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Sedimentology and Sequence Stratigraphy of the Eocene Nanka Formation (Ameki Group): An Evaluation of Ogbunike Reference Locality in Anambra Basin, South-Eastern Nigeria.

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Abstract: *Sedimentology and Sequence stratigraphic study of Eocene Nanka Formation,situated at a reference locality in Ogbunike south-eastern Nigeria,showed a section made up of ironstone/sandstone and shale, sandstone, sandstone/siltstone and interstratified calcareous clay and shale facies.Palynological analyses on Facie A shows that the presence of monoporitesannulatus ,proxapertitescursus/ operculatus,schizosporisparvus, Homotryblium spp.anddiphysescolligerum suggest a paleoenvironment in a continental shelf,while age diagnosting index palynomorphs species present,suggest a middle Eocene age for the section.The sieve and paleocurrent analyses carried out on Facies C shows fluvial dominated environment.Sequence stratigraphic analyses of the area indicate a late highstand systems tract and lowstand systems tract,with a type II sequence boundary.*

Keywords*: Sedimentology,Sequence stratigraphy,Anambra Basin,Nanka Formation and Eocene*.

I. Introduction

This study examines part of the sedimentary units of the Eocene Nanka Formation of Anambra Basin exposed at (lat. 6°10' 52.4" N and long. 6° 51'54.3" E) Ogbunike near Old Onitsha toll gate, along Onitsha-Enugu expressway in Anambra State, Southeastern Nigeria.See Fig, 1. Reyment, (1965), Nwajide, (1979, 1980, 2006).Nwajide and Reijers (1996), Umeji,(2003) and Chiaghanam, (2008) have studied the Nanka Formation with respect to their lithostratgrphy, age relations, sequence stratigraphy, depositional environment, reservoir properties and clastic sedimentary structures.

This study has integrated lithofacies, palynology, paleocurrent and sequence stratigraphy in the interpretation of EoceneNankaFormation in the Anambra Basin, Southeastern Nigeria.

This paper attempts to re-evaluate the sedimentology, palynology and stratigraphic architecture of the Nanka Formation, using Ogbunikereference locality as a model that may be used as a regional framework for a basin-wide predictions.

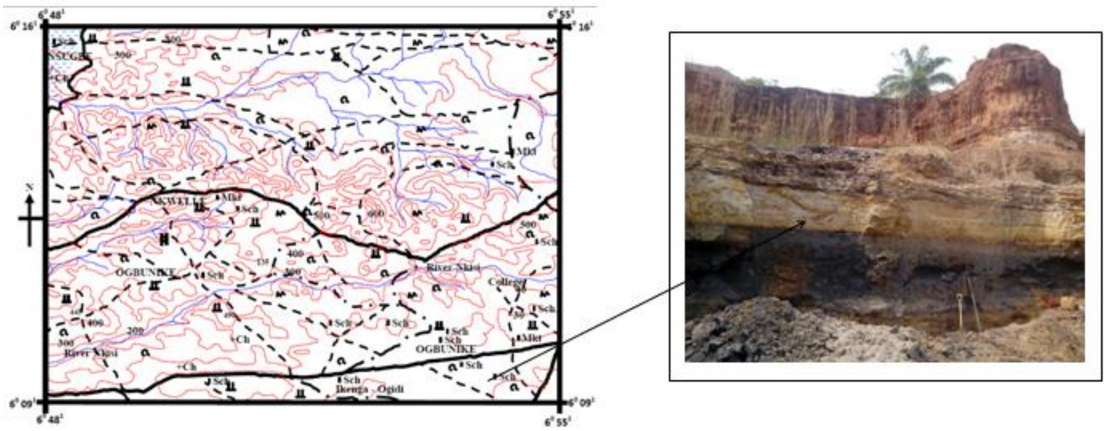

Fig 1: Map of the Study Area with the photograph inserted

Regional Tectonic And Stratigraphic Setting-

Anambra Basin developed as a result of the Santonianevents which greatly affected the Benue through terminating sedimentation in the Abakaliki Basin. However, sedimentation in Southern Nigeria which began in the early cretaceous was facilitated by the breakup of the African and South American continents leading to the formation of the Benue Trough (Benkhelil, 1989). Sedimentation in the trough was controlled by three major tectonic phases, giving rise to three successive depocenters (murat, 1972: Oboh-Ikuenobe et al, 2005, Nwachukwu et, al, 2011).

The First phase (Albian- Santonian) featured the deposition of the Asu River Group, Eze-aku and AwguFormations within the Abakaliki-Benue Trough which was flanked to the east by the Anambra platform and to the Southwest by the Ikpe platform (Nwachukwu et, al. 2011).

The second phase (Campanian- Eocene) was characterized by compressive movement along the NE-SW axis which resulted in the folding and uplift of the trough into an anticlinorium. This forced the Anambra platform to subside and the depocenter to shift South-Westwards to the newly formed Anambra Basin and the Afipko syncline on the other side of the anticlinorium in the southeast. The deposition of the Nkporo Group, MamuFormation, Ajali Sandstone, NsukkaFormation, Imo Formation and the Ameki Group followed (Nwachukwuet, al, 2011). The third phase commenced towards the end of Eocene and was characterized by the structural inversion of the Abakaliki region, further shifting the depocenter down dip (southwards) to form the Niger Delta basin(obiet, al, 2001, Nwachukwu et, al, 201).see table 1

The lithology of the formation (Nanka Formation) of the study area, as typified in the type locality,taken along agully between Nanka and Agulu, is overwhelminglyloosed;flaser bedded to medium sand, with a few mudrock breaks. The sand consists of sub-rounded to sub-angular grains and has an average of 5% clay content which makes it texturally submature. It is however compositionally high mature on account of the absence of feldspars and the dominance of the ultrastableheavy mineral suit-Zircon, tourmaline and rutile. Kyanite and staurolite constitute the balance of the non-opaque heavies, and point to metamorphic parents rocks as the main provenance material. The area is generally of calcareous clays and silts with thin shelly limestone, rich in foraminifera. Nwajide(2013).

Table 1: Lithostratigraphic Framework of Anambra Basin (after Nwajide, 1990)

AGE		ABAKALIKI-ANAMBRA BASIN	AFIKPO BASIN
30 my	Oligocene	Ogwashi-Asaba Formation	Ogwashi-Asaba
54.9 my	Eocene	Ameki/NankaFormation/Nsugbe Sandstone	Ameki Formation
60 my	Paleocene	Imo Formation Nsukka Formation	Imo Formation Nsukka
73 my	Maastrichtian	Ajalli Sandstone Mamu Formation	Ajalli Sandstone Mamu Formation
83 my	Campanian	Nkporo/ Owelli Formation/Enugu Shale	Nkporo Shale/Afikpo Sandstone
87.5 my	Santonian	Non-deposition	
88.5my	Coniacian	Awgu Group (Agbani Sandstone/Awgu Shale)	
93 my	Turonian	Ezeaku Group)	Ezeaku Group (inclAmaseri Sandstone)
100 my	Cenomanian- Albian	Asu River Group	Asu River Group
	Aptian Baremian Hauterivian	Unamed Units	
	Precambrian	Basement Complex	

Table 1: Lithostratigraphic Framework of Anambra Basin (after Nwajide, 1990)

II. Methods And Materials

The slope of the Ogbunike area provides complete and easy access to the outcrop of Nanka Formation in the study area (see fig. 2).

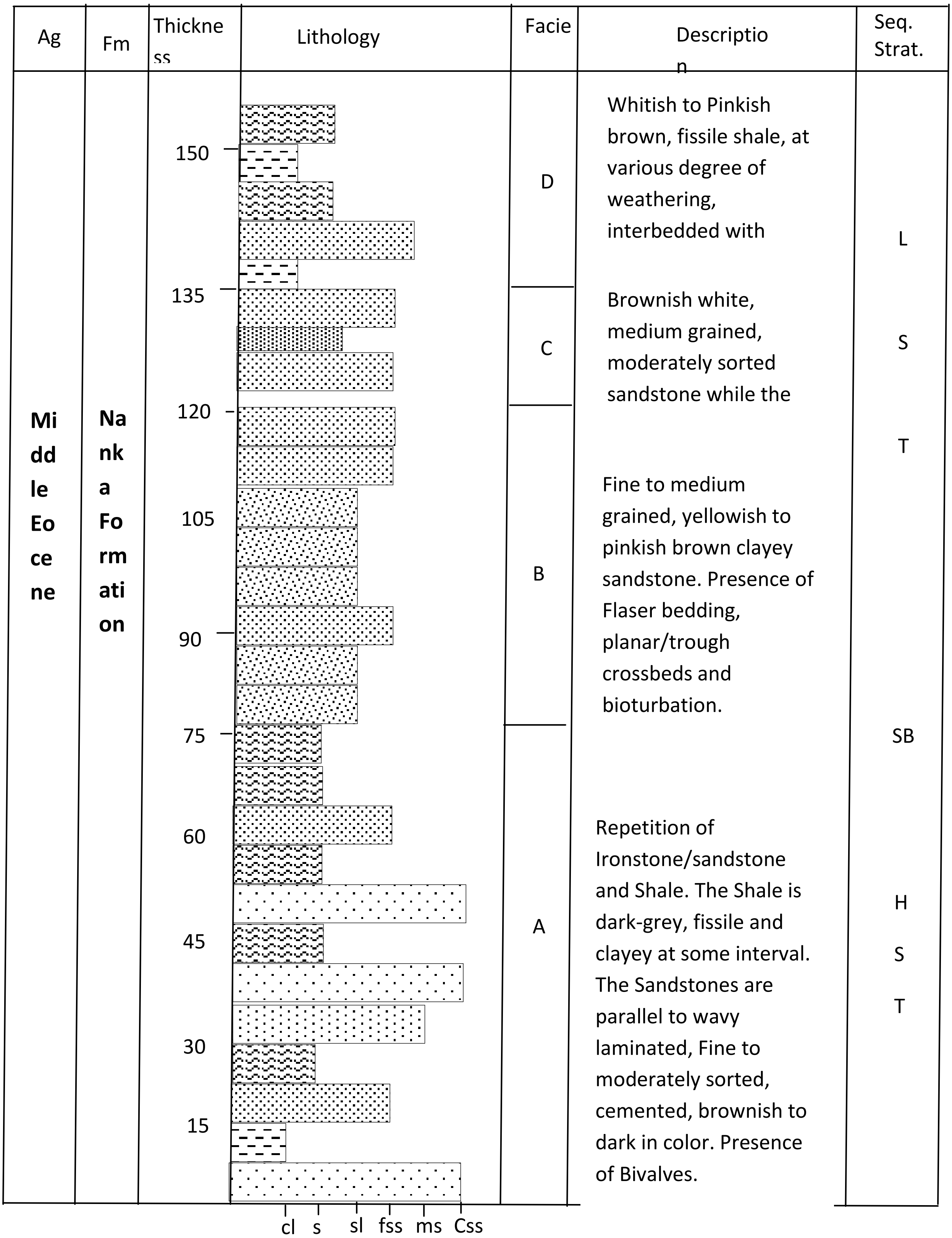

Fig 2: Logged Outcrop Section showing facies and sequence stratigraphy

Fresh samples of shales recovered from units 21, 23, 25 and 28 of the outcrop were analyzed for palynomorphs using the maceration technique. Each sample was digested for 30 minutes in 37% hydrochloric acid to remove traces of carbonate and 72 hours in 48% hydrofluoric acid to remove silicate. The extracts were sieve-washed with water through 10 microns nylon mesh, oxidized for 30 minutes in 70% $HNO_3$and 5 minutes in Schulz solution to render the fossils translucent for transmitted light microscopy. The oxidized residues were rinsed in 2% KOH solution to neutralize the acid.Swirling treatment was undertaken in order to get rid of the resistant coarse inorganic mineral particles. The residues were stained with Safranin-0 to increase the contrast. The orientation of directional sedimentary structure (cross beds) was determined with a silver compass by taking measurements from individual beds that are cross bedded, following Sam Boggs, Jr. (2006) model. Sequence stratigraphic interpretations followed the method ofVan Wagoner et, al. (1988).

III. Result And Interpretations

Ironstone/sandstone and shale facies (A) -This forms the base of the outcrop. It is made of repetitive or cyclic deposition of ironstone/sandstone and shale at an almost equal proportion. The shales are dark –grey in colour, fissile ,and clayey in some places. The sandstone intervals are parallelto wavy laminated, fine to medium grained, moderately sorted and occasionally highly compacted/cemented. They are generally brownish to dark in colour, highly fossilferrous as evidenced by the presence of bivalves that occurred in coquina form. Large assemblage of palynomorphs were recovered from the shale intervals (unit 21, 23, 25, 28) which includes *verrucato sporitesus mens is, laevigatos poritesovatus, psiltricolporites operculatus, Spinizonocolpites echinatus,proxapertitescursus,retistephanocolpiteswilliamsi,psilatricolporites sp., Psiltricolporitescrassus, psitricolporitesrotundos, Echitriporitestrianguliformis, Achilleodiniumbiformoides*, *Homotryblium spp.*, among other (Fig 3 and table 2). The presences of shale are an indication of marine influence environment, but are tidal dominated.

Table 2: The occurrence and distribution of Palynomorphs species in the analyzed section.

Sample No. / Palynomorphs species	UNIT 21	UNIT 23	UNIT 25	UNIT 28
TERRESTRIAL SPECIES				
Spores				
Schizosporisparvus	-	4	-	1
Cyathidites minor	-	2	3	2
Leiotriletesadriennis	8	4	2	1
Leiotriletesmaxoides	2	-	-	-
Verrucatosporitesusmensis	7	12	5	3
Laevigatosporitesovatus	17	14	9	10
Cicatricosisporitesdorogensis	-	1	-	-
Polypodiaceoisporites sp.	-	-	-	-
Pollen				
Psiltricolporitesoperculatus	4	8	2	1
Spinizonocolpitesechinatus	6	2	1	2
Proxapertitesoperculatus	-	-	-	-
Proxapertitescursus	7	3	2	1
Retitricolporitesirregulari	3	1	-	-
Retistephanocolpiteswilliamsi	4	2	1	1
Pachydermitesdiederixi	2	-	-	-
Ctenolophoniditescostatus	-	4	-	-
Tricolpiteshians	1	2	3	-
Striatopolliscatatumbus	-	1	-	-
Monocolpitesmarginatus	2	-	-	-
Monoporitesannulatus	2	3	1	1
Psilatricolporites sp.	3	2	5	2
Psiltricolporitescrassus	4	2	2	1
Inaperturopollenites sp.	-	1	-	-
Retibrevitricolpitestriangulatus	3	2	1	2
Psilatriporitesrotundus	4	3	1	1
Echitriporitestrianguliformis	-	4	-	-
Psilastephanocolporites sp.	-	2	2	-
Echitricolporitesspinosus	-	1	-	-
Anacolocidites cf. luteoidies	-	-	-	1
Brevicolporites (P) molinae	-	-	-	1
Scabratriporitesannulatus	2	-	-	-

Bombacidites sp.	-	1	-	-
MARINE SPECIES				
Dinoflagellate cysts				
Coroniferaoceanica	-	1	-	-
Hafniasphaeraseptata	-	1	-	-
Achilleodiniumbiformoides	-	2	-	-
Diphyescolligerum	-	1	-	-
Homotryblium spp.	-	2	-	-
Cordosphaeridiuminordes	-	-	-	-
Spiniferiteshyperacanthus	-	-	-	-

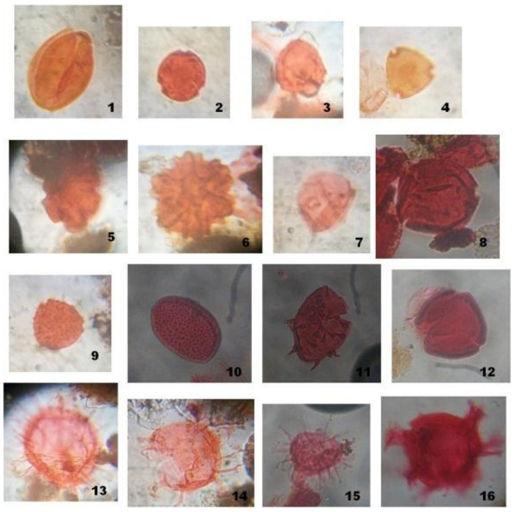

Fig. 3: Micrographs of some palynomorphs recovered from the analyzed samples.
Magnifications nos. 13 and 14 (X 100 oil immersion), others (X 40)

1. *Schizosporisparvus*
2. *Scabratriporitesannulatus*
3. *Psilatricolporitesoperculatus*
4. *Psilatriporitesrotundus*
5. *Retistephanocolpiteswilliamsi*
6. *Ctenolophoniditescostatus*
7. *Monoporitesannulatus*
8. *Pachydermitesdiederixi*
9.*Echitriporitestrianguliformis*
10. *Proxapertitescursus*
11.*Spinizonocolpitesechinatus*
12. *Psilatricolporitescrassus*
13. *Coroniferaoceanica*
14. *Hafniasphaeraseptata*
15. *Diphyescolligerum*
16.*Achilleodiniumbiformoides*

Sandstone facies (B) - The interval is fine to medium grained, clayey, yellowish to pinkish brown sandstone. The sandstone isparallel laminated, friable and areeasily susceptible to erosion. The main characteristicsedimentary structures are flaser bedding, planar/ trough crossbeds with intervening mud drapes. There are also presence of reactivation surface and ironstains. The fossil assemblage'spresentfacies includesskolithus, ophiomorpha, with bioturbationsat various intervals.Paleocurrent analysis was carried at on the crossbedded units. The results as indicated from the rose diagram shows that the studied area is characterized by a unimodalpaleaocurrent pattern which indicate a fluvial environment. The Mean Vector Azimuth (MVA), Variance and Vector Strength were derived based on Steinmetz, (1962). See tables 3a, 3b, 3c and 3d.

Table 3a: Paleocurrent Parameters for Crossbed 0

1	2	3	4	5	6	7	8	9
Azimuth (A)	Dip (D)	Sine A	Cos A	Cos D	5x4 **B**	5x3 **a**	Sine D **C**	$(A_I\text{-}A)^2$
74	28	0.9613	0.2756	0.8829	0.2433	0.8487	0.4695	40.83
68	18	0.9272	0.3746	0.9511	0.3563	0.8818	0.3090	153.51
52	20	0.7880	0.6157	0.9397	0.5786	0.7405	0.3420	806.56
80	16	0.9848	0.1736	0.9613	0.1669	0.9466	0.2756	0.15
82	14	0.9903	0.1392	0.9703	0.1351	0.9609	0.2419	2.59
84	17	0.9945	0.1045	0.9563	0.0999	0.9510	0.2924	13.03

70	12	0.9397	0.3420	0.9781	0.3345	0.9191	0.2079	107.95
82	20	0.9903	0.1392	0.9397	0.1308	0.9306	0.3420	2.59
67	24	0.9205	0.3907	0.9135	0.3569	0.8409	0.4067	179.29
94	28	0.9976	-0.0698	0.8829	-0.0616	0.8807	0.4695	185.23
116	20	0.8988	-0.4384	0.7397	-0.412	0.6648	0.3420	1268.07
110	12	0.9397	-0.3420	0.9781	-0.3345	0.9191	0.2079	876.75
80	17	0.9848	0.1736	0.9563	0.166	0.9418	0.2924	0.15
76	15	0.9703	0.2419	0.9659	0.2337	0.9372	0.2588	19.27
73	7	0.9563	0.2924	0.9925	0.2902	0.9491	0.1219	54.61
Totals		14.2441	2.4128	14.2083	2.2841	13.3128	4.5795	3710.6
(Total)^2		202.8934	5.8216	201.8758	5.2171	177.2306	20.9718	13768419.5

Table 3b: Paleocurrent Parameters for Crossbed 1

1	2	3	4	5	6	7	8	9
Azimuth (A)	Dip (D)	Sine A	Cos A	Cos D	5x4 **b**	5x3 **a**	Sine D **C**	$(A_I\text{-}A)^2$
100	20	0.9848	-0.1736	0.9397	-0.1631	0.9254	0.3420	62.41
68	22	0.9272	0.3746	0.9272	0.3473	0.8597	0.3746	580.81
100	19	0.9848	-0.1736	0.9455	-0.1641	0.9311	0.3256	62.41
98	24	0.9903	-0.1392	0.9135	-0.1272	0.9046	0.4067	34.81
98	24	0.9903	-0.1392	0.9135	-0.1272	0.9046	0.4067	34.81
88	16	0.9994	0.0349	0.9613	0.0335	0.9607	0.2756	16.81
80	14	0.9848	0.1736	0.9703	0.1684	0.9556	0.2419	146.41
94	12	0.9976	-0.0698	0.9781	-0.0683	0.9758	0.2079	3.61
88	14	0.9994	0.0349	0.9703	0.0339	0.9697	0.2419	16.81
104	18	0.9703	-0.2419	0.9511	-0.2301	0.9229	0.3090	141.61
96	18	0.9945	-0.1045	0.9511	-0.0994	0.9459	0.3090	15.21
100	20	0.9848	-0.1736	0.9397	-0.1631	0.9254	0.3420	62.41
64	22	0.8988	0.4384	0.9272	0.4065	0.8334	0.3746	789.61
110	22	0.9397	-0.3420	0.9272	-0.3171	0.8713	0.3746	320.41
Total		13.6467	-0.501	13.2157	-0.47	12.8861	4.5321	2288.14
(Total)^2		186.232	0.251	174.654	0.221	166.051	20.539	5.23*10^6

Table 3c: Paleocurrent Parameters for Crossbed 2

1	2	3	4	5	6	7	8	9
Azimuth (A)	Dip (D)	Sine A	Cos A	Cos D	5x4 **b**	5x3 **A**	Sine D **C**	$(A_I\text{-}A)^2$
78	20	0.9781	0.2079	0.9397	0.1954	0.9191	0.3420	3.8416
70	24	0.9397	0.3420	0.9397	0.3214	0.8830	0.4067	99.20
56	22	0.8290	0.5592	0.8470	0.4736	0.7022	0.3746	574.08
62	24	0.8829	0.4695	0.9135	0.4289	0.8065	0.4067	322.56
84	30	0.9903	0.1392	0.8660	0.1205	0.8576	0.5	16.32
74	28	0.9613	0.2756	0.8829	0.2433	0.8487	0.4695	35.52
73	28	0.9563	0.2924	0.8829	0.2582	0.8443	0.4695	48.44
108	30	0.9511	-0.3090	0.8660	-0.2676	0.8236	0.5	786.24
63	30	0.8910	0.4540	0.8660	0.3932	0.7716	0.5	287.64
100	20	0.9848	-0.1736	0.9397	-0.1631	0.9254	0.3420	401.60
98	16	0.9903	-0.1392	0.9613	-0.1338	0.9520	0.2756	325.44
80	18	0.9848	0.1736	0.9511	0.1651	0.9366	0.3090	0.016
90	26	1	0	0.8988	0	0.8988	0.4384	100.80
88	18	0.9994	0.0349	0.9511	0.0332	0.9505	0.3090	64.64
78	19	0.9781	0.2079	0.9455	0.1966	0.9248	0.3256	3.84
Totals		14.3171	2.5344	13.6512	2.2649	13.0448	2.2649	3.1*10^3
(Total)^2		204.98	6.423	186.36	5.1297	170.167	5.1297	9.4*10^6

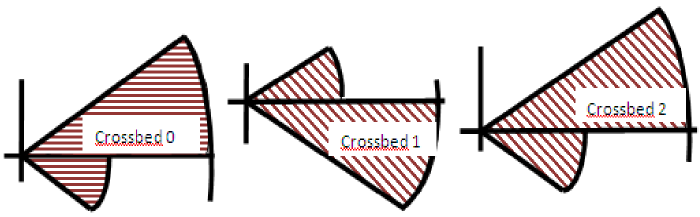

Fig 3: Rose diagram for Ogbunike sandstone

Table 3d: Paleocurrent Results for the Nanka Formation(Ogbunike) and their Environment implication

Locality	Outcrop	Lithostratigraphic Unit	Pattern	MVA	Variance	Vector Strength	Environmental implication
Ogbunike	Crossbed 0	Nanka Formation	Unimodal	260.39°	265.04°	13.914°	Fluvial
Ogbunike	Crossbed 1	Nanka Formation	Unimodal	272.10°	176.00°	13.32°	Fluvial
Ogbunike	Crossbed 2	Nanka Formation	Unimodal	259.96°	219.31°	14.09°	Fluvial

The sieve analysis was carried out based on Folk and Wards, 1957 model. The univariate results as obtained from the sieve analysis carried out on samples 12, 19, crossbed o,crossbed 1 and crossbed 2 shows a mean size that is basically medium grained which suggests moderately energy of deposition. It is basically moderately sorted, positively skewed which is an indication that the distribution has fine material, with kurtosis that is basically mesokurtic.

The bivariate results if plotted as obtained from the sieve analysis (mean size vs. standard deviation; skewness vs. sorting) will indicate a fluvial dominated environment. See tables 4 and 5.

Table 4: Summary of Univariate Result

Sample No.	Mean (ME)	Standard deviation (Sd)	Skewness (ski)	Kurtosis (KG)
Unit 12	1.03 Medium Grained	1.15 Poorly Sorted	0.16 Positively Skewed	0.91 Mesokurtic
Unit 19	1.07 Medium Grained	0.78 Moderately Sorted	0.11 Positively Skewed	0.98 Mesokurtic
Cross bed zero (0)	1.65 Medium Grained	0.82 Moderately Sorted	0.27 Positively Skewed	0.93 Mesokurtic
Cross bed one (1)	1.65 Medium Grained	0.81 Moderately Sorted	0.27 Positively Skewed	1.06 Mesokurtic
Cross bed two (2)	1.35 Medium Grained	0.64 Moderately Sorted	0.21 Positively Skewed	1.17 Leptokurtic

Table 5: Summary of Bivariate Result

Sample Number	Mz	6	Ski	MzVs 6	Ski Vs 6
Unit 12	1.03	1.15	0.16	Fluvial	Fluvial
Unit 19	1.07	0.78	0.11	Fluvial	Fluvial
Cross bed 0	1.65	0.82	0.27	Fluvial	Fluvial
Cross bed 1	1.39	0.81	0.27	Fluvial	Fluvial
Cross bed 2	1.35	0.64	0.21	Fluvial	Fluvial

SANDSTONE/SILTSTONE FACIES(C) The lithology of facies C exhibits clayey sand dominated units with siltstone. The siltstone are pinkish-brown, while the sandstone are brownish white, fine to medium grained moderately sorted with lenses of clay. They do not exhibit any noticeable sedimentary structure, but are moderately bioturbated.

INTERSTRATIFIED CALCAREOUS CLAY AND SHALE FACIES (D)

The interstratified calcareous clay and shale facies are white to pinkish brown, with various degrees of weathering and ferruginization. The shale issub fissile to fissile with interbedded calcareous clay, with thin lensoid. The top unit is medium to coarse, poorly sortedferruginous sandstone. These beds are laminated with mm-scale,parallel to wavy lamination in some sections.

PALEOENVIRONEMNT-The palynological analysis carried out on the shale units in facie A of the studied area aided in paleoenvironment interpretation. The palynomorphs of environmental value encountered in some of the examined samples include*monoporitesannulatus*, grass pollen, which indicates open vegetation as in reed swamp within the tropical rainforest, (Umeji, 2002). *Proxapertitiescursus/operculatus, spinizonocolpitesechinatus* and *psilatricolporitescrassus* are pollen of brackish water palms inhabiting similar environment as that of mangrove swamp, (Umeji, 2002, Umeji and Nwajide, 2013).*Schizosporisparvus* is a fresh water alga, which inhabited fresh water swamp environment.*Homotryblium spp*.,is a typical of warm masses of lowerlatitudes (william and Bujak, 1977), and has also been related to near-shore and reduced conditions (Dybkjaer, 2004). The occurrence of *Achilleodiniumbiformoides* and the presence of species such as *Homotryblium sp*.,*cordosphaeridium sp*. and *Diphysescolligerum* in unit 23, indicate restricted neritic to outer neritic (continental shelf) depositional environment, with maximum depth range less than 200m, (van mourik and Brinkhuis, 2001) see table 4.

Table 6: Summary of the palynomorphs % frequency distribution and their paleoenvironmental inferences

SAMPLE NO.	PALYNOMORPHS % FREQUENCY			PALEO-SALINITY	PALEOENVIRONMENTS
	Spores	Pollen	Marine Species		
UNIT 21	44 %	56 %	0 %	Fresh water	Non-marine/Continental Upper deltaic plain
UNIT 23	42 %	50 %	8 %	Brackishwater	Marginal marine Probably (estuarine or lagoon)
UNIT 25	48 %	52 %	0 %	Fresh water	Non-marine/Continental Upper deltaic plain
UNIT 28	55 %	45 %	0 %	Fresh water	Non-marine/Continental Upper deltaic plain

IV. Age Determination-

Based on the stratigraphically important palynomorphs recovered from units 21, 23, 25 and 28 in facies A of the outcrop studied, middle Eocene was assigned to the area based on the following recovered age – diagnosing index palynomorphs species such as *monoporitesannulatus, Retibrevitricolpitestriangulatus, Retitricolporitesirregulari, Retistephanocolpiteswillamsi, ctenolophoniditescostatus, spinizonocolpitesechinatus, psilatricoploritescrassus, psilatricolporitesoperculatus, proxaperitescursus, striatopollisctatumbus,* and *Bombacidites sp.* (Van Hoeken- Klinkenberg, 1996: Germereraad et al. 1968). This assemblage corresponds to the middle Eocene pantropical*monoporitesannulatus* zone of Germeraad et al (1968).

However, the presence of dinoflegellage cysts species, *Achilleodiniumbiformoides* in sample from unit 23, confirmed the above assigned age, (Eaton, 1976).

V. Sequence Stratigraphic Interpretation

The interpretation of sequence stratigraphy of the studied outcrop is based on vertical relationship of lithofacies, microfossil, palynology and stratigraphic model as adopted from Van-Wagoner et al., 1988.see fig 4 Dinoglagellatescrsts assemblages have proved to be useful in sequence stratigraphic model where they are abundant and diverse (Onuigbo et al, 2012).

The outcrop of the studied area was analyzed in terms of their main systems tracts, sequence boundaries, maximumflooding surfaces and stacking patterns.Highstand systems tract, which is a progradational deposits that form when sediment accumulation rate exceed the rate of increase in accommodation space was identified. Consequently, its depositional trends and stacking pattern are dominated by a combination of aggradation/progradation processes of sandstone/ironstone and shale. It is believed that thehighstand system tract is bounded it the base by amaximum flooding surface, which may be located within AmekiFormation.The frequent sandstone occurrence in the studied area may be linked to preferential fluvialincision during the subsequent stage of base level fall, as the forefront of the high stand wedge, which inherits the slope gradient of the shoreface or delta front environment, is commonly steeper than the fluvial equilibrium profile. catuneanu(2006),saucier (1974), Leopold and Boll (1979), Rashmani (1988), Blum (1991),Posamentier et al(1992),Allen and Posamentier(1994), Ainsworth and Walker (1994).

The High stand systems tract of the studied area showed an upward-fining sequence that continued the overall upward-decrees in grain size. The system tract which is a late high standsystem tract is defined by much lower rate of base level rise, which results in a stacking pattern (progadational components) that may be prone to channel clustering (Catuneanu 2006), toward the end of the High stand system tract was a forced regressive phase (forced regression) which is defined by Catuneanu(2002) as occurring during stage of base level fall, when the shoreline is forced to regress by the falling base level irrespective of the sediment supply. The low magnitude fall in base level which is always the case in a fluvial dominated environment gave rise to the high preservation potential of bivalvecoquina in the studied area.This suggest that the nature of scouring vs.aggradation processes is low and the angle of repose of clinoform (> 1) is steeper and the fall in base level does not trigger scouring, and the forced regressionshoreface deposits are gradationally based (Catuneanu 2006). Sequence boundary which is a product of a fall in sea level that erodes the sub aerially exposed sediment surface capped the High stand system tract and the eroding surface of the down stepping sediments accompanying forced regression in the studied area. The sequence boundary was overland by the low stand systems tract in the studied area, which is sedimentary deposits accumulated during the stage of early-rise normal regression (Hunt and Tucker, 1992), is bounded by the sub aerial unconformity and it correlative conformity at the base and by the maximum regressive surface at the top. The depositional processes and stacking pattern as noted in the studied area are dominated by low-rate aggradations and progradation (Catuneanu, 2006). The area showed a coarsing upward sequence, with poor preservation potential and issusceptible to erosion.

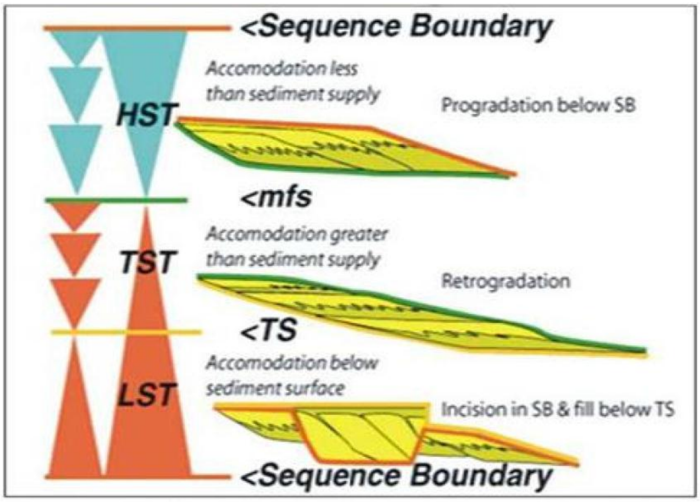

Fig 4: Sequence stratigraphic model (after Van Wagoner et al., 1988)

VI. Conclusion

The Eocene Nanka Formation situated at a reference locality in Ogbunike south-eastern Nigeria shows a fluvial dominated environment,based on the paleocurrent and sieve analyses results.The age-diagnosting index- palynomorphs species recovered from shale units in Facies A suggest a middle Eocene age for the studied section;while paleoenvironmental result as revealed by the palynological analyses suggest an environment within a continental shelf.The sequence stratigraphic model indicated the presence of one type II sequence boundary,with a late highstand systems tract associated with forced regression and lowstand systems tract

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