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Paleoenvironmental Recontruction of Tertiary Sediments in F-Field, Greater Ughelli Depobelt Niger Delta Basin

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Abstract Paleoenvironmental recontruction of tertiary sediments in F- field, greater Ughellidepobelt Niger delta basin was carried out using Fifty (50) Ditch Cutting samples at different intervals between 2,010ft and 10,170ft, prepared using palynological sample processing technique and analyzed under the microscope. A total of 4,243 palynomorphs were recovered, the presence of diagnostic palynomorphs such as *Zonocostites ramonae, Monoporites annulatus, Verrucatosporites usmensis and* dinocysts such as *spiniferites sp, sumatradinium hispidicum, Lingulodinium machaerophorum* aided in the establishment of two varying paleoenvironments which are Continental – Transitional Environment and Paralic (Inner Neritic) Environments. The Continental – Transitional settings is suggested from depths (15ft to 7,800ft) based on the abundance of miospore (pollen and spore) such as *Zonocostites ramonae, Monoporites annulatus and Verrucatosporites usmensis* and the absence of dinocysts. The Paralic (Inner Neritic) Environment was defined at depths (7,830ft – 10,185ft). This environment was suggested due to the presence of dinocysts such as *spiniferites sp, sumatradinium hispidicum* and *Lingulodinium machaerophorum.*

Keywords: *Depobelt, Niger delta Basin, Palynomorphs, Oligocene to Early Miocene, Paleoenvironment*

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1. Introduction

The Niger Delta Basin is economically important because of its petroliferous nature and the economy of Nigeria depends largely on the oil and gas derived from it. Geologically, it is found in the Tertiary period in the geologic column. It lies mainly in the Gulf of Guinea to the southwest of the Benue – Trough and constitutes the most important Cenozoic deltaic construction in the South Atlantic. The combination of source rock, lithologic types, structures and thermal history of the basin are favorable for the generation, accumulation and preservation of hydrocarbons [13,14].

The use of lithofacie and palynology as tools and components in evaluating sedimentary pile and basin analysis has become increasingly important in recent times as seen in works by [2,3,5,6,7,8,10,11,12,15].

Palynology is the study of palynomorphs and is an essential tool for dating rocks and identifying the biotic record through time. Palynological study is necessary for correlation, paleoenvironmental reconstruction, paleogeography and calculating rates of geologic processes. It is essential to the petroleum industry as a tool for defining geologic constraints on prediction of exploration risk and modeling reservoir simulation. Palynomorphs are acid resistant organic-walled Microscopic plants and animals remains preserved in rocks. These include pollen, spores, Dinoflagellate cysts (dinocysts), acritarchs etc. By the term acid resistant we mean they survive the HF, HCl and HNO_3 acid treatment used to demineralized rocks samples in which these forms could be possibly contained or preserved. This study is aimed at establishing a palynological zonation and age of deposition of the sediments.

2. Materials and Method

Fifty (50) Ditch Cutting samples at different intervals between 2,010ft and 10,170ft of OG#1 Well were prepared using standard palynological sample processing technique and analyzed for further studies.

2.1. Palynological Sample Preparation

The sample preparation was carried out following the international standards given below:

10g of sample was crushed between aluminum pie dishes, collected and tested for limestone ($CaC0_3$) using HCl, while effervescence occurred, the limestone was eliminated by further addition treatment with concentrated HCl.

After two or three hours, the sample was decanted and the waste solution transferred to one special waste container bottle. The broken down mineral material and fossils were removed and centrifuged for about 1-2 minutes and decanted repeatedly until a neutral reaction was reached. Concentrated HNO_3 was used for oxidization and heated over bunsen burner. KOH of 10% solution was added to the sample and transferred to styrofoam cups and HF added and let to stand overnight. The sample was then washed with water until a neutral reaction was reached and decanted. Sodium hypochlorite (Purex) as well as some drops of HCl was added, agitated and let for about 15 minutes. Two drops of Ammonium Hydroxide concentrate was added and diluted with water. At this stage, separation of the organic matter from the inorganic material (silica) was done by floatation using diluted zinc bromide (ZnBr).

The samples were transferred to a flexible plastic tubes, already prepared (cut and mount immersed into warm water); such plastic tubes are set into centrifuge tubes with water around them. Zinc bromide has a specific gravity of 2.2 thus, everything with a specific gravity of more than 2.2 will settle down. The process of centrifugation using zinc bromide took about 15 minutes. A small portion of the supernatant liquid was observed under the microscope. Then, a clip across the flexible plastic tube was inserted so that the supernatant liquid would be easy to take out by pipette decantation or eye dropper.

Microscopic view of the supernatant liquid decided how to clean, run acetolysis or stain. Add acetic anhydride and three of four drops of H_2SO_4 to take out the water, then immerse test tube in boiling water for about ten minutes. The sample was properly washed at each stage. Here, it was ready for cleaning and mounting; during this stage several views under the microscope accomplished with some attempt to get mainly fossil material was done.

The palynomorph counting and logging were done by straight transects across each slide and coordinates. The recovered palynomorphs species were identified with the aid of Shell palynological photo album, other relevant publications and manuals such as web-based albums. Morphological characters of the pollens and spores such as the size, exine, structure, shape, sculpture and aperture type provided the basis for the identification of the forms. Species name and their abundance were recorded in the analysis data sheets.

3. Result and Discussion

Diagnostic Palynomorphs that were important and environmentally indispensable were recovered in the analyzed samples and plotted in order to interpret the P-zones, age and paleoenvironment of deposition of sediments. A total of 4243 palynomorphs were recovered, the pollen and spores recovered are relatively moderate in abundance.

PALYNOMORPHS DISTRIBUTION CHART

A thorough distribution chart showing the stratigraphic ranges of the palynomorph in the Well was established based on the First Appearance Datum (Last Downhole Occurrence) and the Last Appearance Datum (First Downhole Occurrence) of each palynomorph recognized in the well section. The recovered palynomorphs are listed below.

The Miospore recovered are: *Acrostichum aureum (smooth trilete spore,) Aletesporites sp, Arecipites exilimuratus Bombacacidites sp, Cicatricosisporites dorogenesis, Cingulatisporites ornatus, Cingulatisporites cingulatus,Cinctiperiporites mulleri, Classopollis sp, Crassoretitriletes vanraadshooveni, Cupaniodites reticularis, Cyperoceapollis sp, Dichtyphidiles. Harassi, Dualaidites laevigatus, Dualaidites sp, Echimonocolpites rarispimosus, Echiperiporites estelae, Echistephanoporites echinatus, Echitricolporites spinosus, Echitriletes pliocenicus, Elaeis guineenses, Ericipites sp, Filtrotriletes nigeriensis, Foveotriletes margaritae, Gemmamonocolpites gematus sp, Gemmamonoporites sp, Gematricolpites scabratus, Gemmatriporites sp, Laevigatosporites, Lycopodium sp, Marginipollis concinnus, Monoporites annulatus, Nympeapollis clarus, Omnipites africanus, Pachydermites diederixi, Perfotricolporites digitatus, Perisyncolpites pokornyi, Peregrinipollis nigericus, Poladopollenites vancampori, Polypediaceisporites sp, Praedapollis africanus, Praedapollis flexibilis, Proteacidites longispinosus, Proxapertites operculatus, Psilaheterecolpites sp, Psilatricolporites crassus, Psilatricolporites operculatus, Psilatricolporites rotundiporis, Psilatriporites sp, Psilamonocolpites marginatus, Racemonocolpites hians, Retibrevitricolporites obodoensis, Retibrevitricolporites protrudens, Retistephanocolpites williamsii, Retitricolporites crassireticulatus, Retitricolporites irregularis, Retricolpites sp, Rugulatisporite caperatus, Sapotaceae pollinites, Scabratriporites simpliformis, Spirosyncoporites brunnii, Stereisporites sp, Striatmonocolpites rectostriattus, Striatricolpites catatumbus, Striatricolporites pimulus, syncolpites marginatus*, *Triorites africaensis, Verrucatosporites usmensis, Verrutricolporites rotundiporis, Zonocostites ramonae*.

Paleoenvironment of Deposition

Paleoenvironmental interpretations has been made by incorporating quantitative palynological data such as their occurrence and distribution. Two (2) depositional environments have been deduced: Continental - Transitional and Paralic environment.

Continental – Transitional Environment: (15ft – 8,790ft).

A Continental – Transitional settings is suggested from 15ft – 7,800ft based on the abundance of miospore (pollen and spore) such as *Zonocostites ramonae, Monoporites annulatus and Verrucatosporites usmensis* which are terrestial speciesand the absence of dinocysts which are marine species as seen in the distribution chart of the well.

Paralic (Inner Neritic) Environment: (7,830ft – 10,185ft).

This environment is defined due to the presence of marine dinocysts such as *spiniferites sp,sumatradinium hispidicum, Lingulodinium machaerophorum* and the few occurrence of terrestial miospores such as *Zonocostites ramonae, Monoporites annulatus and Verrucatosporites usmensis* within 7,830ft – 10,185ft of the studied Well section.

Table 1. Range Chat of recovered Palynomorphs

PALYNOMOPH DISTRIBUTION CHART OF THE WELL SECTION																							
Depth(ft)	***Acrostichum aureum*(8)**	***Zonocostites ramonae*(531)**	***Laevigatosporites*(2)**	***Monoporites annulatus* (125)**	***Verrucatosporites usmensis* (5)**	***Racemonocolpites hians* (250)**	***Peregrinipollis nigericus* (399)**	***Praedapollis flexibilis* (420)**	***Cinctiperiporites mulleri*(190)**	***Verrutricolporites rotundiporis* (440)**	***Pachydermites diederixi* (317)**	***Retibrevitricolporites obodoensis* (178)**	***Striatmonocolpites rectostriatus* (252)**	***Magnastriatites howardi* (9)**	***Marginipollis concinnus* (556)**	***Bombacacidites sp* (400)**	***Spirosyncolpites brunni* (412)**	***Arecipites exilimuratus* (280)**	***Praedapollis africanus* (443)**	***Crassoretitriletes vanraadshooveni* (17)**	***Gemmatriporites sp* (573)**	***Cicatricosporites dorogenesis* (30)**	***Retibrevitricolporites protrudens* (175)**
2,025	4	20	3	17	4	1	3	1															
2,175	8	32	5	10	6	2		6															
3,000	7	25	3	33	10	6		2	1	2	16	1	1										
3,510	9	27	11	15	14	7	3				2												
3,720	11	32	10	18	5	7	1				6	4											
3,810	7	34	8	24	14	6				1	3	3		1									
4,170	4	27	5	10	15			1				1	2										
5,310	7	28	7	19	8			1				1											
5,355	6	31	5	23	13		1	1			2												
5,385	4	37	6	15	7	2	1																
6,060	4	28	9	17	12	6							4		1								
6,630	7	34	7	14	7	11	1					7	9										
6,660	22	21	7	28	6	10	1	1				3	4										
6,675	11	15	9	21	12	6	2	5				1					1	2					
6,690	5	24	5	18	13	7						1	3					1	1				
7,005	7	22	7	17	13	15		3				7	2					1					
7,035	5	25	6	23	17	16	2	3			1	3	17		3	1							
7,770	8	16	5	17	9	20	8	7	1		8	7	12	1	1	1				1			
7,800	10	26	13	25	11	18	5	4	2	4	7	2	6		1						1		
7,830	8	14	7	10	5	44	4	4		3	3	1	15		1							2	
8,025	6	15	7	13	7	22	1	1		5	3		1			1							
8,100	7	12	9	18	6	38	7	3		1	2	13	11	2	1		1						1
8,145	3	18	7	17	10	15	5	12			4	3	15	1	2				2	2		2	
8,250	10	20	5	16	11	10	3	14	3	5	4	20	5		2				3			1	1
8,295	5	13	4	21	9	9	3	1		1	1	2	1						2				
8,340	7	15	8	14	6	40	1	4		3	4	8	17	2									
8,400	6	11	7	12	5	12						26		2			2	1					1
8,505	5	13	7	18	13	87					2	18	12										
8,535	6	14	5	13	8	18						6	5					2					
8,610	7	15	4	17	9	8					1	10	3										
8,670	7	9	23	21	41	12	4	3			2	5	6										
8,760	12	17	5	26	19	12		2			1	6	3				2						
8,865	5	16	16	16	22	7	1	4	1			9	1	1			3		1				
9,225	7	15	10	17	7	10		3			1	9	1										
9,255	6	13	9	16	11	2																	
9,465	4	17	11	15	14	15					1	7											
9,525	5	15	6	17	15	10		4			1	8	1										
9,585	7	12	12	18	9	5	3					3							1				
9,645	8	15	9	14	10	2	1	1		2		2				1							
9,705	4	7	5	10	9	1	1					3											
9,720	3	8	4	10	3	4						2			1								
9,750	7	10	6	12	6	2	1					3	3		1						1		
9,780	4	8	8	9	7	1							1					1					
9,840	6	10	9	11	10	5	1					2	1					1					
9,900	8	11	9	13	11	7					1	6	1				2	2					
9,960	6	9	4	9	7	8			1		1	10	8	4	1			1					
10,020	8	7	5	9	8	7						8	3	1				1					
10,110	4	6	4	8	6	5						1	2					1					
10,140	5	8	5	9	7	8						2					2						
10,185	6	5	7	12	9	4											1	1					

4. Conclusion

The Palynological analysis of the studied samples was used to determine the Paleoevironment of the sediments. The pollen and spores recovered are relatively moderate in abundance with the presence of diagnostic palynomorphs such as *Zonocostites ramonae*, *Monoporites annulatus and Verrucatosporites usmensis and* dinocysts such as *spiniferites sp, sumatradinium hispidicum*, *Lingulodinium machaerophorum* whichaided in the establishment of the Paleoevironmen.

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