SEDIMENTOLOGY OF THE STRATIGRAPHIC SUCCESSIONS IN AFIKPO AREA, SOUTHERN BENUE TROUGH, NIGERIA.

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Abstract

Ezeaku Group is an old stratigraphical unit(s) in the sedimentary environment of the Southern Benue Trough, but the heterogeneity in its successions structurally has made it a reoccurring area of interest, when studying the sedimentary basins in the Lower Benue Trough. This research work intends to carry out a sedimentological study of the lithological sections observable in Ezeaku Group, with emphasis on the main stratigraphical successions. These would be achieved through examining the individual lithologs to determine depositional process, also examining the petrophysical properties of the units through X-Ray Diffraction analysis for clay minerals studies. The study integrated various methods from field to laboratory. Lithofacies, sedimentary structures, petrography and geochemistry have provided useful data for interpreting the depositional environments and model for the Ezeaku Formation in the Southern Benue Trough. Five (5) lithofacies were described and interpreted namely: Mudstone facies (A), Marl Facies (B), Silty Sandstone Facies (C), Laminated Sandstone Facies (D) and Cross bedded Sandstone Facies (E). The facies were deposited in a wide range of depositional environments varying from shallow shoreline (tidal lithofacies association) through shelf to slope. In the depositional model, shoreline progradation initiated shelfal erosion creating submarine canyons through which sediments were transported into deeper water environments. Information from thin section petrography of the Marl samples shows that the allochem is composed of quartz and other unidentified microfauna, cement is composed of clay, iron oxide and calcite while the matrix is composed mainly of unrecrystallized calcareous mud. Petrographic evidences from Amasiri sandstones such as the presence of quartz with sub angular to sub rounded grains and weathered Feldspar imply the significance of both mechanical and chemical weathering in the grains of the sandstone. They therefore, suggest that the compositional submaturity of these sandstones may be due to the short distance transport, relatively low source relief and relatively close provenance which may be related to humid climatic condition. This was confirmed by Mineral maturity index which showed an index value of 1.7. Dunham classification model of (1962), was adopted in the classification of the Carbonates of the study area, texturally, it revealed the Carbonates to be grain supported, hence referred to as Packstones, with values of 90% clast and 10% matrix, while Folks classification model using the recalculated modal composition of major sandstone elements revealed Quartz and Feldspars to be 61% and 15% respectively which explains their clan designation as subarkose, while rock fragments is 21% which is sublitherinite. Diagenetic imprints on the sandstone include fracturing and long contact of the grains suggesting an advanced level of diagenesis. Identified clay minerals from XRD are mostly tetrahedron clay minerals with high rate of clay sensitivity, thus in most cases blocking the pore throat of host lithology, which in turn affects the permeability and porosity of the formation in general.

Keywords: Petrography, decantograph, markovian, litho section, successions.

1.0 Introduction

The Benue Trough is a unique rift feature on the African continent, such that it occupies an intra-continental position. It has a thick compressionally folded Cretaceous supracrustal fill, which is generally divided into Lower, Middle and Upper Benue Troughs sub-basins (Cratcheley and Jones 1965; Wright 1968; Grant 1971; Burke et al., 1971; Burke and Whiteman 1973; Nwachukwu 1972; Olade 1975). The Lower Benue Trough (LBT) has a lateral extent of about 250km in the south and includes the Abakaliki anticlinorium and the Afikpo syncline, It is a linear, intracratonic, graben basin, trending NE-SW (Cratcheley and Jones 1965). The major fills in the Lower Benue Trough includes The Amasiri Sandstone, Ezeaku Shale, all located in the Southern Benue Trough.

Even though there exist counter opinions on the depositional environment of the group (Ezeaku), it has remained an important study area in the southern Benue Trough because of the heterogeneity in its succession(s). Some works previously done in the area interpreted the formation as shallow water deposits based on Ammonite content, while a counter opinion picked out the shaly unit of the Ezeaku member alone, and regarded it as transgressive deposits in shallow shelf setting.

The interpretation of many rock types relative to their provenance may have characteristic textures and composition that allow them to be identified, this is so because textures and structures of the sedimentary sequences usually suggest their dominant provenance. Hence part of the provenance interpretation in this work will involve the examination of the clast types present (Pettijohn, 1975; Basu, 2003). If a particular clast type present in a sediment can be recognized as being characteristic of a known source area by its petrology and chemistry, then its provenance can be established. Therefore the work is aimed at examining the lithologies and their stratigraphic relationships with a view to making inferences on the geology, and of course the environment of deposition (EOD) of the sedimentary units.

1.1 Regional Tectonics and Stratigraphic Setting of the Study Area

Benue Trough has been described as a rift depression of up to 80 km long and 90 km wide on the average, in eastern Nigeria; composed of marine and fluvio-deltaic sediment that have undergone distortion by compressional folding (Cratchley and Jones, 1965). With the emergence of sea floor spreading tectonic hypotheses. Burke et al. (1970) came up with a new theory for the origin of the trough. These authors contended that the Benue rift first opened in the Cretaceous, due to the spreading of a crustal ridge in the region of the present trough, according to Burke et al. (1970), the tectonic activity seized by late cretaceous and was followed by a closing episode of the North Atlantic and South Atlantic African plates in the Santonian. The resultant differential motion of the two parts of the African plate, in their view, resulted in the Santonian folds and gave them their unique parallel and sub-parallel structure along the Trough.

The Benue Trough consist of a linear stretch of sedimentary basin running from the present confluence of the Niger and the Benue rivers to the northeast, and bounded by the Basement Complex areas in the north and south of the River Benue. This elongate Trough Basin is continuous with the Coastal Basin, it has been described as the long arm of the Nigeria Coastal Basin (Reyment, 1965).

The stratigraphy of the Southern Benue Trough is marked by two cycles of marine transgressions and regressions which occurred from the middle Albian to the Coniacian culminating in the deposition of marine mudrocks, sandstones and limestones as well as pyroclastic flows and basic intrusives (Murat, 1972; Hoque, 1977).

Stratigraphically, Benue Trough is arbitrarily subdivided into three regions; the upper or north-east regions; middle Benue region or the Lafia-Muri area; and the lower or southern Benue Trough (Obaje et al., 2004), which is the area South and west of Markurdi, as illustrated below.

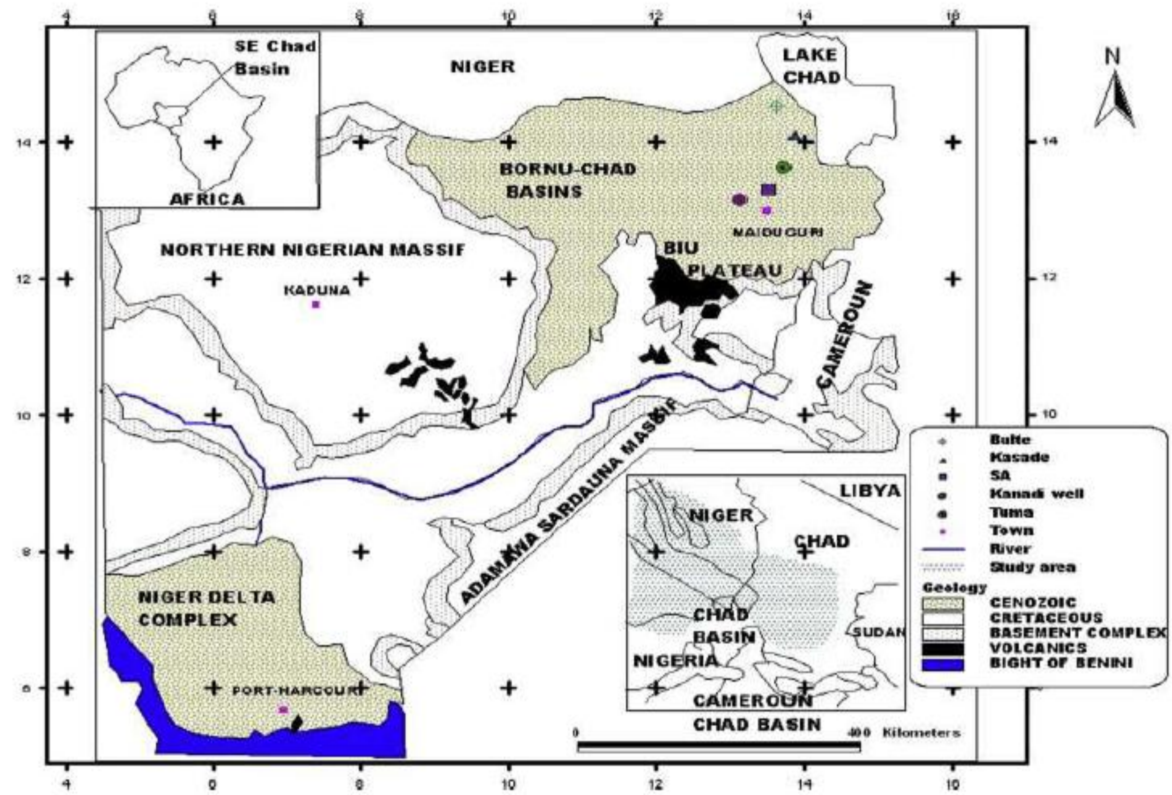


Fig 1: Geology of the Cretaceous sediments of the Benue Trough (After Cratchley and Jones, 1965).

These series of transgressive and regressive phases which affected the Benue Trough according to (Reyment, 1965), defines the Stratigraphy and Palaeogeography of different sedimentary basins, as illustrated below in the stratigraphic framework of the southern Benue Trough and Anambra Basin, after (Okoro et al., 2012).

Table 1.0 Lithostratigraphic Framework for the Southern Benue Trough, Southeast Nigeria (after Okoro et al., 2012)

		Lithostratigraphic Unit		**Basin**
		Formations	Members	
Late Cretaceous	Late Maastrichtian	Nsukka Formation		Afikpo Sub-basin
	Middle Maastrichtian	Ajali Formation		
	Early Maastrichtian	Mamu Formation		
	Late Campanian	Nkporo Formation	Nkporo Shale Afikpo Sandstone Nkporo Shale Afikpo Sandstone	
	Santonian	Angular Unconformity		
	Turonian	Ezeaku Group		Benue/Abakaliki Basin/Calabar Flank
	Cenomanian	Odukpani		
Early Cretaceous	Albian	Asu River Group		
Precambrian	Precambrian Basement Complex			

Note: The Stratigraphic position of the Amasiri Sandstone and Ezeaku Shale relative to other formation in the Southeastern Nigeria. Sediments of Benue Trough show markable variation in lithostratigraphy and biostratigraphy. The various lithologies range from the Albian to the Maastrichtian age, with the oldest sediments being Albian in age (Fig 2.0).

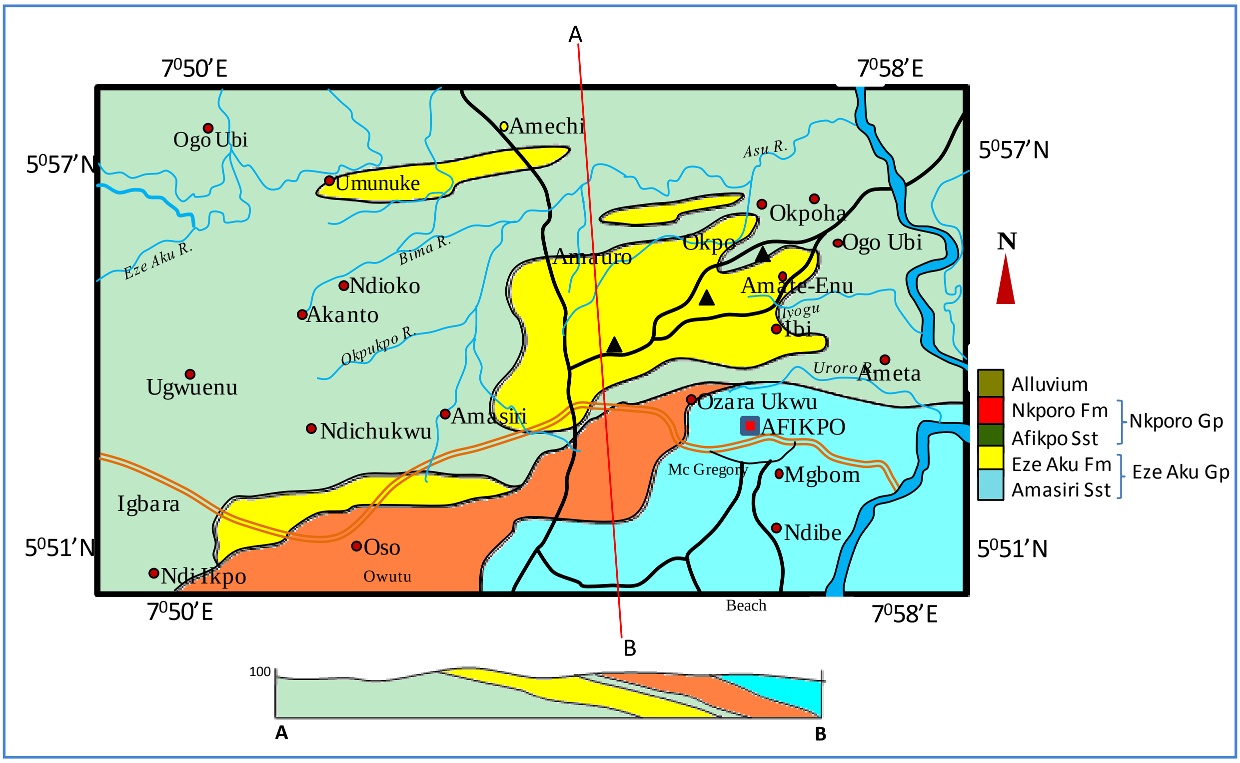


Fig: 2.0 Geologic map and cross-section of the study area, (modified after NGSA, 1994).

Table: 2.0 Description and coordinate of sample locations

Outcrop Location	**Coordinate**	**Elevation (ft)**	**Dip direction**	**Description**
Km 6 Ibii Abalakilki road	Long 7.54.534, Lat 5.54.712	192	NE-SW	Outcrop
Ibii Abakaliki road	Long 7.54563, Lat 5.54712	21	NE-SW	Outcrop
Ozaraukwu community	Long 7.54.60, Lat 5.474	208	NE-SW	Quarry site
Akpoha community	Long 7.5785, Lat 5.5785	126	NE-SW	Outcrop
Behind Govt. tech College	Long 7.5785, Lat 5.5785		NE-SW	Outcrop
Km 11 before Julius berger quarry	Long 7.54705, Lat 5.55241	168	SE-NW	Road Cut

2.0 Materials and Methods

2.1 Facies Analysis

A facie is a body of rock with specified characteristics, it can be any observable attribute of rocks such as their overall appearance, composition, or condition of formation, and the changes that may occur in those attributes over a geographic area.

Ideally, a sedimentary facie is a distinctive rock unit that forms under certain conditions of sedimentation, reflecting a particular process or environment. Sedimentary facies are either descriptive or interpretative. Sedimentary facies are bodies of sediment that are recognizably distinct from adjacent sediments that resulted from different depositional environments. Generally, Geologists distinguish facies by the aspect of the rock or sediment being studied, while facies based on petrological characters (such as grain size and mineralogy) are called lithofacies, whereas facies based on fossil content are called biofacies.

A facie is usually further subdivided, for example, one might refer to a given facies as, “cross-bedded oolitic limestone facies" or a “shale facies". The characteristics of the rock unit come from the depositional environment and from the original composition. Sedimentary facies reflect their depositional environment, each facies being a distinct kind of sediment for that area or environment.

2.2 Thin-Section Analysis

Four (4) fresh representative Sandstone samples collected from sections of some of the Lithostratigraphic units in the study area including Amasiri Sandstone and Ezeaku Shale were randomly selected and prepared for thin section microscopy.

Thin-section slides were prepared from the representative Sandstone samples obtained from the field for thin section petrography**,** and further examination was made under transmitted light petrographic microscope. After which, the photomicrographs of these thin sections were taken to illustrate their mineralogy, mineral associations and provenance assertions.

Samples of sandstones were analyzed using a classification method, that encompasses the framework of qartz (Q), feldspar (F), and rock fragment (RF), this is to ascertain the quantitative prevalence of certain minerals in the rock samples.

2.3 X-Ray Diffraction Analysis

This is another method of sedimentological study, because certain clay minerals are characteristically formed by weathering of a particular bedrock (Blatt 1985). Example is weathering of basaltic rocks which produce clay minerals in the smectite group, viz; Kaolinite, Illite, Chlorite and Ionite.

The study above requires high technological approach and the two major techniques known includes: scanning electron microscope and X-Ray diffraction pattern analysis –XRD (Tucker, 1988).

The powdered sample prepared is regarded as bulk Sample. The sample is smeared evenly on the sample holder made of aluminum material, with the aid of smooth slide or any material with smooth surface edge.

The setting is between angles of 2^o to 60^o theta as the bulk sample scanning range. The running rate (scanning speed) is set at 6 degree per minutes.

The holder is carefully placed on the loading point of the movable **goniometer** arm that contains a clamp capable of gripping the sample firmly. The window indicating readiness after properly closed. By commanding the software, the analysis commenced automatically.

The pronounced **peaks or diffractogramms** displayed, express the minerals composition at the various angle of the degree theta.

3.0 Results

3.1 Lithostratigraphic study

A total of five (5) outcrop sections were studied, the rock types that dominated the study area are sandstone, shale, limestone and patchy presence of mudstone. In most cases, the fine grained sandstones are highly fossiliferous, indurated with presence of molds and casts, appearing grayish-white in colour (fig. 3 below). Sedimentary structures observed in most areas includes crossbeds, occasionally overlain by few meters of thick fine to medium grained bioturbated impure limestone (marl), which in turn is overlain by mudstones (fig. 4).

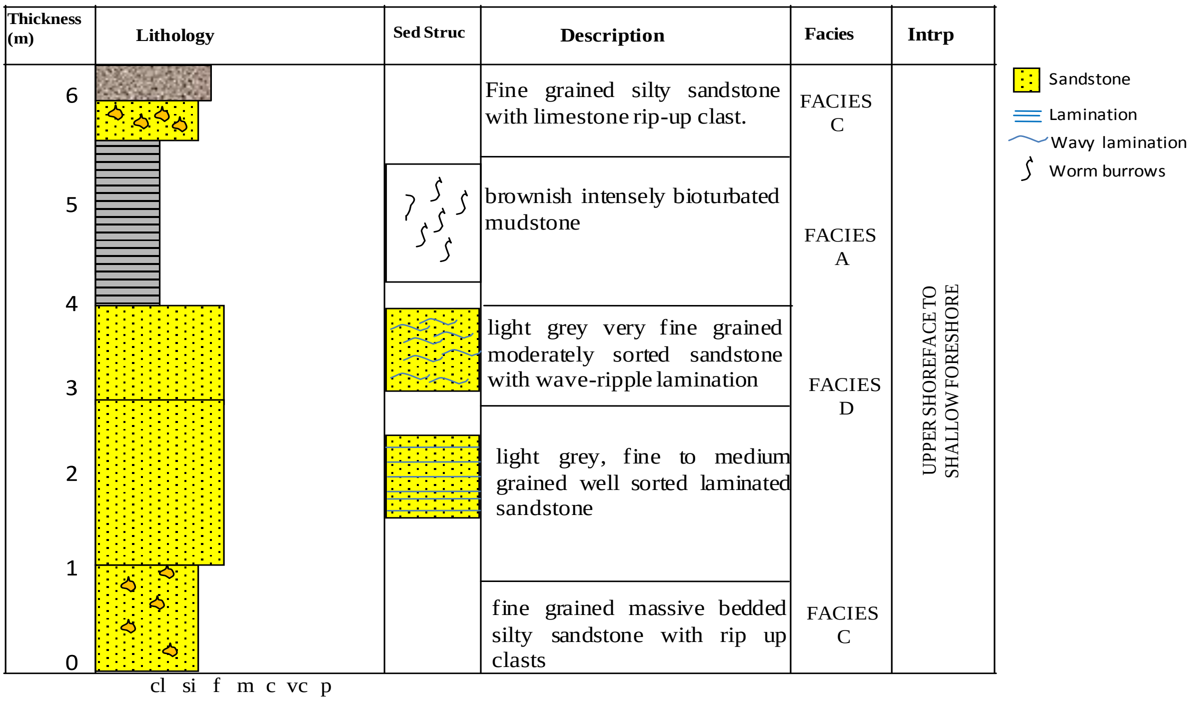


Fig 3. Litholog of section behind Government College Akpoha

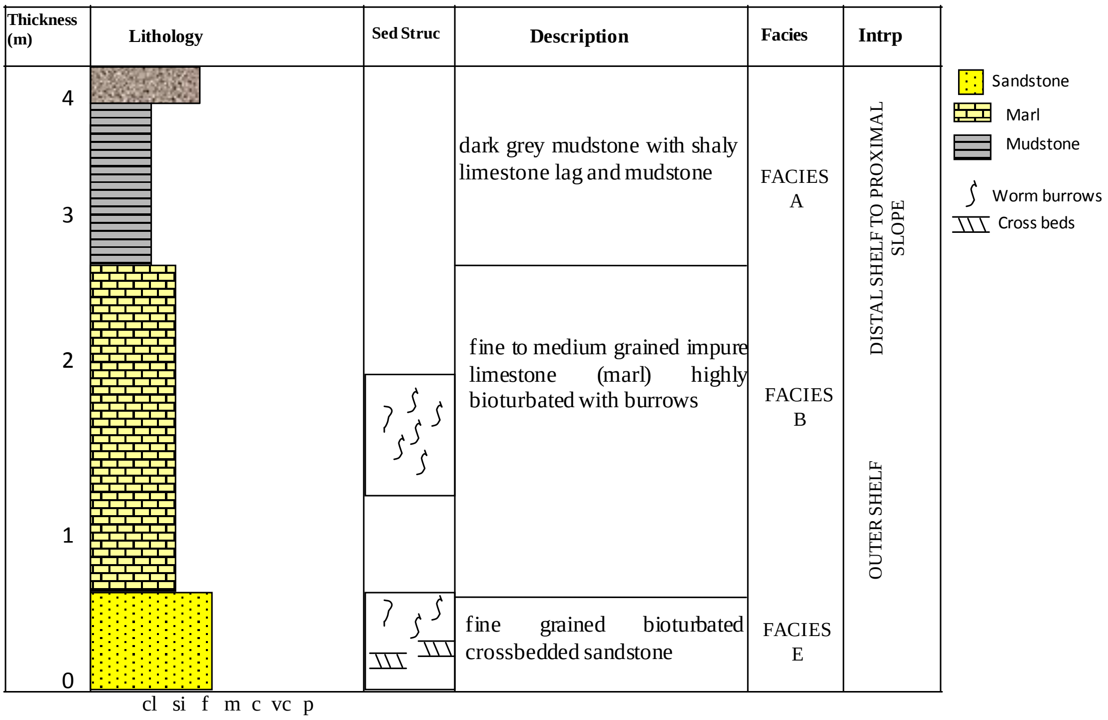


Fig 4. Litholog of Quarry section along Akpoha road

3.2 Results of Thin section Petrography

The result of Thin Section Petrography of representative sandstone and marl samples from the study area is presented as modal composition (Table 3a and b) and photomicrographs (Fig 5).

The percentage composition of minerals and petrographic attributes is also shown on the modal count table.

Table 3a: Modal composition of representative sandstone samples

Sample	Qtz%	Feld%	RF%	Fe%	Bio%	Si%	Total	Description
SB	75	15	0	10	-	-	100	Sub angular to sub rounded, Medium to fine grained and Poorly sorted Fractured grains observed.
SC	70	15	5	10	-	-	100	Sub angular to sub rounded, Medium to very fine grained, Poorly sorted and fractured.
SD	50	10	15	10	10	5	100	Angular to sub angular, Medium to fine grained, Poorly sorted, quartz overgrowth observed.
SA	40	0	60	-	-	-	100	Angular to rounded, Fine to very fine grained, Moderately sorted, Iron mineral and silica are cement material, Iron minerals have nearly obliterated Quartz grains have been corroded by iron minerals.

Table 3b: Modal composition of representative Marl samples

	% Clast	%Matrix
Sample L_3	90	10
Sample L_5	90	10

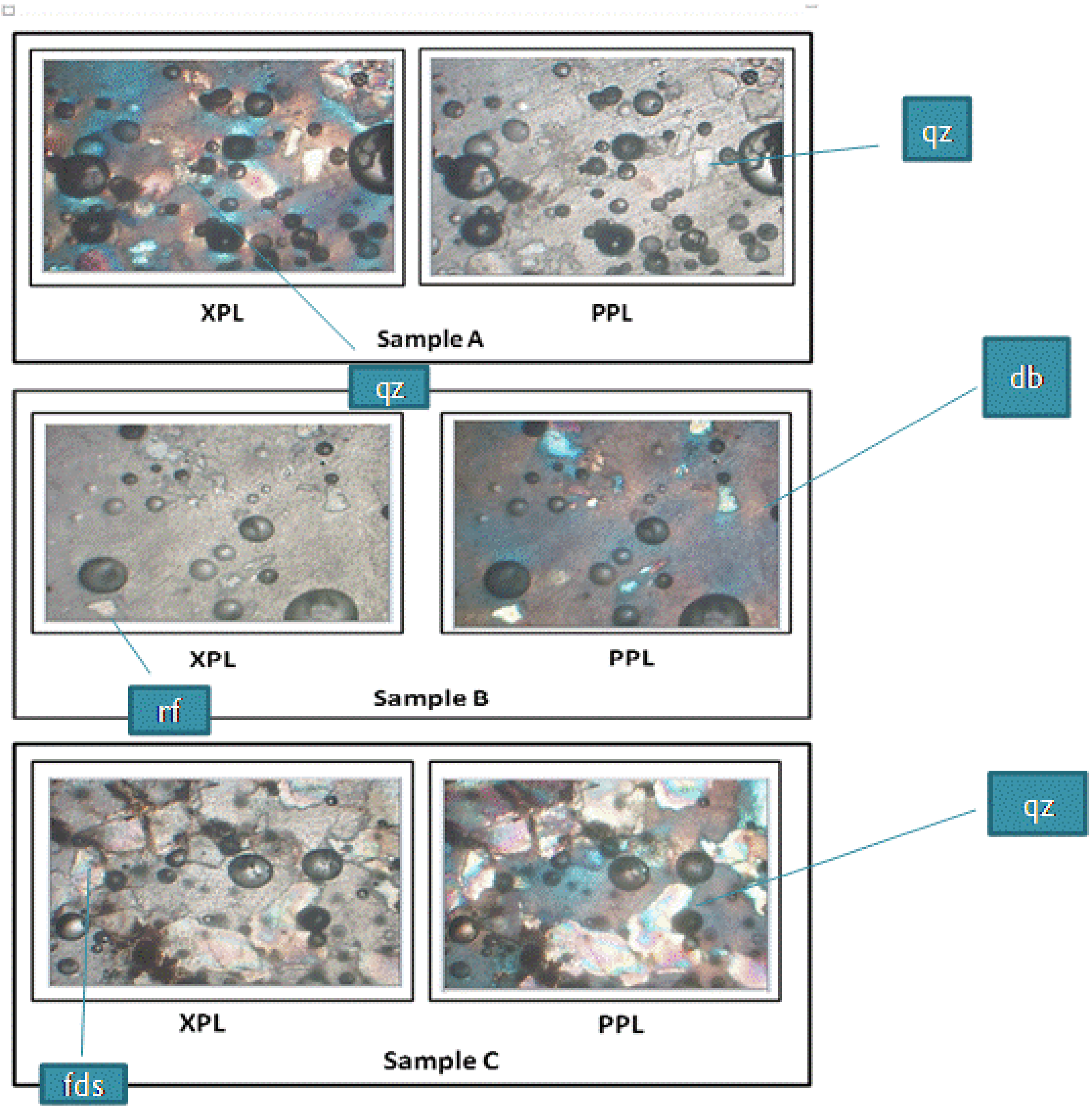


Fig. 5: Photomicrograph of Outcrop Samples From Eze-Aku Group viewed under XPL and PPL.

Information from thin section petrography of the marl samples shows that the allochem is composed of quartz and other unidentified microfauna, cement is composed of clay, iron oxide and calcite while the matrix is composed mainly of unrecrystallized calcareous mud.

Petrographic evidences from Amasiri sandstones such as the presence of quartz with sub angular to sub rounded grains and weathered Feldspar imply the significance of both mechanical and chemical weathering in the grains of the sandstone. They therefore, suggest that the compositional submaturity of these sandstones may be due to the short distance transport, relatively low source relief and relatively close provenance which may be related to humid climatic condition. This was confirmed by Mineral maturity index which showed an index value of 1.9.

Diagenetic imprints on the sandstone include fracturing and long contact of the grains suggesting an advanced level of diagenesis.

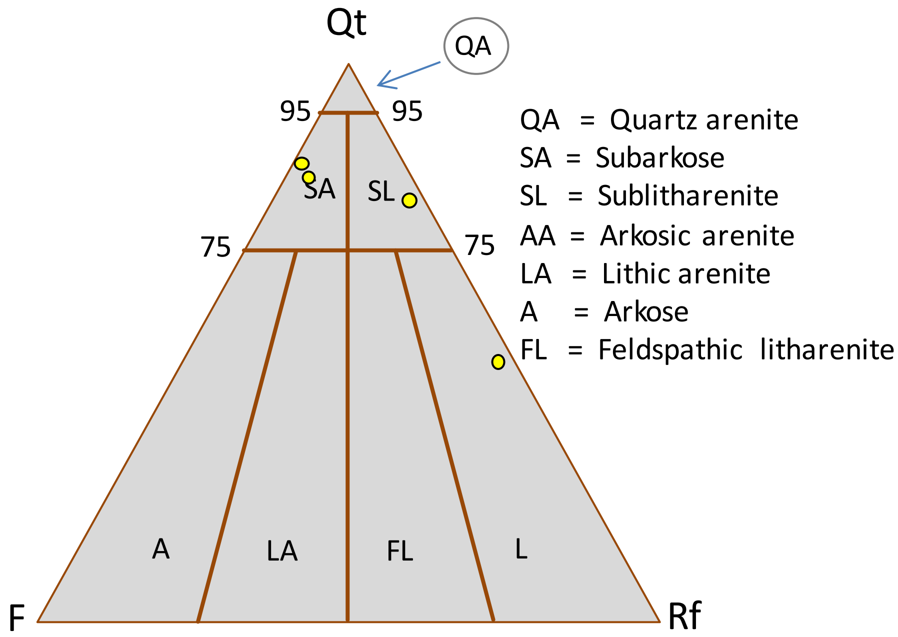


Fig. 6: Triangular diagrams for the classification of the studied sandstones (after Folk, 1980)

Mineralogical maturity

The mineralogical maturity is deduced using the mineralogical maturity index method (MMI), with the following descriptive steps and subsequent substituting values gotten from the indexes (Table 4.7).

The Mineral Maturity Index (MMI) was also calculated as follows:

$$\frac{Proprtion\ of\ Quartz\ (Q)}{Proportion\ of\ Feldspar\ (F) + \ Proportion\ of\ Rock\ Fragment\ (RF)}$$

Table 3 c. Maturity scale of sandstones (After Pettijohn, 1975)

Limiting % Q and (F + R. F)	MI and maturity stage
Q = ≥95% (F + R. F) = 5- 10%	MI = ≥ 19 super mature
Q = 95 - 90 ((F + R. F) = 5 -10%)	MI = 19 - 9.0 mature
Q = 90 -75% (F + R. F) = 10 25%	MI = 9.0 - 3.0 sub mature
Q = 75 -50% (F + R. F) = 25 -50%	MI = 3.0 - 1.0 Immature
Q = < 50%	MI ≤ 1
(F + R. F) > 50%	Extremely Immature

3.3 Facies Interpretation

A facie is a rock unit distinguishable in the field by its geometry, texture, lithology, and sedimentary structures. Lithofacies description was based on distinctive lithologic features including composition, grain size, bedding characteristics and sedimentary structures. The outcrop locations were subdivided into Lithofacies following the standard facies practices such as that proposed by Miall (1978). They have been described briefly below:

1. Dark grey mudstone facies (A)
2. Calcareous muddy limestone (marl) facies (B)
3. Fine to very fine slightly bioturbated silty sandstone facies (C)
4. Fine grained laminated sandstone facies (D)
5. Medium to coarse grained cross bedded sandstone facies (E)

Hence these observed facies occurrence was used in constructing the transition patterns seen on different lithosections (Markov chain analysis).

3.4 Result of Markov Chain Analysis

Figure 7 shows the Individual facies relationship diagrams for the lithosections in the study area. The various sections studied in the field were erected based on observed facies transitions. The composite facies relationship diagram for the formations was constructed by combining their respective individual FRDs (Fig.8). Table 4.1 shows the summary table of the number of occurrences of each facies while Tables 4.2 to 4.5 on the other hand show the computed transition count matrix, observed transition probabilities, random probability and difference matrix for the sections in the study area.

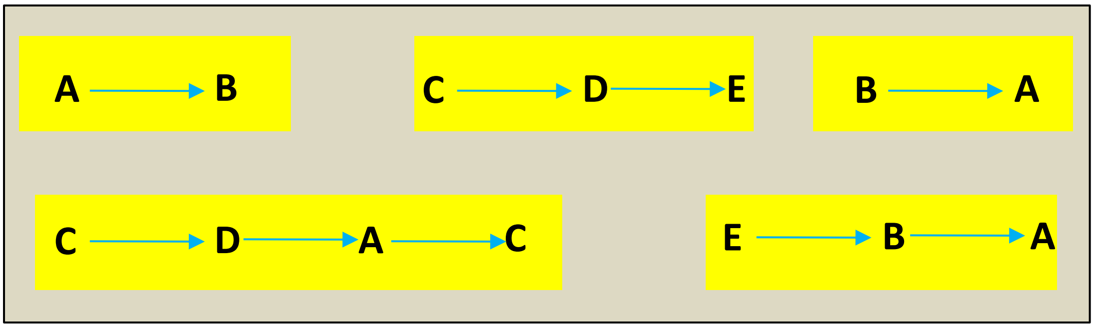


Fig 7: Facies Relationship Diagram for sections in the study area

Table 4.1 Facies occurrence summary

Facies	Frequency
A	4
B	3
C	3
D	2
E	2
TOTAL	**14**

Table 4.2. Transition Count matrix for facies

	A	B	C	D	E	Rt
A		1	1			**2**
B	2					**2**
C				2		**2**
D	1				1	**2**
E		1				**1**

Table 4.3. Transition Probability matrix for facies

	A	B	C	D	E
A	0	0.5	0.5	0	0
B	1.0	0	0	0	0
C	0	0	0	1.0	0
D	0.5	0	0	0	0.5
E	0	1.0	0	0	0

Table 4.4. Random matrix for facies

	A	B	C	D	E
A	0	0.3	0.3	0.3	0.2
B	1.4	0	0.3	0.2	0.2
C	0.36	0.27	0	0.18	0.18
D	0.33	0.25	0.25	0	0.16
E	0.33	0.25	0.25	0.16	0

Table 4.5. Difference matrix for facies

	A	B	C	D	E
A	0	0.2	0.2	-0.3	-0.2
B	0.6	0	-0.3	-0.2	-0.2
C	-0.36	-0.27	0	0.82	-0.18
D	0.17	-0.25	-0.25	0	0.34
E	-0.33	0.75	-0.25	-0.16	0

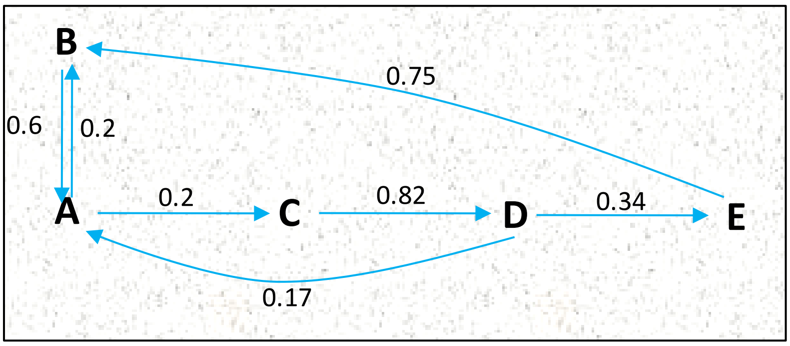


Fig 8. Composite FRD for lithofacies

3.5 Results of X-Ray Diffraction Analysis

The results of X-ray diffraction obtained from three Marl samples in the study area is shown in diffractogram, showing peaks of identified minerals (fig.9.1-3) summary of identified minerals is shown in table 5.

XRD results/ interpretation of sample - A

The three major or strongest peaks for sample **-A** as expressed on the diffractogram were at angles 23.9627 (as the 1st strongest peak), 18.2055 (as the 2nd strongest peak) and 47.4687 (as the 3rd strongest peak).

- The intensity ratios exhibited are 100, 15 and 12 respectively.
- Detail expression of these peaks as contained on the **CARD DATA** after searching and matching procedures are stated below:
- Column 1,2,4,6,7 and 8 have the 1st and the 2nd strongest peaks corresponding to the angles at 23.9627 and 18.2055 respectively
- Column 1,2,3,5,and 6 have the 2nd and 3rd strongest peaks corresponding to the angles at 18.2055 and 47.4687respectively
- Column 2,3,4 and 6 have the 1st and 3rd strongest peak corresponding to the angle at 23.9627 and 47.4687 respectively.
- Some residual peaks present are found to correspond to the angles at 36.7808, 52.1850 and 57.2916 respectively.

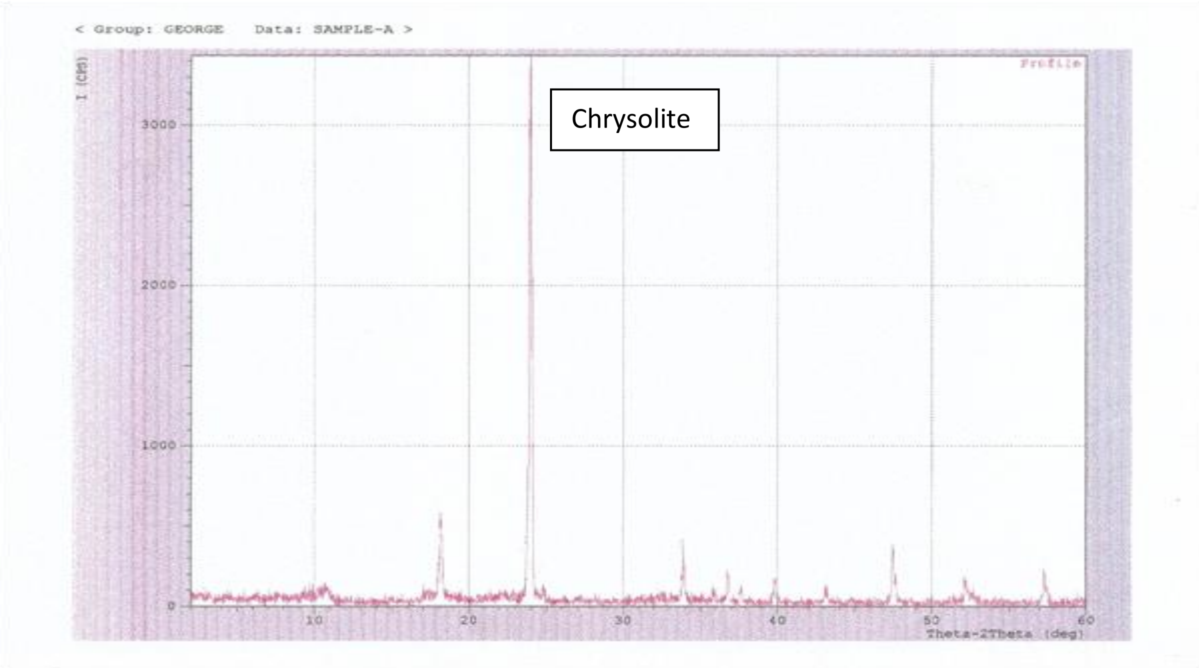
The major minerals as confirmed by the various peaks are: Mordenite, Chrysotile, Osmulite, Antigorite and Sepiolite.

The minor minerals found are: Lizadirite, and Ramsidellite.

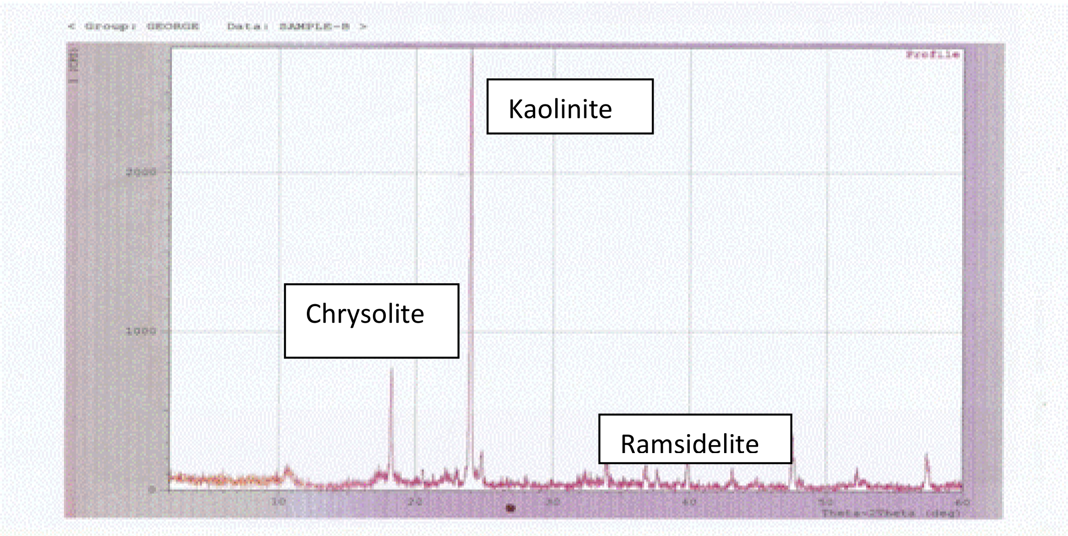
The same process above was repeated for other samples and their various peaks detected respectively, and their corresponding minor and major clay mineral types were subsequently analyzed, and tabulated below.

Table 5: Summary of the major and minor clay mineral groups from the XRD Analysis

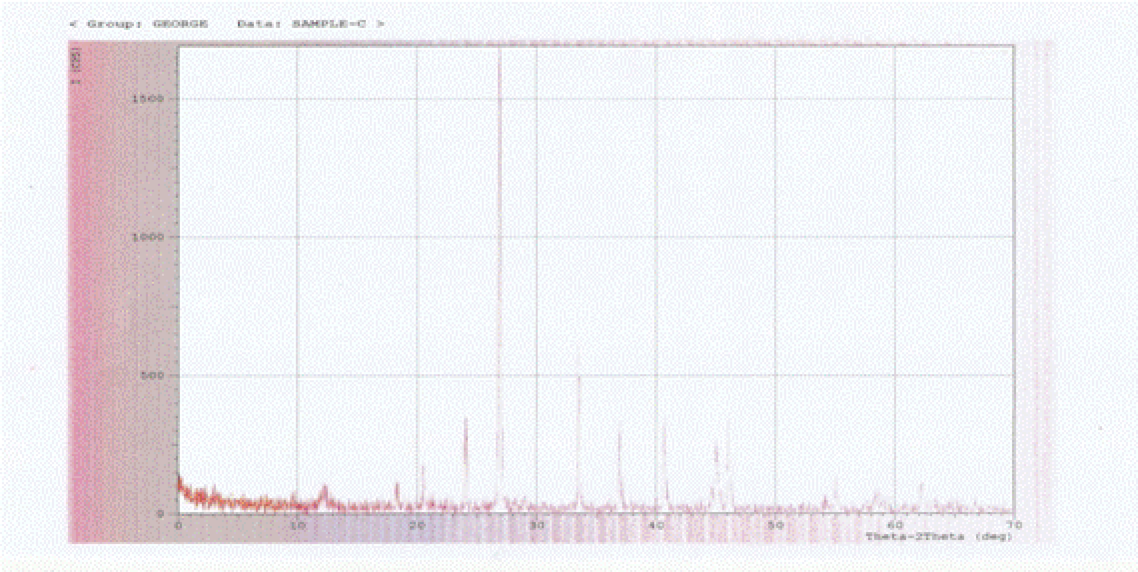
	Major Clay Minerals	Minor Clay Minerals
Sample A	Mordenite, Chrysolite , Osmullite Antagorite Sepiolite	Ramsidellite
Sample B	Chrysolite, kaolinite, Dickite, Illite, Antigorite Osmulite Halloysite	Haematite,
Sample C	Chrysolite, kaolinite, Sepiolite, Dickite, Illite, Antigorite Osmulite	Haemalite, Tobermorite



(Fig. 9a) X-Ray diffractogram of marl sample (A)



(Fig. 9b) X-Ray diffractogram of marl sample (B)



(Fig. 9c) X-Ray diffractogram of marl sample (C)

Evidence from X-Ray Diffraction

XRD analysis has been strongly recommended when carrying out Lithological or Sedimentological study of an area, especially if there are evidences of Carbonate occurrence in the area. XRD analysis uses pulverized samples, mostly in powdered form, and subsequently interprets Clay minerals with the highest peak fluctuations as observed above, the reoccurrence and abundance of such Clay mineral type determines its effect on the porosity and permeability of the Lithologies of the area. The major minerals that were identified include Kaolinite, Osmullite, Chrysolite, Sepiolite and Antigorite, these are mostly tetrahedron clay minerals with high rate of clay sensitivity, thus in most cases blocking the pore throat of host lithology, which in turn affects the permeability and porosity of the formation in general.

Significance of the Clay Minerals in the Host Lithology and Environment

Detailed examination of the host lithologies, first of all confirmed field evidence of weathering processes in limestones. It has demonstrated that Kaolinite is the end product of clay mineral weathering under conditions of acid leaching. Furthermore, limestones that were not exposed to periodic weathering, may contain hydrous mica or montmorillonite, and this in turn explains the presence of K_2O, MgO and CaO in the analysis, although the $CaCo_3$ of the parent limestone has been removed.

Significantly too, the rapid erosion experienced at the troughs in the study area prohibits large-scale development of completely leached soils and encourages the deposition of alluvium whereby the soil material is incompletely weathered, thereby greatly boosting fertility from the agricultural perspective. The deposits laid down by the draining medium contains less amount of Kaolinite, but mostly Mica, which may later convert to Kaolinite as the host lithology matures.

4.0 Discussion

Environment of Deposition:
Evidence from Facies Study

Five lithofacies were described In the study area:

Cross bedded Sandstone Facies (E)

This lithofacies comprises of light grey to whitish sandstone, fine to very coarse and pebbly but dominantly medium to coarse grained and pebbly in places; moderately to poorly sorted. The sandstones displays prominent sigmoidal planar cross beddings with mud draped foresets and tidal bundles. This lithofacies represents the uppermost part of several upward coarsening cycles of deposition on the Amasiri Sandstone ridges from Akpoha to Afikpo. It is interpreted as products of tidal processes in shallow upper shoreface – foreshore setting (Anderton, 1976; Shanmugam, 2003; Nichols, 2009).

Silty sandstone and Laminated Sandstone Facies (C,D)

These lithofacies are composed of light to grey sandstone with mudstone interlamination/interbedding. The sandstones are very fine to fine and moderately to well sorted. The lithofacies was deposited during late stage of forced regression when the shore line was near the shelf edge (Catuneanu, 2006). The lithofacies is part of the weakly confined and distributary splay associations/environments (Sprague et al. (2005).

Shale/Mudstone Facies (A)

This lithofacies comprises of very thinly bedded shales interlaminated/interbedded with cm – thick beds of mudstone beds. The interstratifications of thin deposits of silty mud and shale is evidence of waning flow, typical of storm or turbidity currents (Amajor, 1987).

Marl Facies (B)

This facies occurs as parallel to near parallel ridges exhibiting an upward coarsening profile from the marl at low lying areas to massive sandstone at the top of the ridges. Trace fossils observed in this facies belong to the cruziana ichnofacies represented by planolites. Cruziana ichnofacies are mainly produced by deposit feeders foraging for food in the muddy substrates (Igwe and Okoro, 2014).

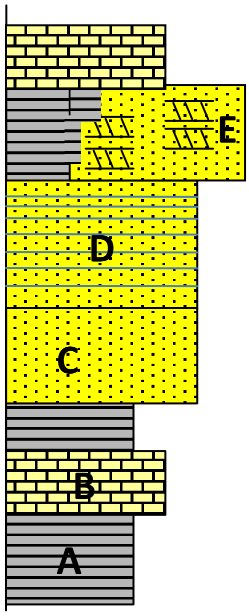
Depositional Model

The depositional environments for the different depositional units within the Ezeaku Formation were interpreted by integrating results of lithofacies analysis, sedimentary structures interpretation and petrography. A 2-D and 3-D model was generated based on information distilled out from facies analysis using the Markov chain statistical technique. Facies transitions from the difference matrix were used to generate a 2-D model depicting a shallowing upward trend (Fig. 9 and 10).

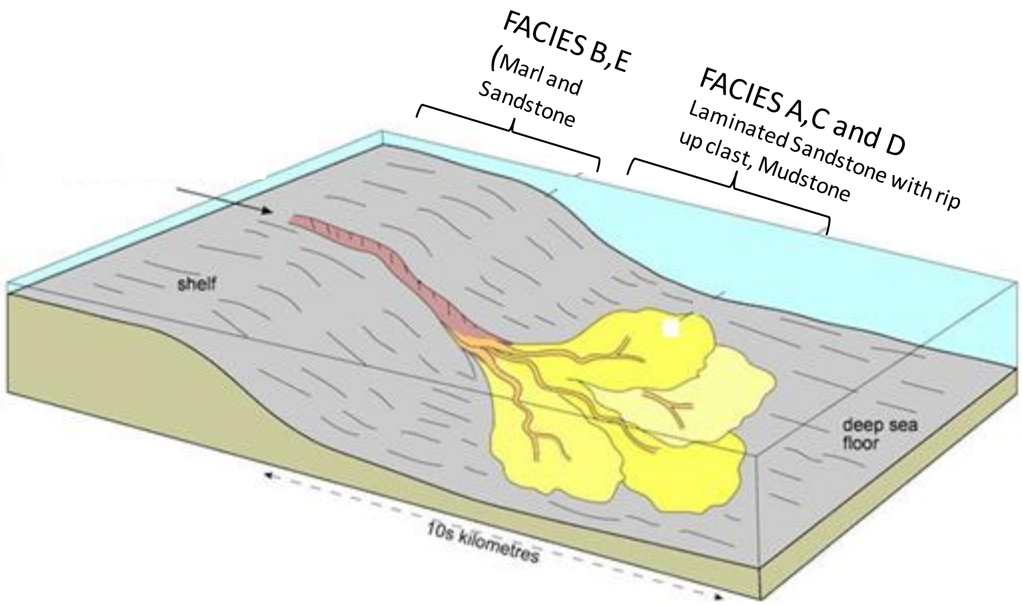
The Ezeaku facies have been particularly studied by Banerjee (1980) and Amajor (1987) both with different interpretations of depositional environments. While Banerjee (1980) suggested subtidal and tide dominated shallow marine depositional environment. Amajor (1987) suggested deposition in storm dominated, shallow shelf environment. Recently, Okoro and

Igwe (2014) suggested a wide range of depositional environment ranging from shallow shoreline through shelf to submarine canyon.

In the model depicted in the present study, the environmental setting of the Ezeaku Formation changed in the late Turonian when sea level fall and shoreline progradation initiated shelfal erosion creating submarine canyons through which sediments were transported into deeper water environments. Sediment-laden water masses triggered turbidity currents at the shelf edge and deep water with the deposition of the Amasiri Sandstone. The exotic limestone, carbonaceous and shale clasts of pebble to cobble sizes scattered in different orientations and floating within fine-grained matrix of the conglomeritic lithofacies interpreted as weakly confined distributary splay lithofacies association in the distal/lower fan settings.



(Fig. 10) 2D depositional model for stratigraphic sections in the study



(Fig. 11) 3D depositional model for the Ezeaku Formation

Conclusion

The study of the sedimentology and stratigraphic successions of Ezeaku group Mid-Createaceous (Turonian) age, Lower Benue Trough was carried out through detailed and analytical processes, was preceded by outcrop-to-outcrop study, for the purpose of identifying the lithologies in the area and also understand different Geologic activities which occurred as at the time of deposition. Lithofacies, sedimentary structures, petrography and geochemistry have provided useful data for interpreting the depositional environments and model for the Ezeaku Formation in the southern Benue Trough. Five (5) lithofacies were described and interpreted.

The rocks were deposited in a wide range of depositional environments varying from shallow shoreline (tidal lithofacies association) through shelf to slope.

Identified clay minerals from XRD are mostly tetrahedron clay minerals with high rate of clay sensitivity, thus in most cases blocking the pore throat of host lithology, which in turn affects the permeability and porosity of the formation in general.

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