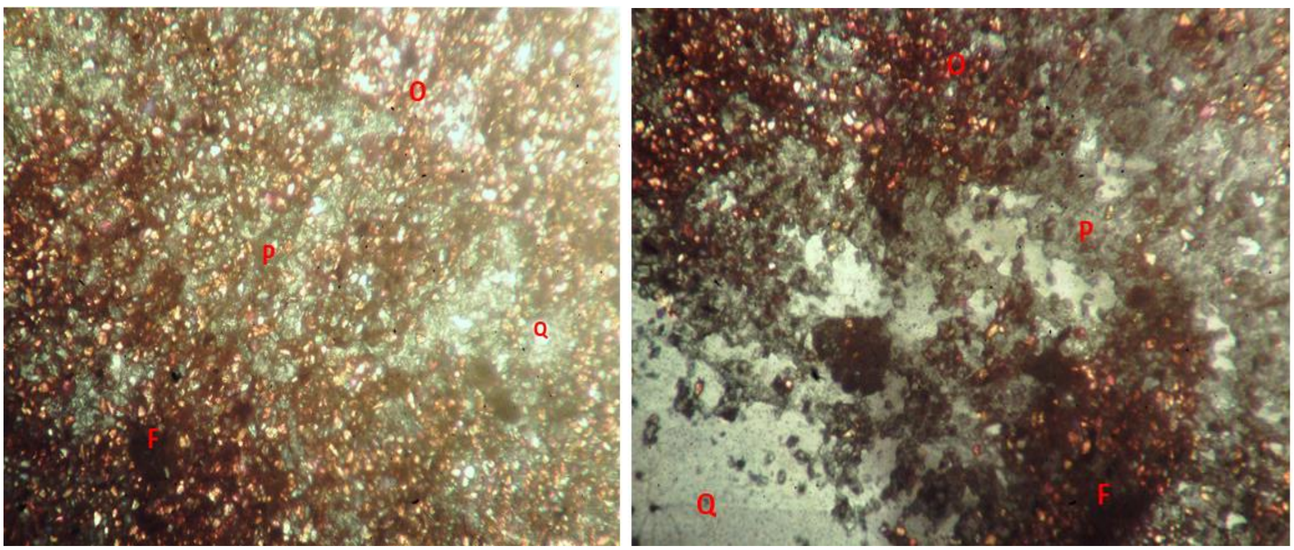

Plate 4. Photomicrograph of sandstones exposed at Location 5. O – Orthoclase feldspar; Q – Quartz; P – Plagioclase feldspar; F – Iron oxide (image on Left = Location 5 Top; Right = Location 5 bottom). Magnification X 200.

initially impregnated prior to cutting. The impregnation helped to harden the samples. The highly consolidated samples were thoroughly washed with water. The samples were each mounted with polished slide on a glass slide using Canada balsam. The mounted sample was again ground on a lap wheel with a coarse abrasive and was later washed with water. These was followed by manual grinding with sludge of fine abrasive on a glass plate until the slide was fine or thin enough for individual mineral identification. The slide was then thoroughly washed with water and was allowed to dry before covering with a cover slip. A total of eleven representative samples of sandstones were cut into thin sections. The prepared slides were viewed under plane polarized light (PPL) and cross polarized light (CPL) using a petrological microscope to obtain information on the lithology, fabric, texture and mineralogy. The stage of the microscope was rotated continuously to attain different views of the slides. The petrographic studies enabled the identification of various mineral contents as photomicrograph of each slide were taken under plane polarized light and crossed nicols to ascertain their compositional features.

RESULTS AND DISCUSSION

The sieve analysis was carried out based on Folk and Ward (1957) model and the ogive curves were plotted (Figs. 8a-c). Table 2 shows the percentile values for grain size analysis. The results of the various parameters

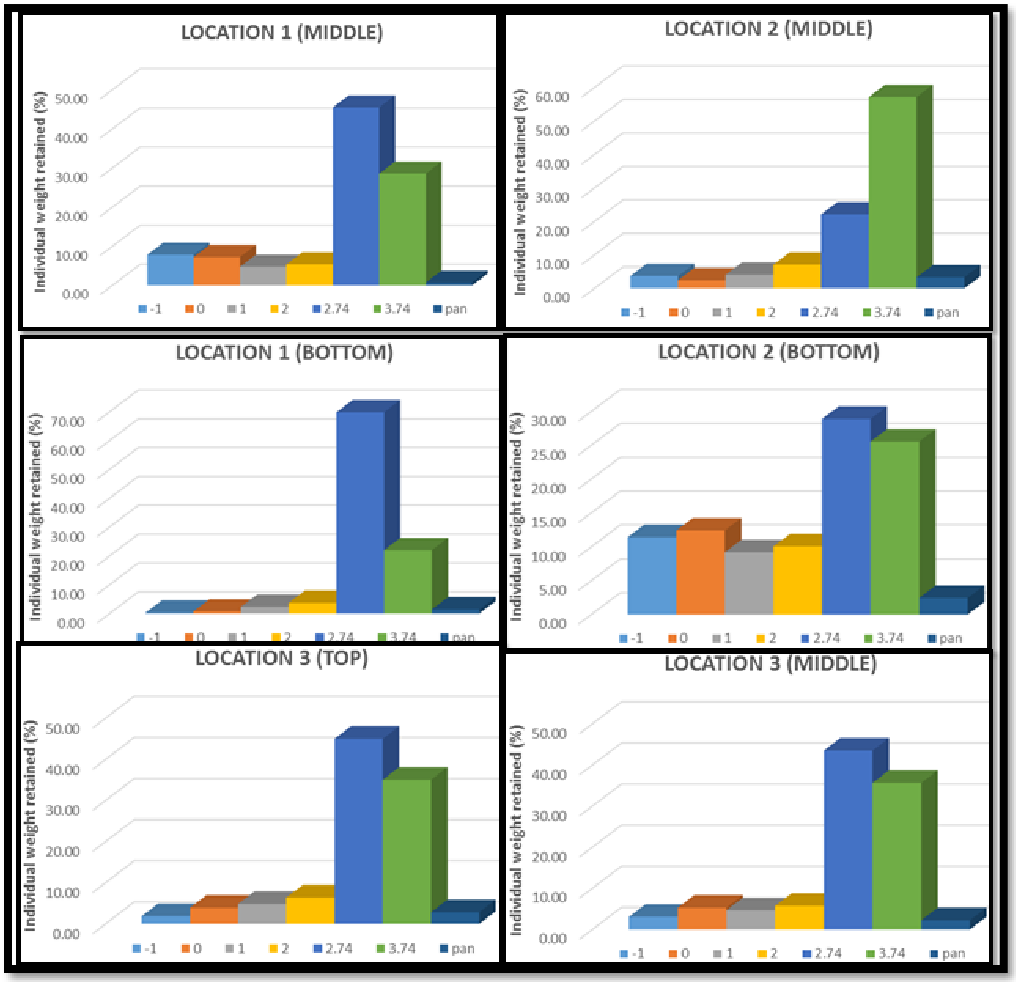

Figure 7a. A graphical plot of individual sample weight retained (%) versus particle size (L1, L2 & L3)

including mean grain size, sorting, kurtosis and skewness are presented in Table 3. The result from the statistical data on size distribution was used for bivariate plot which was used to deduce the depositional environment of the sediments.

The histogram plot for the individual sample weights from the study area reveals a unimodal frequency distribution for the soils. Only sample location 5 (Top) reveals a bimodal distribution pattern (Figs. 7a-b).

Graphic Mean

According to Folk (1980), the best graphic measure for determining overall size of sediment is the graphic mean. The graphic mean values (Mz) were used for the classification of sediments in the study area as it describes the average grain size of the sediments. The lowest graphic mean value is obtained from sample L2 (B), while the peak value of is associated with sample L2 (T). Mean graphic mean value is 2.36 Φ (fine grained). The result of the graphic mean as shown in Table 3 reveals that all the samples are fine to medium grained sediments. The result suggests deposition in a dominantly low energy environment (Folk, 1974; Eisema, 1981).

Sorting

This is a measure of the standard deviation which is the spread of the grain size distribution with respect to the mean. Sorting is the most useful grain size data since it gives an indication of the effectiveness of the depositional medium in separating grains of different classes. For this study, the calculated values indicated a sorting values range from 0.45 to 1.58 ø, mean of 0.99 ø and defined poorly sorted to moderately sorted, with only one sample at L1B (0.45) characterizing well sorted sandstones (Table 3).

According to Friedman (1961), the various ranges of sorting in sands indicate the various environments of deposition of the sands and results from this analysis depict a fluvial (river) and shallow marine shelf

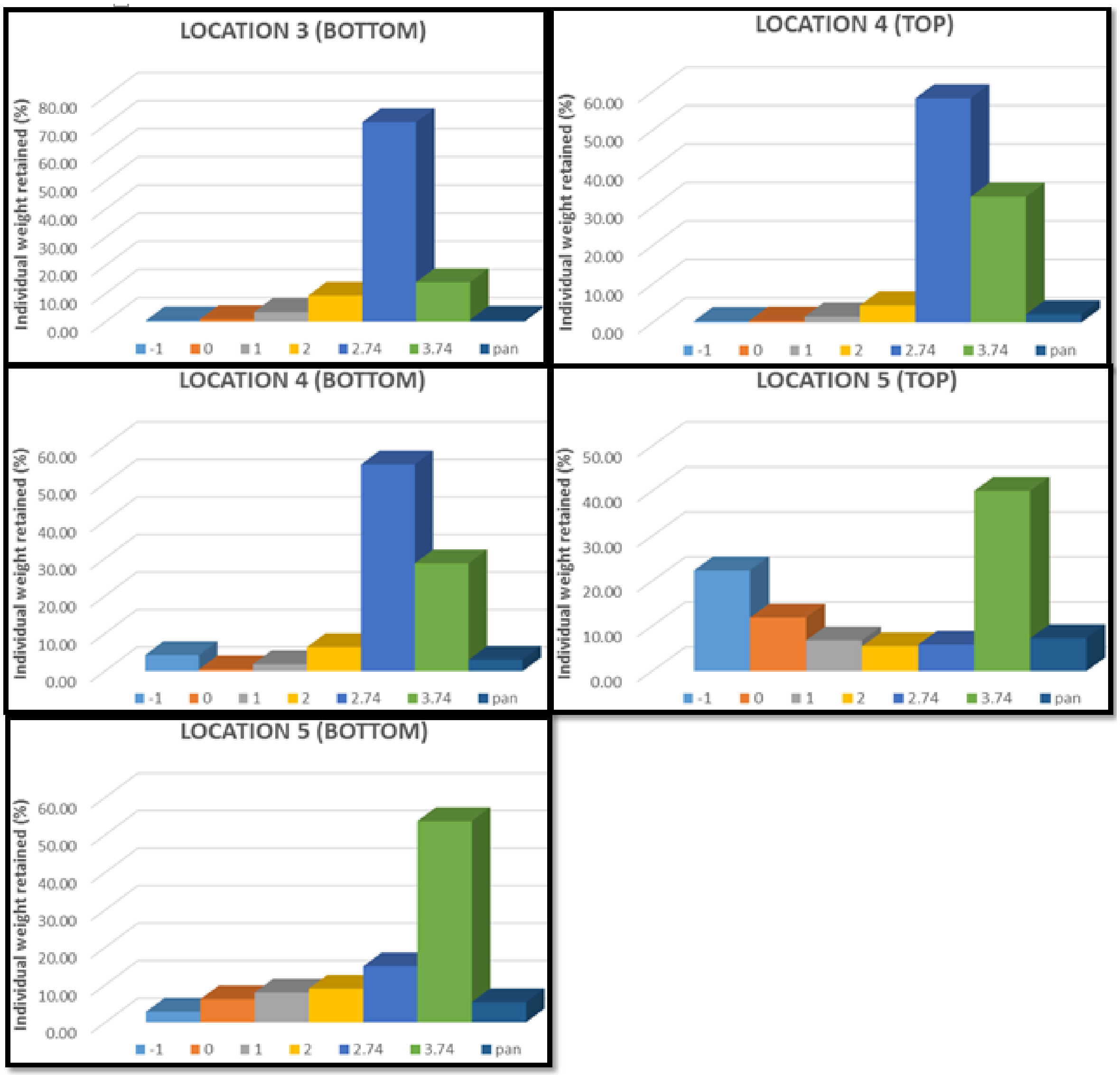

Figure 7b. A graphical plot of individual sample weight retained (%) versus particle size (L3, L4 & L5)

environment (Table 3 and 4). These results are consistent with studies of Adekoya et al. (2011) on sedimentological characteristics of Ajali sandstone in the Benin flank of Anambra basin and reported deposition in shallow marine (littoral) environment as indicated by the shale facie as well as in fluvial environments as indicated in the attributes of the overlying tabular and ferruginous upper sandstone facies.

Skewness

This is a reflection of the depositional process. It is simply a measure of the symmetry of the distribution. Skewness is useful in environmental diagnosis because it is directly related to the fine and coarse tails of the size distribution, and hence suggestive of energy of deposition. The dominance of negative values indicating skewness towards the coarser grain sizes, hence, suggesting that the coarse admixture dominates and therefore exceeds the fine components. Coarse skewed to strongly coarse skewed are indicative of low energy environments (Table 3).

Kurtosis

This is a measure of the peakedness of the curves towards the coarser grain sizes. In numerical terms, the range of kurtosis in the area is between 0.28 and 2, and mean of ø 1.41 (Table 3). If the tails are better sorted than the central portions, then it is termed as platykurtic, whereas leptokurtic, if the central portion is better sorted. The samples analyzed shows a dominance of leptokurtic (9 samples) followed by Platykurtic (1 sample) and mesokurtic (1 sample). The results suggest a generally

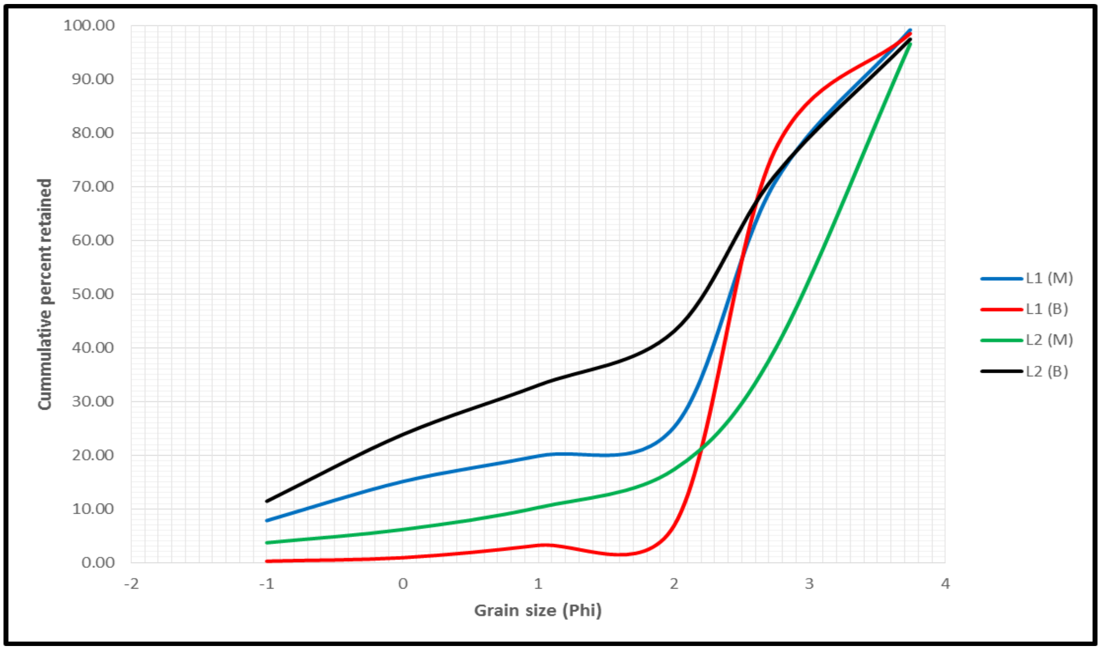

Figure 8a. Grain Size curves for the Ajali sandstone samples from Okigwe (Location 1 and 2). M- middle of exposure; B – bottom of exposure.

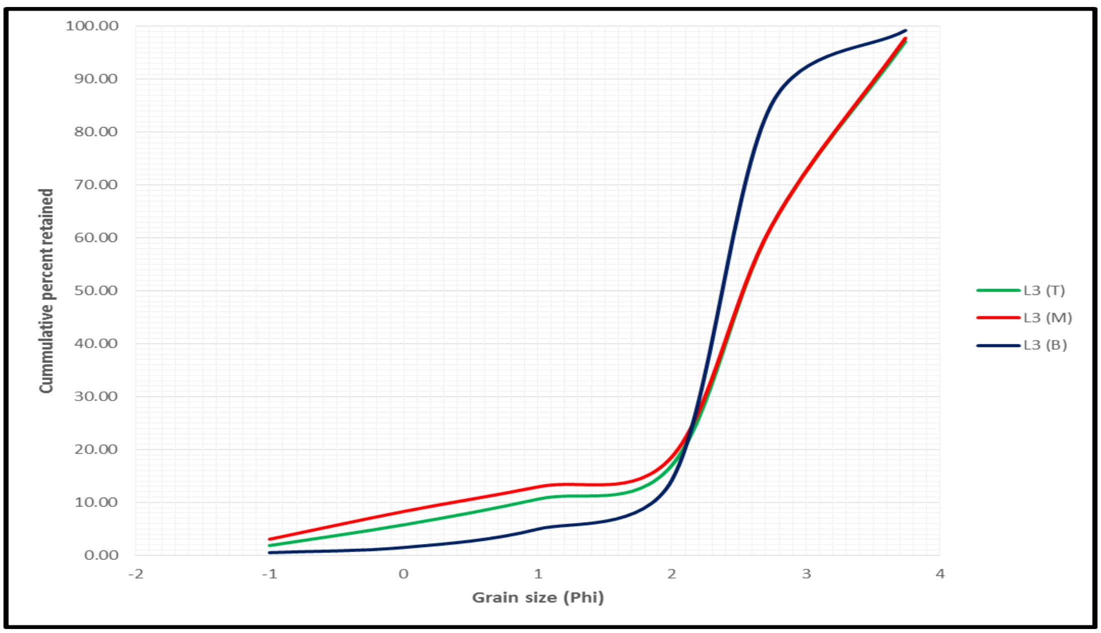

Figure 8b. Grain Size curves for the Ajali sandstone samples from Okigwe (Location 3). T – top of exposure; M- middle of exposure; B – bottom of exposure.

better sorting at the central portion. This strongly suggests a fluvial environment, confirming that the sands are river deposited.

Bivariate and multivariate analysis

Plots of mean grain size (Mz) against standard deviation (D) were plotted for the Ajali sandstones at Okigwe using the methods of Miola and Weiser (1968) and Folk, (1974). The results of mean grain size against sorting after Miola and Weiser (1968), shows that deposition occurs in the fluvial field (Fig. 9). The plot of mean grain size against sorting (After Folk, 1974) show that deposition was in a fluvial environment with minor tidal influence (Fig. 10). The result of multivariate analysis shows that Ajali sandstones were deposited in a fluvial

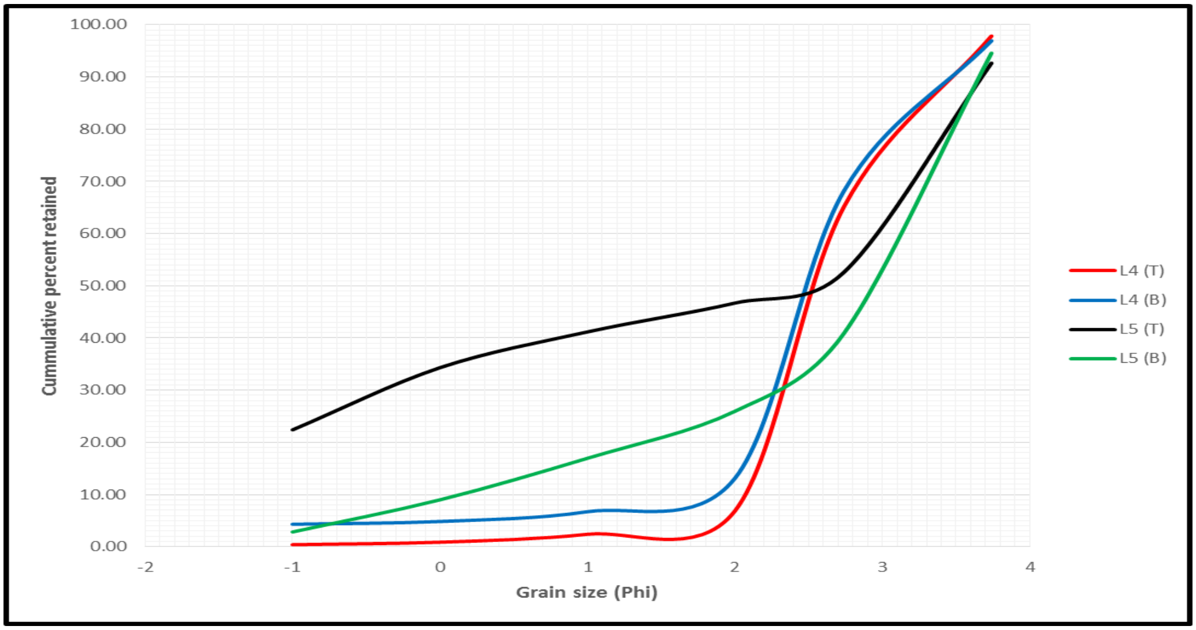

Figure 8c. Grain Size curves for the Ajali sandstone samples from Miliken Hill (Location 4 and 5). T – top of exposure; B – bottom of exposure.

Table 1. Percentile values for grain size analysis

Sample locations	5%	16%	25%	50%	75%	84%	95%
L1 (M)		0.1	2	2.4	2.85	3.15	3.6
L1 (B)	1.95	2.15	2.25	2.45	2.7	2.95	3.6
L2 (M)	-0.3	1.9	2.35	2.95	3.4	3.55	3.75
L2 (B)		-0.9	0.1	2.2	2.85	3.2	3.65
L3 (T)	-0.2	2	2.2	2.5	3.1	3.3	3.7
L3(M)	-0.6	1.9	2.2	2.5	3.1	3.3	3.7
L3 (B)	1	2	2.15	2.4	2.6	2.7	3.2
L4 (T)	1.95	2.15	2.25	2.55	2.95	3.25	3.65
L4 (B)	0.5	2.05	2.2	2.5	2.9	3.2	3.7
L5 (T)			-0.8	2.6	3.35	3.55	3.8
L5 (B)	-0.6	0.9	1.9	2.95	3.4	3.55	3.8

environment with shallow marine incursions akin a deltaic setting (Table 3).
Table 3: Multivariate results of the Ajali Sandstone in the studied area

Petrology of the Ajali sandstones

The result of petrographic analysis for the Ajali sandstones exposed at Okigwe is displayed in Table 6. The result reveals the presence of quartz, plagioclase, orthoclase, and iron oxide as the only opaque mineral. The quarts are fine grained and together with the iron oxides, they constitute the cement.

MQ - Monocrystalline Quartz; PQ - Polycrystalline Quartz; TQ –Total Quartz; KF - Potassium Feldspar; PF - Plagioclase Feldspar; TF - Total Feldspar;

Microscopic studies show that the dominant mineral is fine grained quartz and orthoclase crystals with a small

Table 2. Calculated values for grain size parameters for Ajali sandstones

Sample locations	Graphic mean	Standard deviation	Skewness	Kurtosis
L1 (M)	1.88 (Medium grain)	1.31 (Poorly sorted)	-0.42 (Very coarse skewed)	1.74 (Very leptokurtic)
L1 (B)	2.52 (Fine grain)	0.45 (Well sorted)	0.32 (Very fine skewed)	1.50 (Leptokurtic)
L2 (M)	2.8 (Fine grain)	1.03 (poorly sorted)	-0.44 (Very coarse skewed)	1.58 (Very Leptokurtic)
L2 (B)	1.5 (medium grain)	1.58 (poorly sorted)	-0.36 (Very coarse skewed)	0.54 (Very platykurtic)
L3 (T)	2.6 (Fine grain)	0.92 (Moderately sorted)	-0.08 (near symmetrical)	1.78 (Very Leptokurtic)
L3(M)	2.57 (Fine grain)	1.00 (Moderately sorted)	-0.15 (Coarse skewed)	1.96 (Very Leptokurtic)
L3 (B)	2.37 (Fine grain)	0.51 (Moderately well sorted)	-0.21 (Coarse skewed)	2.00 (Very Leptokurtic)
L4 (T)	2.65 (Fine grain)	0.53 (Moderately well sorted)	0.28 (Fine skewed)	1.0 (Mesokurtic)
L4 (B)	2.58 (Fine grain)	0.77 (Moderately sorted)	-0.02 (Near symmetrical)	1.87 (Very Leptokurtic)
L5 (T)	2.05 (Fine grain)	1.46 (Poorly sorted)	-0.42 (Very coarse skewed)	0.38 (Very platykurtic)
L5 (B)	2.47 (Fine grain)	1.33 (Poorly sorted)	-0.58 (Very coarse skewed)	1.20 Leptokurtic)

amount of clay matrix and opaque minerals probably iron oxide. The cement is made of fine grained quartz and iron oxide. The clasts in the sandstone range from angular to subangular. They are mostly monocrystalline quartz although some are polycrystalline. Most of the clasts are not in contact but a few show straight, concavo-convex and sutured contacts. Cementing materials are mainly silica in form of authigenic quartz and iron-oxide coatings. The modal analysis of framework element shows in an average of 32.6% monocrystalline quartz, 9.3% polycrystalline quartz, 16.1% plagioclase, 25.9% potassium feldspar, 4.9% clay matrix and 14.3% opaque. Due to the dominance of monocrystalline quartz and feldspars (Plagioclase and orthoclase), the sandstones are sub-feldspathic arenites. Quartz is colourless under plane polarized light, but white to dull white in colour under crossed nicols. Plagioclase is gray and orthoclase is brownish. Iron oxide is generally dark under crossed polarized light.

Provenance of the Ajali sandstones

The establishment of source area for the sandstones in the study area is achieved by considering grain texture and mineralogical compositions. The dominant unimodal pattern of grain size distribution indicates a single source.

Table 3. Multivariate results of the Ajali Sandstone in the studied area

Sample locations	Results	Interpretation
L1 (M)	-6.25	Shallow marine
L1 (B)	-9.69	Fluvial
L2 (M)	-5.89	Shallow marine
L2 (B)	-6.60	Shallow marine
L3 (T)	-7.73	Fluvial
L3(M)	-7.39	Shallow marine
L3 (B)	-7.17	Shallow marine
L4 (T)	-9.44	Fluvial
L4 (B)	-8.03	Fluvial
L5 (T)	-6.16	Shallow marine
L5 (B)	-5.27	Shallow marine

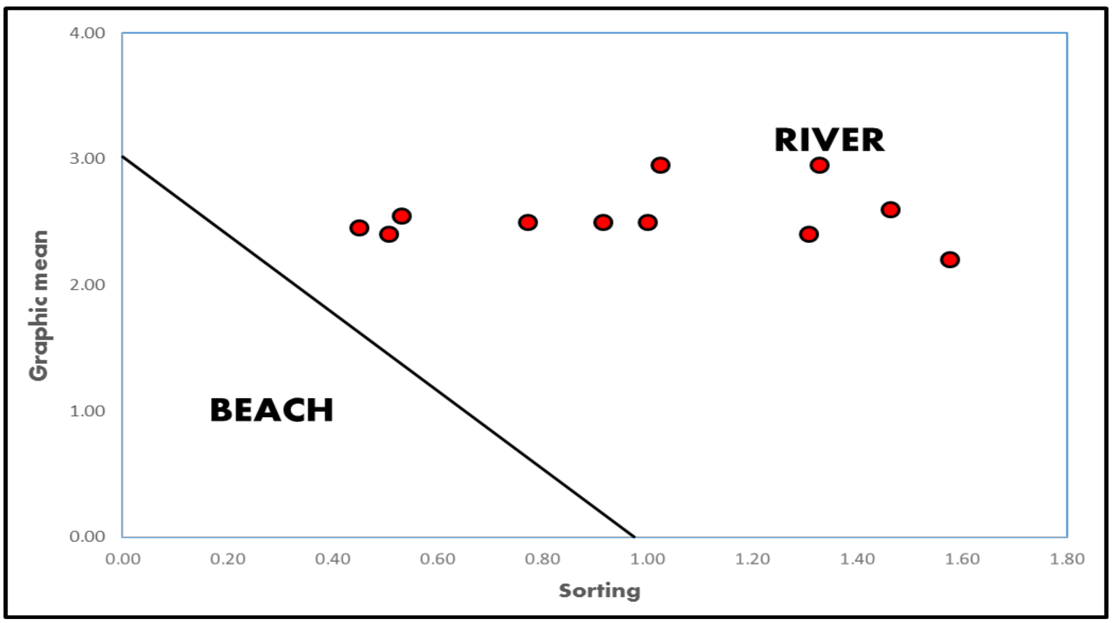

Figure 9. Bivariate plot of Mean against Sorting for the Ajali sandstone exposed at Okigwe (After Miola and Weiser, 1968).

The angular to sub-angular quartz grains and the opaque heavy minerals suggest a shorter distance of transportation. This similarly, confirms the presence of feldspar in some of the rocks of the sandstones since it may rarely survive long distant transportation due to their chemical instability. This result generally confirms studies of Odumoso et al. (2013).

Palaeoenvironment

Reconstruction of an ancient depositional environment of sandstones was originally dependent on the study of grain size distribution. The usefulness of statistical grain size parameters in characterizing sedimentary environment has become increasingly apparent over the past five decades as previous studies revealed that, correlation actually exists between textural parameters based on grain size, frequently distribution of sands and their environments of deposition (Odumoso et al., 2013). Attempts have therefore been made to relate statistical parameters (obtained from grain size distribution) to different environments of deposition. These attempts have proved very fruitful in environmental interpretation especially when they are integrated with other parameters such as sedimentary structures and geological settings.

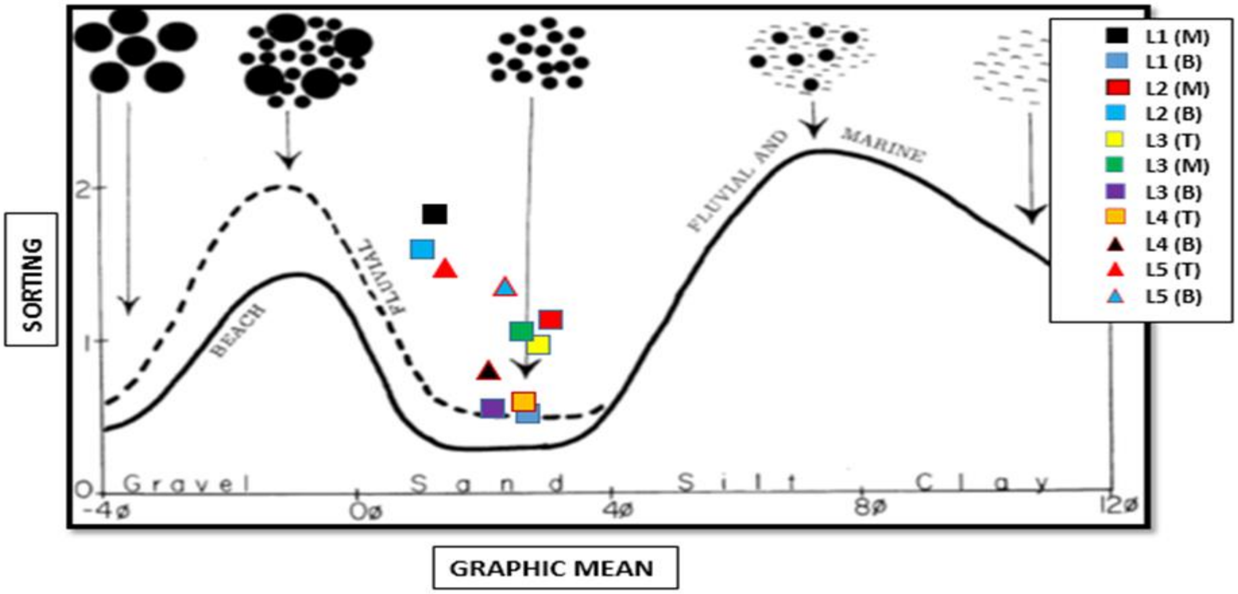

Figure 10. Scatter plot of sorting versus graphic mean (modified after Folk, 1974)

Table 4. Mineralogical Composition of the Sandstones from Thin Section.

Sample locations	Quartz (%)			Feldspar (%)			OTHERS	
	MQ	PQ	TQ	KF	PF	TF	CLAY	IRON
L1 (M)	40	5	45	30	8	38	2	15
L1 (B)	30	-	30	35	15	50	-	20
L2 (M)	37	10	47	25	15	37	-	16
L2 (B)	32	5	37	25	15	40	5	18
L3 (T)	22	8	30	30	17	47	3	20
L3(M)	30	20	50	20	15	35	-	15
L3 (B)	20	16	26	30	15	45	5	14
L4 (T)	50	5	55	20	15	35	2	8
L4 (B)	40	-	40	30	13	38	5	10
L5 (T)	30	10	40	25	19	44	7	9
L5 (B)	28	5	33	15	30	45	10	12
Average	32.64	9.33	39.36	25.91	16.09	41.27	4.88	14.27

Large amounts of heavy opaque minerals in the samples suggest an aerated environment of deposition while the predominance of quartz grains in the sandstones of the study area indicates an oxic environment. The sandstones in the study area are medium to fine grain suggested that such sediments were deposited by river and possibly tidal systems. The poorly sorted nature of the sandstones indicates that the sediments were deposited under variable current velocities and turbulence which led to the deposition of variable sand-sized sediments in the area (Mbulk et al., 1985). Poorly sorted sandstones were being deposited in a river environment (Friedman, 1961). The skewness of the sandstones range from strongly coarse skewed to strongly fine skewed. This is characteristic of fluvial/glacial environment (Lancaster, 1981; 1986). The different bivariate plots suggest a dominance of sandstone samples mainly of river environment. Similarly, multivariate results reveals fluvial and shallow marine dominated environments for the Ajali sandstones.

The general local unimodal patterns suggest sediments deposition in fluviatile environment (Selly, 1968). Considering all the above palaeoenvironmental tools, a fluviatile environment is firmly established with a stretch into deltaic regime for Ajali sandstones exposed at Okigwe.

CONCLUSIONS

The study area falls within Ajali Formation of Anambra basin which is an extension of the stratigraphic unit that is conformably overlying the Mamu Formation and underlying the Nsukka Formation. These Formations were deposited during the Maastrichtian (Hogue and Ezepue, 1977). The study of the ancient environment of the sediments has been reconstructed from the field relationships and textural analysis results. The sandstone outcrops in the study area exhibit a variety of colours ranging from white, pink, red, grey to dark grey. The sandstone consists of one major lithofacie: the false bedded ferruginised sandstone. Texturally, it consists of fine grained, negatively skewed and mostly leptokurtic, poorly to moderately well-sorted, friable to hard sandstone. The facies are interpreted as representing two major paleoenvironments: the near shore littoral environment as well as fluvial environment. The sandstones in the study area lack body fossils but contain bioturbations.

The mineralogical composition shows on the average; 32.6% monocrystalline quartz, 9.3% polycrystalline quartz, 16.1% plagioclase, 25.9% potassium feldspar, 4.9% clay matrix and 14.3% opaque. The high quantities of Quartz and feldspar classify the sandstone as sub-feldspathic arenites based on Pettijohn (1975) sandstone classification. Cementation is highly enhanced by the quartz overgrowth as well as by iron-oxide coatings (ferruginisation). Ferruginisation could have resulted from a precipitated Fe^{2+} and Fe^{3+} within the sediment particles as a result of changes in pH and Eh of the inter-particulate fluid (Adekoya et al., 2011).

The depositional history of the deposited sediments in Okigwe and environs therefore began with sedimentation in a nearshore littoral environment which was subsequently subjected to the influence of fluvial sedimentation as revealed from bivariate and multivariate analysis. A similar effect of the facies changes of Ajali Sandstone is reflected in the interpretations of the earlier workers notably Hoque and Ezepue (1977) as well as Ladipo (1986). The former inferred a continental fluvio-deltaic depositional setting while the latter referred to the depositional environment as tidal shelf.

Petroleum and groundwater geologists are especially concerned with the porosity of sedimentary rocks because porosity determines the volume of fluids (oil, gas, water) that can be held within a particular reservoir rock. Poorly sorted sediments tend to have lower porosities and permeabilities than well-sorted sediments. Ajali sandstones exposed at Okigwe are poorly sorted to moderately well sorted, hence, they are poor to fairly good reservoir rocks.

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