

**PALEOENVIRONMENTAL RECONSTRUCTION AND AGE
DETERMINATION OF SEDIMENTS FROM SHEET 288 BENIN FLANK OF
NIGER DELTA SEDIMENTARY BASIN, NIGERIA**

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ABSTRACT

A palynological study was carried out to elucidate the presence of pollen and spores and other microscopic sized structures to reconstruct ancient environment of deposition and determine the age of sediments obtained from sheet 288 Benin Flank of Niger Delta Sedimentary Basin, Nigeria. Nineteen (19) core samples were collected at interval of 3m from a section of a well ranged 605 – 663 metres depth and fifty Seven (57) metres thick. The samples were macerated (grinding to powder) and treated with Hydrochloric (HCL) and Hydrogen Fluoride acid (HF) respectively to remove the silicate cementation and the carbonates to obtained organic residues which was prepared into slide for petrographic analysis. The following Palynomorphs, Miospores and dinoflagelates; *Monoporites annulatus*, *Psilacolporites crassus*, *Zononolporites ramone*, *Sapotaceo*, *Laevigatos*, *Cynathiditesminor*, *Acrostichumaureum*, *Longapeitities* sp. *Verrucatosporites usmensis* *Verrucatosporites* sp. and *Aduntosporidinium* were recovered from the sediments. These fossils were compared with the standard work of Jan du Chene and others which gave an age of middle to upper Eocene. The lithological deductions as well as the presence of some index fossils such as *Laevigatosporites ovatu*, *P. Crassus* indicated that the sediments were deposited in a coastal deltaic/mangrove swamp environment. Ultimately, the findings correlate with Ameki Formation, which has its depocenter in Anambra Basin, eastern Nigeria.

KEYWORDS: Palynology, Palaeoenvironment, Palynomorphs Anambra Basin and Miospores

INTRODUCTION

One way of reconstructing ancient environment, decipher the conditions and timing under which sediments were deposited is by the application of Palynological studies. This involves the

study of pollen, spores, particulate organic matter (POM) kerogen in sedimentary rocks and certain minute planktonic organisms, in fossil and living form (Brocks and Summons 2003; Omorogieva, 2008).

Palynological methods have been successfully applied in collaboration with plant and geologic sciences in reconstructing ancient environment for oil and gas exploration, crime investigation, climatic conditions, correlation and in the determination of the age of sediments through time by the analysis of pollen and spores as well as microorganism like *Dinoflagellate Cyst*, *Acritarchs*, *Chitinozoans* and *Conodonts* found in sediments (Behling, 2005, Dawson and Mayes, 2015). According to Behling (2005), Pollen grains transported by wind, insects and other animals may find their way into deposits of Lakes, Oceans, Swamps, Mangroves and Peat bogs. Pollen is usually very small grains between 20 and 40 μm and can be observed under a light microscope. It is also possible to illustrate past plant diversity, stability and dynamic of ecosystems through the study of Palynology (Ajipe and Adebayo, 2018). Because strong relationship exist between vegetation and climate (temperature, precipitation), the recognition of ancient times vegetational changes permit reconstructing climate variability in the past because pollen and spore are good indicators of changes in the flora and environmental conditions. Conversely, lithostratigraphy refers to the rock units with special characteristic chosen to represent product of a given depositional environment or process. However, sedimentary rocks may have

unique bedding style and suit of sedimentary structures, it can be formed by various processes in different environments consequently, lithology are interpreted in terms of facies association that considered being generally or environmentally related. Rocks unit consist of one or more lithologies and they are interpreted to mean or reflect particular depositional events, it also represent on a bed or sequence of beds deposited under different energy conditions. The current study is aimed at presenting a detailed Palynological study of a section of an X well in the north-western portion of Niger-Delta Sedimentary basin by using the Palynomorphs and Miospores found in the sediments to reconstruct the paleoenvironmental condition and determine the age and condition under which the sediments were deposited. This is because sedimentary strata are repository of geologic and paleobotanic information. The result obtained in the study will provide useful information to researchers engaged in the study of Sedimentology, Stratigraphy, and Petroleum Geology, hydrocarbon prospecting companies as well as government and industry stakeholders.

Study Area

The study area is located within Ifon sheet 288 on Benin Flank, Niger Delta sedimentary basin between latitude 6°-7° N and longitude 5°-6° W as shown in Figure 1.

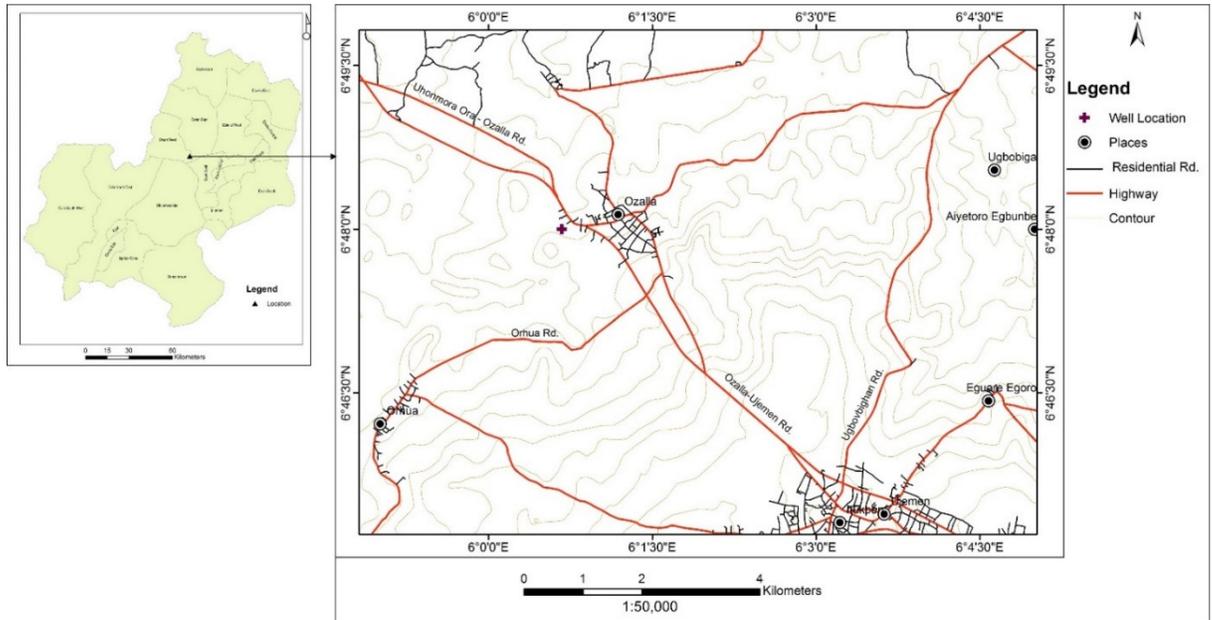


Fig. 1: Location Map indicating sampling points

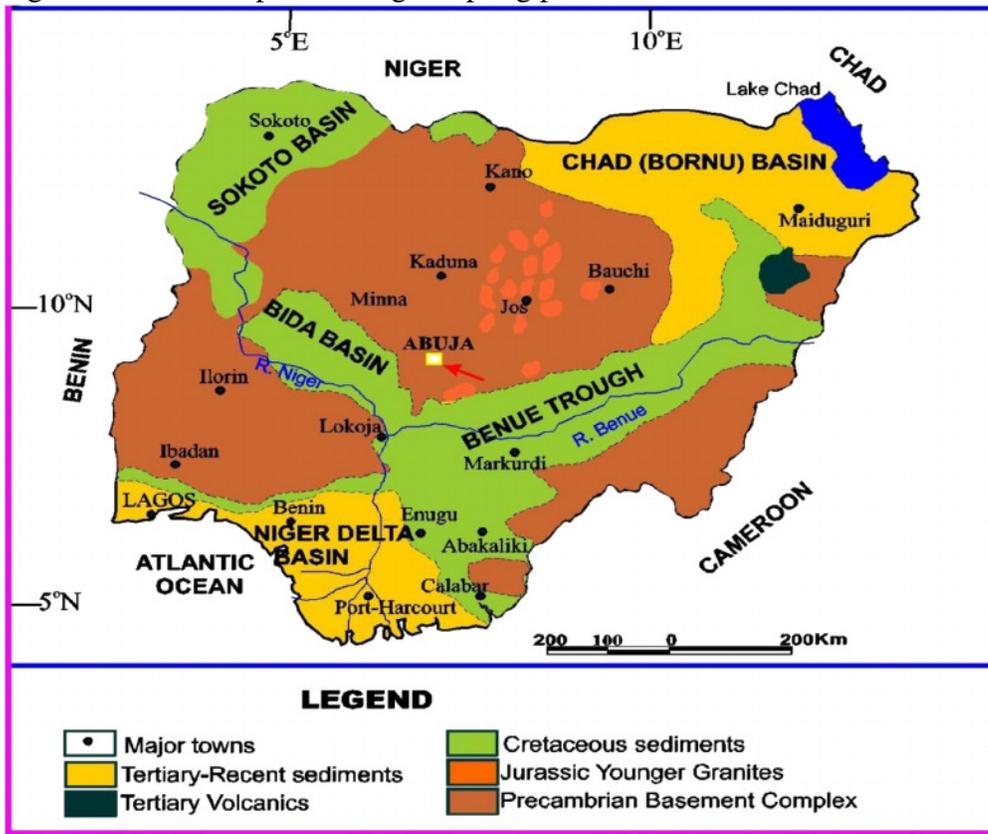


Fig. 2: Map of Nigeria Sedimentary Basins (Extracted from Google, 2019)

METHODOLOGY

Sample Collection

Samples were obtained at an interval of three (3) metres from a section of a well ranged from 605 – 663 metres depth and fifty Seven (57) metres thick drilled in the north-western portion of the Niger Delta Sedimentary Basin. A total of nineteen (19) samples were collected and carefully labelled in a polythene bag for Palynological studies.

Determination of Lithologic Log

The core samples were each subjected to visual examinations, aided with binocular microscope to determine the physical properties of each bed with respect to depth. The result of the examination was used to determine the lithology as represented in Figure 3.

Sample Treatment and Preparation of Slide

Each sample was macerated (grinding to powder) and treated with Hydrochloric (HCL) and Hydrogen Fluoride acid (HF) to remove the silicate cementation and the carbonates so as to obtain the organic residues from which slides are prepared for

microscopic analysis. The next step taken was to prepare the organic residue into slide. Petrographic microscope was applied in identifying the various forms (species) of polymorphs present in each sample. Palynomorphs recovered were used to determine the various geologic events and environment of deposition.

RESULTS

On examining the samples under Petrographic microscope; the following Palynomorphs were recovered; Fungal spores, *Nonocolpites amnulates*, *Zonocostites ramonae*, *Retisetephanocolpites* sp., *Stn catatumbus*, *Proxapertites cursus*, *Acrostrium auren*, *Verrucatosporites usmensis*, *Margocolporites* sp., *Retibrevitricolporites triangulates*, *Maurithidites crassiexin*, *Laevigatosporites*, *polyperdiacolporites*, *Crotonicolpites rirregulatus*, *Proxapertites operculatus*, *Psilamonocolpites* sp, *Retimonocolpites obaensis*, *Retibrevitricolporites protudens*, *Aduntophaeridium* sp., *Cleiseophaedinium* sp.

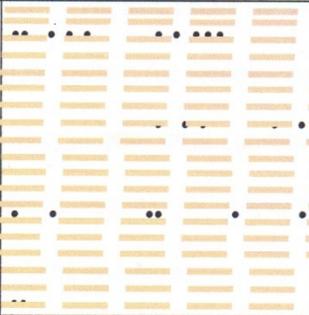
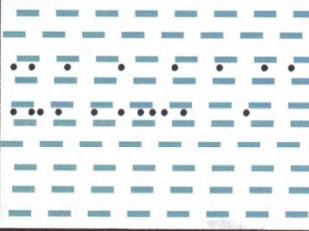
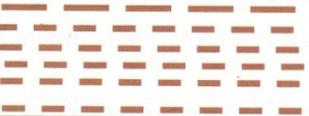
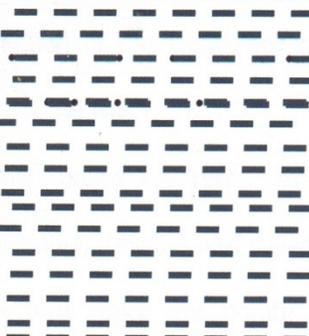
DEPTH (M)	LITHOLOGY OF THE SECTION	LITHOLOGIC DESCRIPTION
03		Shally sand, dull brawn in colouration, highly fossiliferous, thinly laminated. The thickness of the bed is about 24m.
17		Purely shale, grayish in colouration, thinly laminated, moderately fossiliferous and about 15m thick.
22		Shally sand material, redish brown, 3m thick.
25		Shale, poorly fossiliferous, grey to dark grey in colour poorly laminated. The thickness of 15m.
60		

Fig. 3: Lithology of the section of the X-Well under study

Table 1: Distribution of Palynomorphs in the study area

Fungal spore	<i>Monocolpitesan nulatus</i>	<i>Zonocosti tesramonae</i>	<i>Retistephanocolpites</i> sp	<i>Sina catatumbus</i>	<i>Proxaperites cursus</i>	<i>Acrostichum aureum</i>	Sapotaceo	<i>Verrucatosprites usmenses</i>	<i>Margocoporites</i> sp	<i>Retibrevitricolporites triangulatus</i>	<i>Mauritiidites crassiexin</i>	<i>Retitricolporites</i> sp	<i>Laevigatosporites</i> sp	<i>Polypodia colporites</i>	<i>Retitricolporites triangulatus</i>	<i>Proxaperites opercuatus</i>	<i>Psilamonocolpites</i> sp	<i>Retimonocolpites obaensis</i>	<i>Longapete</i> sp	<i>Psilacrassus</i>	<i>Opeculadinium</i> sp	<i>Cyathidites monor</i>	<i>Olysphaeridium</i> sp	<i>Aduntosphaeridium</i> sp
08	07	10	02	03	04	13	5	06	1	1	1	3	6	4	7	2	1	1	31	03	01	03	0	02
					09	02		18					18			08	05	04	15			08		08
					17	40		53					25			35	19	09	23			02		03
					09	38		16		19			16			17	09	03	31			03	02	03
					40	01		30				02					08		10			02		03
					25	05		48			01	01	30				47		03					
										02	01								07	03	03	01		
01		03				03	1							0	01							03		01
														1										

Table 2: Age distribution of Palynomorphs recovered

Maastriechian	Paleocene	Eocene	Oligocene	Miocene	Pliocene	Recent	Age
							Species
							<i>Longernertites manginatus</i>
							<i>Mononorites Annulate</i>
							<i>Psilastenhancocolnorite SD</i>
							<i>Retimonocolnites Obaensis</i>
							<i>Anocolosidites interoids</i>
							<i>Mauritidites Crassexinus</i>
							<i>Proxanertites Onerculatus</i>
							<i>Monocolnites margomatis</i>
							<i>Retirebrevitricolnorites triangulates</i>
							<i>Peregrininollis nigericus</i>
							<i>Verrucatosnorites Sp</i>
							<i>Retivritolnorites irregularis</i>
							<i>Proxanertites carsus</i>
							<i>Verrucatosnorites susmensis</i>
							<i>Retitricolnorites annulatus</i>
							<i>Psilastehanorites crassicostatus</i>
							<i>Schizosnorites nervus</i>
							<i>Retirebrevitricolnorites nrotrudens</i>
							<i>Retirebrevitricolnorites nrotrudens</i>
							<i>Psilastenhancocolnorites</i>

Photomicrographs of Palynomorphs groups used for palynofacies analysis are shown in Plate 1 with interpretation; A,C,D,K (fungi remains); B, J, L, (fresh water algae) while F,G,H,I,M are marine Palynomorphs. Others include A

(trilete) spore, B Fungal fruiting body (mycelium) and C (tricolpate pollen *Praedapolis africanus*). D is *Monosulcate* pollen *Longapertites Vaneendenburgi*. (E) *Pediastrum* sp. (F) Azolla spore with massulae (m). (G)

Inner chitinous lining of foraminifera. (H) Dinoflagellate Cyst *Batiacasphaera* Sp. (I) Dinoflagellate Cyst *Spiniferities mirabilis*. (J) Funga spore with attached

hyphae. (K) Monosulcate pollen *Proxapertites crassus*. (L) Tetracellate fungal spore. (M) *Acritarch* Cyst *Pterospermella* sp.

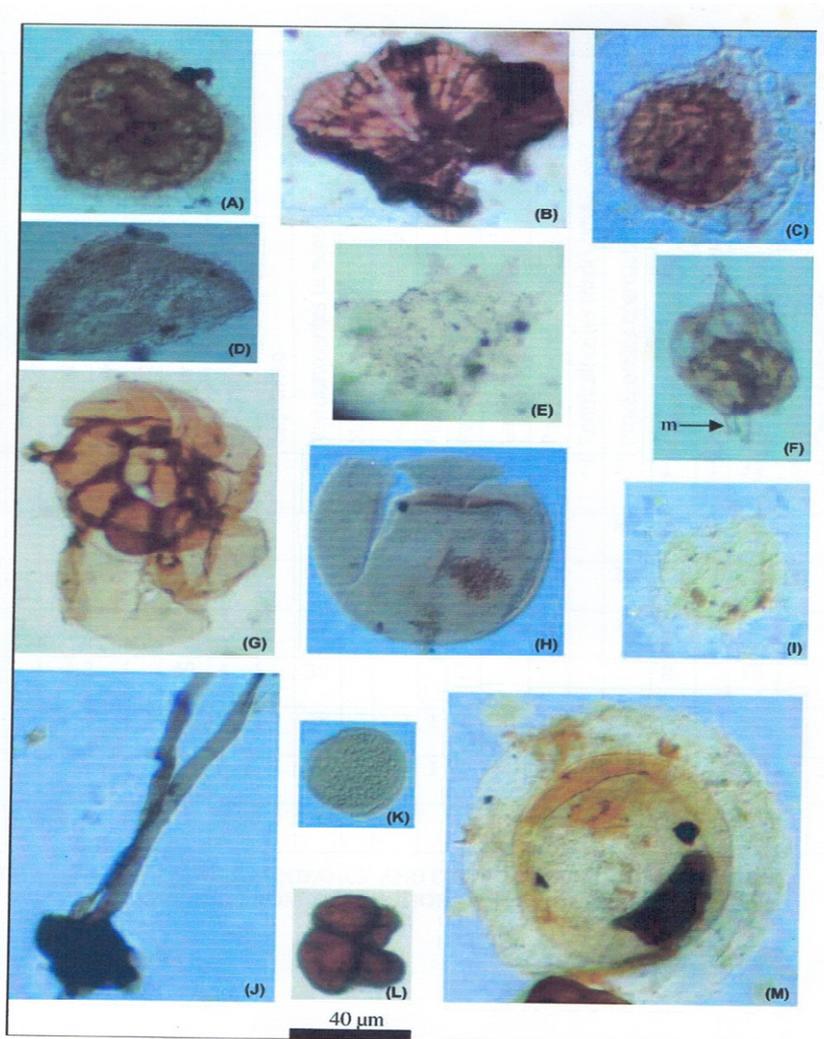


Plate 1. Photomicrographs of Palynomorphs

DISCUSSION

The section of the X well located at Ifon sheet 288 was made up of both terrestrial (continental) and marine palynomorphs as shown in Table 1 and Plate 1 respectively. Some of the fossils like *Verrucatosporites usmensis*, *Psilastephanocolporites* sp.,

Monoporatus annulatus, *Monocolpites margomatis* amongst others were identified as marker species whose ages are known and have been successfully used for age determination (Table 2). The presence of the index maker recovered puts the age of the sediments from middle Paleocene to Miocene with

its equivalent occurring in Ogwashi-Asaba Formation, upper Eocene (Jan du Chene *et al.*, 1979a and 1979b); Kwakwa bore of coastal basin of Cameroun, Paleocene to lower Miocene (Salad-Chebouldaef 1978); the late Oligocene to early Miocene sediments of the Jos Plateau; the Eocene to Miocene sediments of Gwandu Formation in Sokoto basin and the Tertiary of western Senegal. The assemblages are made up of fungi, spore, freshwater algae, ferns, lowland trees and shrubs of marsh lands. The plant types are indicative of continental – deltaic environment. The presence of dinoflagellate such as *Olysphaeridium* sp., *Aduntoxphaeridium* sp. indicates that the fossils were brought to the continent during transgression of sea and were left behind when the sea regresses. On the other hand, lithological analysis of the beds shows that the section of the well was made up of thinly laminated shale and shale sand indicating that the sediments were deposited under quiet and low energy condition. Some of the index fossils like *Psilastephanocolphite* sp. (low land rain forest) and *Monoporatus annulatus* (grass land species); *Acrostichum* (back mangrove swamps) and Dinoflagellates such as *Adunstasphaeridium* sp., *Cleistosphaeridium*, *Operculasdidinium* sp. indicates that the sediments were derived from the continent to near shore environment characterized by swampy vegetation. On the other hand, the presences of Dinocyst in the sediments suggest a periodic inundation of marine water characterized by miospores of lowland rainforest.

CONCLUSION

This study has demonstrated that Palynomorphs, Miospores and Dinoflagellate cyst are good fossils in determining the age of sediments, condition and environment under which sediments can be deposited. From the forms recovered in this study, the sediments were assigned the age of Paleocene to Miocene. However, the age base on the occurrence of *Retimonocolpites obaensis* and *Psilatricolporoties annulipories* suggest that the sediments were deposited in the Eocene as supported by the works of Jandu Chene and others. The Eocene age is more in agreement with the age assignment based on mega-fossils found elsewhere for the same Formation. This shows that sedimentation had continued in the Anambra Basin through the Senonian and Tertiary. Ultimately, the presents of Miospores as well as the dinoflagellate recovered from the sediments concludes that the sediments were derived from continental-deltaic environment under low energy condition.

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