International Journal of Advanced Scientific Research
www.allscientificjournal.com
ISSN: 2456-0421
Received: 22-10-2022; Accepted: 08-11-2022; Published: 25-11-2022
Volume 7, Issue 2, 2022, Page No. 99-103

"Palynomorphs Synthesis of Neogene Sediments: Cognizance from X-Well Offshore Domain of The Niger Delta Basin"

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Abstract
This study presents a **synthesis of palynomorph attributes** recovered from X-Well Onshore Niger Delta. Integrating qualitative and quantitative analyses of terrestrial and marine palynomorph assemblages, ditch cuttings intervals (2960-3050 m) were analysed for age dating, biozonation, lithostratigraphy and environment of deposition. The samples were subjected to standard palynological laboratory processes, which involved the maceration of samples with Sodium-Hexametaphosphate as the reagent solution to remove the drilling muds. Lithologically, the samples consist predominantly fine to medium grained sand with shale intercalations, conformed to the paralic Agbada Formation. The palynormorph recovery was good within the sampled intervals. Based on the recovered key marker palynomorph species identified such as: Nympheapollis clarus, Multiaerolites formosus, Peregrinipollis nigericus, and Stereisporites sp. The stratigraphic intervals infiltrated Late Miocene age. Palynological data enhanced precision in subsurface interpretation. This study highlights how palynology contributes to refining stratigraphic frameworks, and supporting hydrocarbon prospect evaluation in the Niger Delta. The sediments deposited in shallow marine depositional environments. The findings reaffirm that palynology remains a cost-effective and reliable method for assessing sedimentary sequences and identifying hydrocarbon-bearing zones.

Keywords: Palynomorphs, synthesis, Neogene, sediments, Niger Delta

Introduction

Palynomorphs is the microscopic organic fossils extracted from rock or unconsolidated sediment generally between 5 and 500 micrometers that is resistant to decay and common in sedimentary deposit. Using standard palynological processing methods, which involve treating samples with Sodium-Hexametaphosphate ($Na(Po_3)_6$ (Okereke and Ukpabi, 2018) [4]. The study of microfossils (pollen and spores) preserved in sedimentary rocks, provides a valuable tool for dating and correlating stratigraphic sequences (Oyede, 1992) [5]. Palynological data can also be used to establish biozones and reconstruct paleoclimatic conditions during the deposition of reservoir units (Akata and Harry, 2019) [1]. A dominant item of the palynomorph spectrum is the pollen grain. The former is determined by how many layers of acid-resistant sporopollenin are present in the spore wall. Size and specific gravity are crucial factors in a spore's ability to spread. When compared to isospores and microspores, the dispersal of megaspores is limited. In addition, the majority of the particles are smaller than sand and are created in far less numbers. Spore walls may join other organic remnants like plant cuticles in the sedimentary detritus. The vast majority of flowering plants that release spores into the air are either aquatic or subaquatic.
The objective of this study is to carry out palynomorphs attributes on the strata connected by X-well Offshore Niger Delta Basin, and aimed at determining palynological zonations, depositional environment and age determination of the strata for hydrocarbon exploration purposes.

Geological Settings

The studied well 'X' is located in the offshore depobelts, Niger Delta Basin, Southern Nigeria (Fig 1). The Niger Delta is one of the world's biggest deltas, covering an area of around 75,000 km2 below the surface. The total thickness of this regressive clastic sequence is between 30,000 and 40,000 feet (9000 to 12000 m). An upper deltatop facies, a middle delta front lithofacies, and a lower pro-delta lithofacies are typically seen in well sections spanning the Niger Delta (Reijers *et al*, 1996) [6]. The Benin Formation (Oligocene–Recent), Agbada Formation (Eocene–Recent), and Akata Formation (Paleogene–Recent) are all appropriate names for these geological layers. Marine shales make up the bulk of the Akata Formation, with sand and silt strata likely deposited as turbidites and continental slope channel fills. Formation thickness is predicted to be between 7,000 and 13,000 feet (Doust and Omatsola, 1990) [2]. When it comes to petroleum, the Niger Delta's Agbada Formation is where it's at. Shoreface and channel sands predominate in the top part of the formation, while small shales and sandstones are found in the middle, and sandstones and shales alternate in the lower half. The formation is nearly 3,700 meters thick. The Benin Formation, which comprises of continental sands and gravels, is roughly 280 meters thick, but may be up to 2,100 meters in the zone of greatest subsidence (Whiteman, 1982) [8].
The Delta extended over the submerged continental edge, with its center resting on the location of the Triple Junction that originated in the Middle Cretaceous. Most of the silt has come from the Benue and Bida basins, two failed rift arms that the drainage system mostly follows. Since the end of the Cretaceous period, sedimentation has been mostly constant, however periodic incursions have disrupted the regressive record (Weber and Daukoru, 1975) [7].

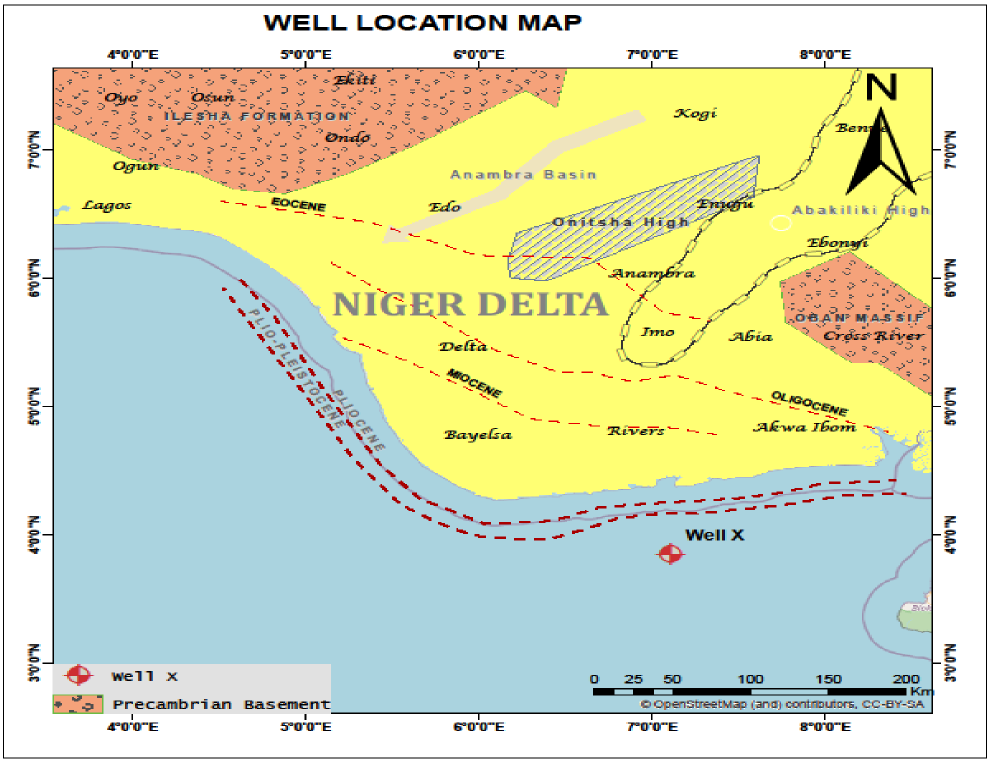

Fig 1: Map of Niger Delta showing the study area (Modified by Okereke and Chikezie2022)

Due to shifting drainage patterns, basement subsidence, and eustatic sea level fluctuations, the Niger Delta has been progressively prograding into the Gulf of Guinea. At first, the delta advanced westwardacross extensionally thinned and collapsed continental crust of the West African border (Fig.2) ultimately reaching the triple junction and filling in the basement graben and horst topography (Murat, 1972) [3]. Increases in sandiness in sedimentary strata may be traced back to the Middle and Late Eocene, when deltaic deposition began to decline.

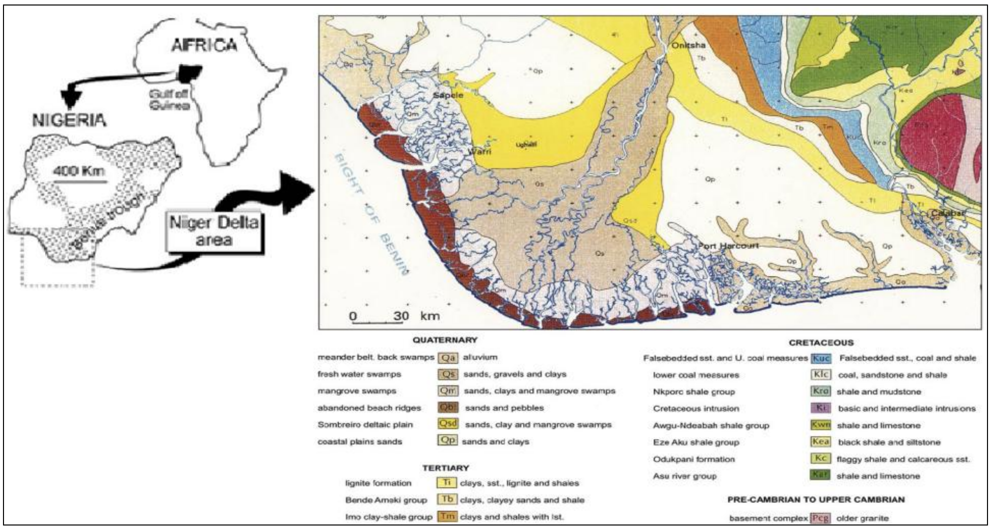

Fig 2: Geologic map of the Niger Delta and surroundings. (After: Reijers *et al*., 1996) [6]

Materials and Methods

The palynological procedure in this study was based on non-acid method using non-acid method (Sodium-Hexametaphosphate). Ten ditch cuttings (2960 to 3050 m) were sampled, 25grams of each sample was weighed and disaggregated to increase the surface area. The disaggregated sample was placed in a labeled beaker and Sodium-hexameta phosphate and detergent was added to remove drilling mud. 4-10ml of water was then added and stirred, using a spatula. Water was added to the brim of the beaker and allowed to settle for one hour before decanting. This process was repeated 3 times to wash off the sodium-hexametaphosphate, detergent, and drill mud. The samples were decanted into small centrifuge tubes. This is to separate the dense mineral fraction from the light organic residue and allow the organic residue to flow to the top of the glass residue. Upon decanting the organic residue on the slide, it was covered with a cover slip and three drops of Norland optical adhesive were added. This was placed on a hot plate, and then heated gradually. The cover slip was dried, then removed with spatula and place on the slides, then viewed and analysed under palynological microscope.

Results

Ten ditch-cuttings obtained from the depth intervals of 20 m were carefully examined and described in detail to ensure accurate characterization and proper lithological examination. Each sample was initially observed macroscopically with the aid of a hand lens to determine its textural and compositional attributes such as grain size, sorting, roundness, and visible mineral components.

The samples were prepared and analyzed under a transmitted light microscope for palynological studies. Palynomorph recovery was good in all the samples under study except for sample 10 where the recovery was very poor. The age diagnostic species recovered from the analysis showed that the sediments of X-well deposited during the Late Miocene times. One sample, was interpreted as indeterminate because of the absence of recovered palynomorphs and index taxa. These combined analytical steps provided a clear lithologic framework for understanding the vertical variation within the studied interval, offering insight into the depositional environment.

Details of the lithologic analysis are given below.

The sequence from 2960-3050 m shows alternating fine sands and silty clays, reflecting cyclic shifts between fluvial-deltaic and shallow-marine conditions. Upward-increasing of fine-grained facies correspond to low energy and increased marine influence, while sandy intervals represent high-energy fluvial or delta-front deposition.

Palynological Fossil assemblage of the study section

Sample 1			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Polyadopollenites sp.	3	42.9
2	Racemonocolpites hians	1	14.3
3	Stereisporites sp	2	28.6
4	Acritarch sp.	1	14.3
Age: Miocene			
Sample 2			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Nympheapollis clarus	2	50.0
2	Proxapertites sp	1	25.0
3	Polypodidites sp	1	25.0
Age: Miocene			
Sample 3			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Psilatricolporites crassus	1	33.3
2	Dinocyst indet	1	33.3
3	Pachydemites diederixi	1	33.3
Age: Miocene			
Sample 4			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Psilatricolporites sp	1	2.4
2	Fungal spore	1	2.4
3	Botryococcus brauni	3	7.1
4	Adenantherites sp.	1	2.4
5	Lygodiumsporites adriennis	1	2.4
6	Cycadopites sp	2	4.8
7	Peregrinipollis nigericus	2	4.8
8	Monoporites annulatus	1	2.4
9	Crassoretitriletes vaanradshooveni	1	2.4
10	Longapertites sp	1	2.4
Age: Late Miocene			
Sample 5			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Psilatricolporites crassus	3	42.9
2	Lygodiumsporites	1	14.3
3	Stereisporites sp	1	14.3
4	Verrucatosporites farvus	2	28.6
Age: Late Miocene			
Sample 6			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Echiperiporites estelae	1	1.8
2	Verrucatosporites sp	3	5.3
3	Retitriletes sp	2	3.5

4	Pollenites rogus	1	1.8
5	Longapertites sp	3	5.3
6	Zonocostites	4	7.0
11	Lygodiumsporites sp	2	3.5
23	Polyadopollenites sp.	1	1.8
Age: Miocene			
Sample 7			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Retibrevitricolporites	1	11.1
2	Zonocostites ramonae	1	11.1
3	Racemonocolpites hians	1	11.1
4	Lygopodium sp	2	22.2
5	Multiaerollites formosus	1	11.1
6	Stereiporites sp	3	33.3
Age: Late Miocene			
Sample 8			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Nympheapollis clarus	1	2.3
4	Monoporites annulatus	2	4.5
15	Verrucosisporites sp	2	4.5
16	Achrostichum aureum	1	2.3
17	Botryococcus brauni	1	2.3
18	Zonocostites ramonae	1	2.3
Age: Late Miocene			
Sample 9			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Smoothtrilete sp	2	50.0
2	Echiperiporites estelea	1	25.0
3	Nympheapollis clarus	1	25.0
Age: Miocene			
Sample 10			
S/No	Taxon Name	Count	Percentage of occurrence (%)
1	Acritarch sp.	1	33.3
Age: Indeterminate			

Palynological Distribution Counts

		Savana Taxa								Montane Taxa				RFS Taxa				Freshwater swamp Taxa											Mangrove Taxa					Others				Dinocyst	
S/N	Sample depth(2960-3050)m	Pteris sp.	Cyperaeapollis sp	Coryius spp.	Stereiosporites sp.	Fungal spore	Reibreviricolporites	Total Savana taxa		Monoporites annulatus	Ainipollenites verus	Total montane taxa		Pachydermites diederxi	Sapotaceae	Total Rainforest swamp taxa		Striatricolporites catatumbus	Gemmamonoporites sp.	Racemonocolpites hians	Multiareolites formusua	Crassoretitriletes vanraadshooveni	Laevigatosporites sp.	Botrycoccus braunii	Verrucatosporites sp.	Total Freshwater Swamp Taxa			Zonocostatites romonae	Psilatricolporites crassus	Acrostichum aureum	Total Mnagroove Taxa		Psilatricolporites sp.	Echistephanoporite estalae	Total others		dinicyst indeterminate	
1								0				0				0							2			2			4										
2								0		1		1				0										0			7										
3		1						1		1		1			3	3							2		5	7			47										
4		1				1		2		2		2				0							1			1			13										
5							2	2				0				0							3	2	2	7			11										
6								0				0				1							1			1			3										
7								0		1		1				1								2		2			3										
8								0		3		3				1				1			1	1		3			8										
9		1						1				0				0							3			3			5										
10								0				0				1			1				3			3			5										

Conclusion

The application of palynology in hydrocarbon exploration has significantly advanced the understanding of subsurface geology in the Niger Delta. Detailed palynological analysis provides accurate biostratigraphic frameworks and environmental interpretations critically for identifying productive palynolofical zones. This study reaffirms that palynological data enhances the precision of hydrocarbon exploration exploration and aids in efficient resource management. As exploration moves toward more challenging and deeper terrains, palynology will continue to serve as a vital instrument in reducing uncertainty and guiding sustainable hydrocarbon development within the Niger Delta.

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