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Palynomorph Biostratigraphy of VIC 97 Well, Nothern Depo Belt, Niger Delta, Nigeria

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ABSTRACT: *Palynological and sedimentological studies were conducted on sixty ditch cutting rock samples from interval 460 to 4550 feets of VIC-97 well, located at OML 38, Northern Depo-belt, Niger-Delta, to delineate lithofacies units and the age of the rock succession. Standard methods of palynological sample analysis were used to disaggregate the palynomorphs from the rock matrix. Log signatures, sand/shale ratios, textural attributes, and accessory mineal compositions of ditch cutting rock samples were used as lithologic parameters to establish two lithofacies units; the transitional unit having a sand/shale ratio of 80:20 and the continental Unit having a 98:2 ratio ascribed to upper Agbada and Benin formation respectively. Palynological analysis revealed that the retrieved palynomorphs were numerous and reasonably diversified, particularly in the lower portion of the sample interval. Palynological zonation was based on the palynofloral assemblage of important species and their stratigraphic distribution. Thirteen informal biozones were recognised on the basis of their first and last downhole occurences and compared with P 560, P580 and P624 to delineate an early to late Oligocene age for the studied interval.*

KEYWORDS: palynomorphs, lithofacies units, rock, age, Niger Delta.

INTRODUCTION

Economically, the Tertiary Niger Delta Basin has been quite influential. Nigeria's economy gradually shifted from being centred on agriculture to being reliant on oil when considerable amounts of petroleum were discovered in the basin in 1956. Numerous strategies and approaches have been created and put into practice to maximize and profit from the remaining petroleum exploration as a result of the difficulties encountered ever since petroleum was discovered and explored in the Niger-Delta area. The development of palynology has been very advantageous because it has helped uncover petroleum in unexpected places hence this study. Palynological and sedimentological analysis were conducted on sixty ditch cutting rock samples from interval 460 to 4550 feets of VIC-97 well, located at OML 38, Northern Depo-belt, Niger-Delta (figure 1), for the purpose of the lithofacies determination and age characterization following standard method of palynological sample processing and analysis.

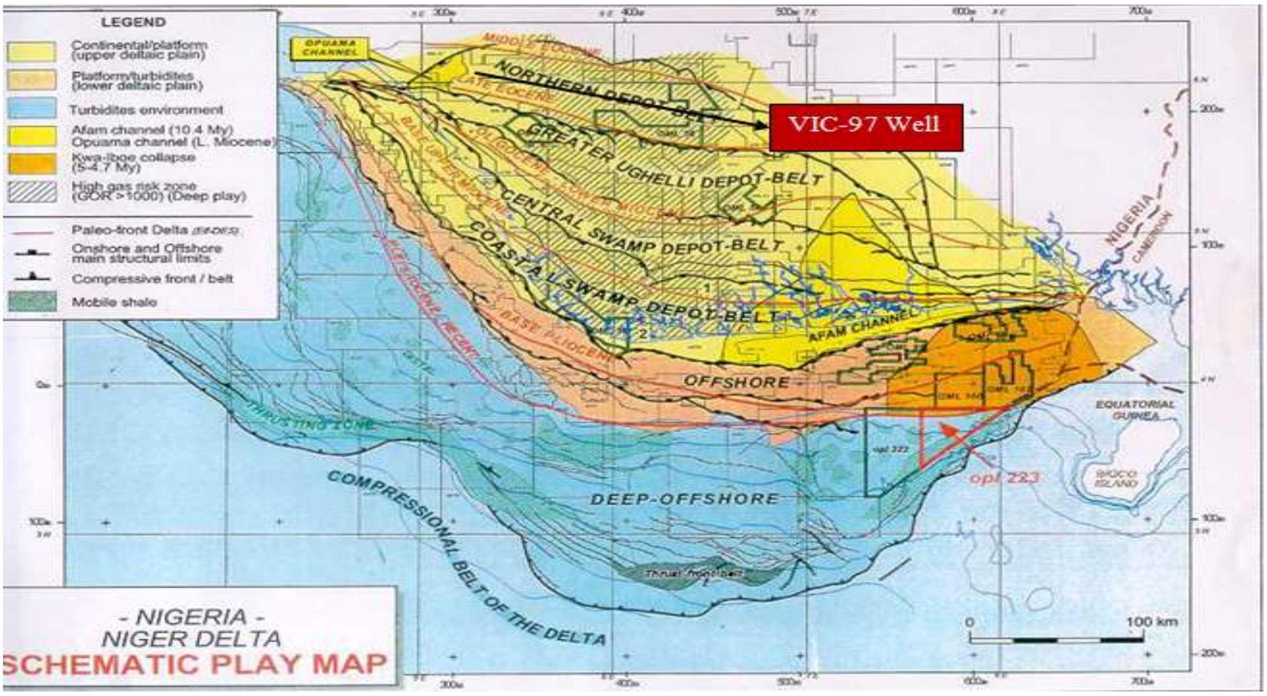

Figure 1: Location map of the study area,

Previous work: In order to create a geological model and shed light on the petroleum systems, the science of petroleum exploration uses a variety of tools, including the integration of palynology with other geological disciplines like geophysics, sedimentology, geochemistry, and petrophysics . Numerous authors from the past and present (Rull, 2002, Asadu & Ofuyah, 2017, Lucas & Ononeme, 2019, Jacinta & Edward, 2019, Fadiya et al., 2020), as well as many others, have conducted numerous research investigations using specific distinctive palynomorph indicators found within sediments with regard to understanding the perception of age determination, stratigraphic biozonation, paleoenvironmental impact, paleo- ecological dominance, and paleo-climatic implications as well as the presence of petroleum and other minerals.

The Niger Delta Basin is located in the Gulf of Guinea at the edge of the West African continent. It is thought to form the southern boundary of the Benue Trough, and the development of the larger sedimentary complex has been linked to it. The Benue Trough was determined to be the failed arm of three radial rift systems that met at an R-R-R triple junction in the Gulf of Guinea that started in the Early Cretaceous as a result of crustal doming (Mamah et al, 2005). Together with its neighboring basins, the Niger Delta Basin represents the trough's third stage of development. In accordance with research by (Whiteman, 1982), a triple junction occurred during the late Jurassic separation of the continents of South America and Africa, and the Cenozoic Niger Delta is situated at the intersection of the Benue Trough and the South Atlantic Ocean. The oil companies engaged in Niger Delta exploration and production activities have thoroughly documented the information regarding the Niger-Delta strata, although this information remain confidential with them. Field surveys conducted by (Nyantakyi et al., 2013) and (Asadu & Onifade, 2020) revealed that the Niger Delta Basin has an upward-coarsening regressive sequence of siliciclastic rocks between 9 and 12 km thick divided into three lithofacies: The Akata, Agbada, and Benin Formations, which, respectively, were deposited in marine, transitional, and continental settings, formed a dense succession of progradational passive margin wedges that displayed a complex fusion of marine, fluvio-marine, and deltaic plain habitats. The strata are interestingly separated based on the ratio of sand to shale, exhibiting a coarsening-upward progradational sequence as they were deposited in marine, fluvio-marine, and deltaic environments (Short and Stauble, 1967, Weber and Daukoru, 1975; Weber, 1987).

Akata Formation: According to Ola and Adewale (2014), the oldest and most fundamental unit is the Akata Formation, which has been dated and shown to span the Paleocene to the Recent. It is predominantly made up of marine shale and is believed to be the main source rock in the basin overlying the Precambrian basement complex (figure 2). According to (Dim, 2017), the Akata Formation of the Niger-Delta basin is made up of under-compacted marine sediments as well as lenses of sand deposited in front of the advancing delta in deep-water settings where these turbidites are suggested to be potential reservoirs (Short and Stauble, 1967). Based on foraminifera evidence, (Short and Stauble, 1967) established that the formation was deposited in shallow to deep marine environments. Doust and Omatsola, (1990), confirmed this finding in their study of the formation, which showed that the formation contained marine planktonic foraminifera that made up up to 50% of the microfauna assemblage, indicating a shallow marine shelf deposition. (Dim, 2017) and came to the conclusion that the formation was diachronous, spanning from the Paleocene to the Holocene. it also occur both onshore and offshore as diapirs along the continental slope and is known as the Imo Shale in the northeastern part of the delta.

Agbada Formation: The Tertiary Niger Delta basin's petroleum-bearing portion is known as the Agbada Formation, which has a thickness of over 3000 meters and sits on top of the Akata formation. The Agbada Formation serves as the basin's reservoir unit thanks to a number of prerequisites that make it a good reservoir (Reijers, 2011). Pochat et al., (2004) identified the Agbada Formation in their study as being distinguished by paralic to marine-coastal and fluvial-marine deposits made of shale and sandstone that were methodically ordered into coarsening upward off-lap cycles.

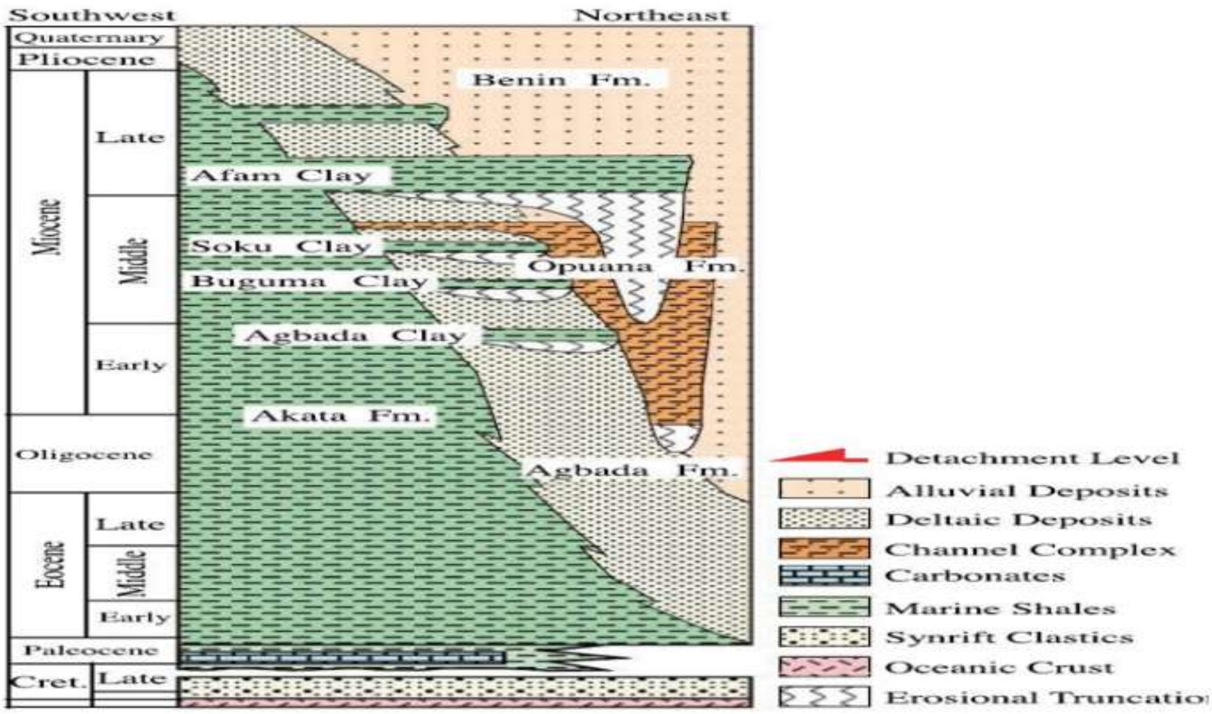

Figure 2: Regional stratigraphy of the Niger Delta (Lawrence et al, 2002).

The Benin Formation, described by (Avbovbo, 1978), is an alluvial and upper coastal plain deposit with a minimum thickness of more than 6000 feet and a maximum thickness of 2000 meters (m). According to Chukwu (1991), the formation is mostly composed of sand, gravel, and back-swamp deposits. The youngest of the three formations in the Niger delta region, the Benin Formation is found atop the Agbada formation and is dated between the Oligocene and Recent epochs. Asadu and Ikporukpo's research on the Benin Formation indicates that it is made up of more than 90% sandstones with shale intercalations. Their investigation also revealed that the Benin Formation was made up of poorly sorted, coarse-grained sands and sandstones with shapes ranging from sub-angular to well-rounded. Additionally, Doust and Omatsola, (1990) submitted that it also has streaks/lenses of shale, clays, and other minerals.

METHODOLOGY

well log signatures, sand/shale ratios, sand textural properties, and accessory mineral compositions of ditch cutting rock samples were used as lithologic parameters to establish the lithofacies units. The samples were treated with concentrated organic acids (5% HCL, 60% HF, and HNO3) in order to break down the rock sample matrix, separate heavy liquids, and oxidize the samples to maximize potential recovery of organic matter. This allowed for the complete digestion and separation of all inorganic matter of the rock samples and produced the greatest amount of the insoluble organic matter. These standard palynological sample preparation procedures were followed during the chemical treatment of the sixty (60) samples of the VIC-97 well between intervals 460 and 4550 meters depth.

To dissolve the carbonates, present in the samples, 25g of the samples were initially treated with 10% HCL while 60% HF was added to dissolve silicates present in the samples, then 5% HCL is added to the mixture to eliminate the silicofluoride gels that have formed in the samples due to the reaction of HF and HCL. After separating the palynomorphs from the residue, HNO3 is added to highlight their distinctive characteristics. The mixture was then mixed with distilled water, and allowed to settle before being decanted twice. The organic material was decanted and then transferred from the glass beaker to the cover slip using a pipette. One or two droplets of norland glue was put to the centre of the slide on the hot plate, allowing it to expand out to the size of the cover slip. On these cover slips, the organic residues were then spread out and given time to dry. The cover slips and their contents were delicately lowered onto the glass slide housing the mounting medium using a picking pin to reduce the creation of air bubbles and allowed to dry in the sun for a little while. After drying, the slides were mounted on a biological microscope (light transmitted type), where the various sporomorphs were observed, recognized, tallied at various depth intervals and recorded. The biostratigraphic analysis program "STRATABUG" was used to input all the information pertaining to the identification and counting of palynomorphs at the specie and sub-species levels, producing a biozone chart of the VIC-97 for comparing with the standard palynological zonation scheme of Evamy et al, (1978), for the purpose of age (chrono-stratigraphy) determination.

RESULTS AND DISCUSSIONS

Lithostratigraphy: Sedimentological analysis delineated two lithofacies units, the transitional Unit (4,550 – 3,480) Feet and the continental Unit (3,480 – 460) Feet ascribed to upper Agbada and Benin Formation respectively.

The continental Unit (3,480 – 460) Feet, Benin Formation: this unit is the most recent of the well section under investigation. It was possible to confidently identify the boundary between this unit of the Benin Formation and the underlying Agbada Formation due to the low quality of the Gamma Ray log supplied over the upper part of the studied sample section and the lack of a resistivity log, which is estimated at 3,480 feet depth. The unit is distinguished by its 98:2 sand/shale ratio. The sand is typically thick, with a milky white colour, fine- to coarse-grained texturally, occasionally very coarse-grained, weakly to moderately sorted, and sub-angular to sub rounded in shape while Shale is very thin and scarce, with dark grey colour, platy to flaggy and moderately hard with ferruginous components and carbonaceous detritus, which is more prevalent at the bottom portion of the unit (2,160–1,420) representing a fluvial system (table 1).

The transitional Unit (4,550 – 3,480) Feet, the Agbada Formation: This lithofacies unit is the topmost and youngest member of the Agbada Formation in the Vic-97 well. This unit is primarily made up of consolidated sand units with relatively thin shale interbeds. The shale, on the other hand, exhibit a somewhat greater frequency near the unit's base. The overall sand/shale ratio for the unit is around 80:20. The shale, dark grey in colour, platy to flaggy in texture, and moderately hard while the sand is generally thicker with milky white coloration, fine- to coarse-grained, granular, poorly to moderately sorted, sub-angular to sub-rounded in shape, and occasionally show rare ferruginous materials and carbonaceous detritus.

Biozonation and age

The Vic-97 Well's palynological zonation is based on the palynofloral assemblage of important species and their stratigraphic distribution in relation to the zonation scheme of (Evamy et al., 1978). Observations revealed that the retrieved palynomorphs were quite numerous and reasonably diversified, particularly in the lower portion (1,800-4,550 ft) of the sample interval, but a decrease in miospore proportion was seen, defining the top region of the Well (460–1,800 feet). The palynomorphs recorded revealed a dominance of land derived lowland pollens such as *Psilatricolporites crassus* and *Psilastephanocolporites sapotaceae* and other significant palynomorphs such as *Cicatricosisporites dorogensis* and *Racemonocolpites hians*. The presence of other palynomorphs, such as the brackish water species *Acrostichumaureum* and pteridophyte spores like *Laevigatosporites* sp, and *Verrucatosporites* sp, was also significantly documented. Additionally, Botryococcus brauni and fungal spores, the wall lining of foraminifera, and spot occurrences of dinoflagellate cysts in very small quantities were all noted (figure 3, and Plates 1 and 2). On the basis of the first downhole occurrence and the last downhole occurrence of the palynomorphs found in the VIC-97 well, thirtheen (13) informal biozones were recognised and defined as follows:

Zone (i): Retibrevitricolporites protrudens/ obodoensis zone- Early Oligocene

The base of the zone is marked at the Terminal Depth at 4550ft while the top of the zone is at 4310ft and is defined by First Downhole Occurrence of *Proteacidites cooksoni* and the Last Downhole Occurrence of *Pachydermites diederixi, Cicatricosisporites dorogensis, Racemonocolpites hians, Peregrinipollis nigericus, Retibrevitricolporites ibadanensis, Verrutricolporites rotundiporus, Cinctiperiporites mulleri*, *Laevigatosporites sp*., *Verrucatosporites sp*., *Cyathidites sp., Polypodiaceoisporites sp., Psilatricolporites sp., Spirosyncolpites bruni, Retibrevitricolporites triangulatus, Retitricolporites sp., Longapertites sp., Striamonocolpites undertostriatus, Psilastephanocolporites sapotaceae, Striamonocolpites rectostriatus, Psilatricolporites crassus*, *Retitricolporites irregularis*, *Canthiumidites sp., Brevicolporites guinetii, Psilastephanocolpites minor, Protaecidites sp., Polyadopollenites leavigatus, Acrostichum aureum, Proxapertites cursus, Foraminifera test lining, Monoporites annulatus*, *Zonocostites ramonae* and *Fungal spore/hyphae* and *Botryococcus braunii*.

Zone (ii): Praedapollis flexbilis zone- Early Oligocene

The base is the same as the top of zone (ii) while the top is at 4050ft and is defined by First Downhole Occurrence of *Inaperturopollenites gemmatus* and the Last Downhole Occurrences of *Praedapollis flexibilis, Verrutricolporites* sp., *Arecipites exilimuratus, Verrucatosporites usmensis, Pollen indeterminate, Retimonocolpites* sp., *Psilatricolporites onitshaensis, Ctenolophonidites costatus, Bombacacidites sp, Bombacacidites* sp. and *Echiperiporites estalae.*

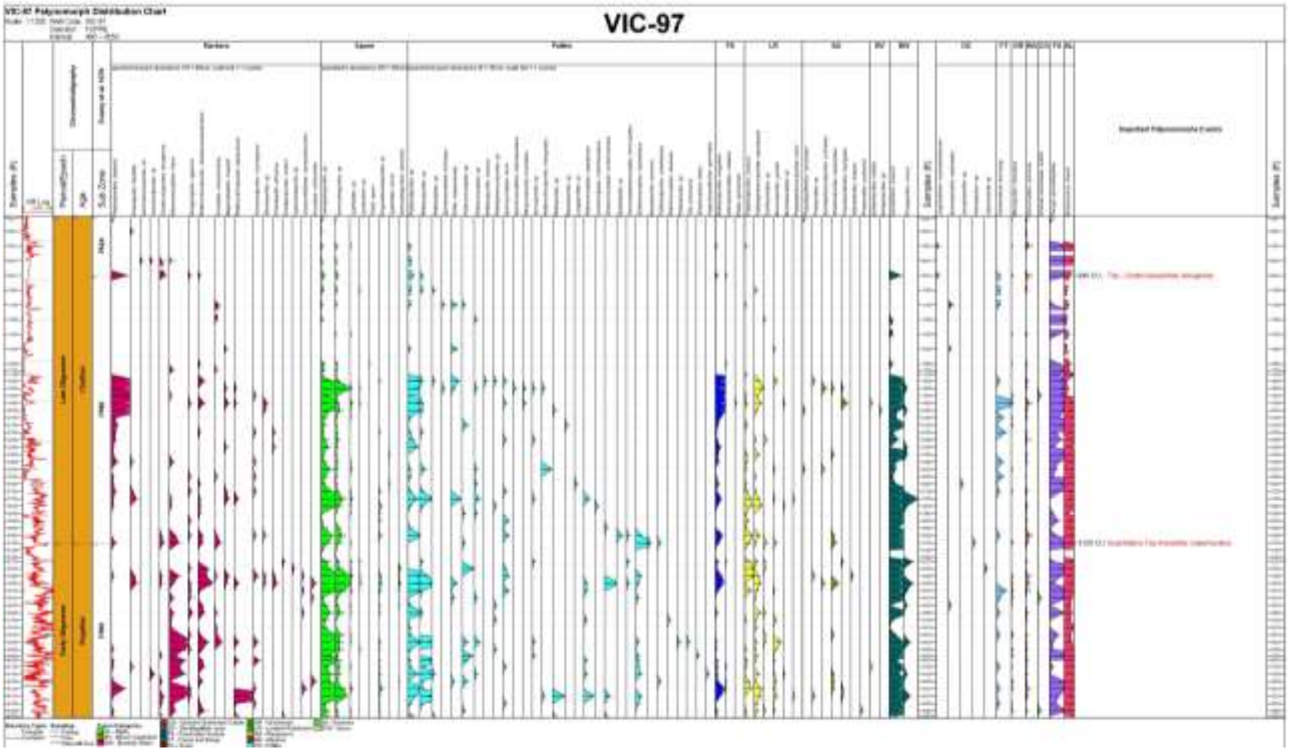

Figure 3: Palynomorph Distribution Chart of VIC-97 Well.

Zone (iii): Lycopodium sp. zone- Early Oligocene

The base is the same as the top of zone (ii) while the top is at 3750ft and is defined by First Downhole Occurrence of *Psilatriporites* sp., *Tillia americana and Striatricolporites* bellus and the Last Downhole Occurrences of *Arecipites crassimuratus, Lycopodium sp. Retistephanocolporites* sp. *and Syncoporites* sp.

Zone (iv): Retimonocolpites obaensis zone- Early Oligocene

The base is the same as the top of zone (iv) while the top is at 3450ft and is defined by First Downhole Occurrence of *Retimonocolpites obaensis* and the Last Downhole Occurrence of *Magnastriatites howardi* and *Selenopemphix nephroides.*

Zone (v): Adenantherites simplex zone- Late Oligocene

The base is the same as the top of zone (iv) while the top is at 3120ft and is defined by First Downhole Occurrence of *Verrucatosporites usmensis, Cyperaceaepollis sp., Adenatherites simplex, Cinctiperiporites mulleri, Craseoiotitrilletes varaadshooveni, Lejeunencysta* sp., *Arecipites exilimuratus* and the Last Downhole Occurrence *of Stereisporites* sp., *Praedapollis africanus, Gemmastephanocolpites brevicolpites and Echistephanocolporites echinatus.*

Zone (vi): Ephedripites sp zone- Late Oligocene

The base is the same as the top of zone (v) while the top is at 2820ft and is defined by First Downhole Occurrence of *Striamonocolpites undertostriatus, Ephedripites* sp., *Striamonocolpites rectostriatus, Homotryblium* sp., *Bacutrippporites orluensis, Psilatricolporites onitshaensis* and Gemmastephanocolpites brevicolpites.

Zone (vii): Retimonocolpites asabaensis zone- Late Oligocene

The base is the same as the top of zone (vi) while the top is at 2520ft and is defined by First Downhole Occurrence of *Psilastephanocolpites minor, Crototricolpites crotonosculptus, Leiosphaeridea* sp., *Retimonocolpites asabaensis* and the Last Downhole Occurrence of *Cyathidites minor, Bacutriporites* sp. *and Polyadopollenites vancampoi.*

Zone (viii): Cyathidites minor zone- Late Oligocene

The base is the same as the top of zone (vii) while the top is at 2220ft and is defined by First Downhole Occurrence of *Cyathidites minor*.

Zone (ix): Praedapollis africanus zone- Late Oligocene

The base is the same as the top of zone (viii) while the top is at 1920ft and is defined by First Downhole Occurrence of *Elaies guineensis, Bombacacidites* sp., *Echiperiporites estalae, Retitriporites sp., Echiperiporites* sp., *Bachutriporites* sp., *Praedapollis africanus* and the Last Downhole Occurrence of *Margocolporites foveolatus.*

Zone (x): Retibrevitricolporites ibadanensis zone- Late Oligocene

The base is the same as the top of zone (ix) while the top is at 1540ft and is defined by First Downhole Occurrence of *T*rilete spores, *Polypodiaceoisporites* sp., *Retitricolporites ituensis, Retistephanocolporites* sp., *Spirosyncolpites bruni, Retibrevitricolporites ibadanensis, Spinizonocolpites microbaculatus, Margocolporites foveolatus, Syncoporites* sp., *Retibrevitricolporites triangulatus, Protaecidites sp., Proxapertites cursus, Echistephanocolporites echinatus, Striaticolporites catatumbus, Polyadopollenites leavigatus, Verrutricolporites rotundiporus* and *Charred graminae pollen* with the presence of the Last Downhole Occurrence of *Spinizonocolpites echinatus.*

Zone (xi): Arecipites Crassimuratus zone- Late Oligocene

The base is the same as the top of zone (x) while the top is at 940ft and is defined by First Downhole Occurrence of *Lycopodium* sp., *Retitricolporites* sp., *Psilastephanocolporites sapotaceae, Arecipites crassimuratus, Spinizonocolpites echinatus, Pollen indeterminate, Psilamonocolpites* sp., *Retimonocolpites* sp., *Canthiumidites* sp., *Magnastriatites howardi, Brevicolporites guinetii* with a Last Downhole Occurrence of *Lingulodinium machaerophorum.*

Zone (xii): Cicatricosisporites dorogensis zone- Late Oligocene

The base is the same as the top of zone (xi) while the top is at 700ft and is defined by First Downhole Occurrence of *Gemmamonoporites* sp., *Verrutricolporites* sp., *Cicatricosisporites dorogensis, Racemonocolpites hians, Peregrinipollis nigericus, Retibrevitricolporites protrudens/ obodoensis, Retitricolporites* sp., *Ctenolophonidites costatus, Acrostichum aureum* and *Foraminifera test lining*.

Zone (xiii): Zonocostites ramonae zone- Late Oligocene

The base is the same as the top of the zone (xii) while the top is at 460ft which is the surface of the well sample interval studied and is defined by the First Downhole Occurrence of *Pachydermites diederixi*, *Praedapollis flexibilis*, *Laevigatosporites* sp., *Verrucatosporites* sp, *Cyathidites sp*., *Psilatricolporites* sp *Psilatricolporites crassus*, *Polyadopollenites vancampoi*, *Selenopemphix nephroides*, *Lingulodinium machaerophorum*, Botryococcus braunii, Retitricolporites irregularis, *Monoporites annulatus*, *Zonocostites ramonae* and *Fungal spore/hyphae* (figure, 27).

Age Characterization: It was possible to determine the age of the well within the sample interval, which ranged from the Early Oligocene to the Late Oligocene, by comparing the erected miospore zones identified from the VIC-97 well with the Evamy et al, 1978, zonation scheme as follows:

Stratigraphic interval	:	3,120 – 4,550ft.
Zone	:	P500
Subzone	:	P560
Age	:	Rupelian

This interval is characterized by miospore zones (i-v). Miospores are well preserved in this sediment interval, which accounts for the high frequency of miospore population that characterizes this zone. The top of P560 zone of Evamy et al, 1978, is indicated by the Quantitative Base of *Peregrinipollis nigericus* located at 3,120 feet, while the base is provisionally located at the last sample studied (4,550 feet, the Terminal Depth), therefore indicates late Oligocene (Rupelian) age for this sedimentary interval.

Stratigraphic interval	:	460 – 940ft
Zone	:	P600, P500
Subzone	:	P624- P580
Age	:	Chattian

This interval is recognized by miospore zones (vi-xiii). The evidence that the well is not older than the Oligocene is provided by the presence of *Zonocostites ramonae* within the well interval. Two zones (P624 and P580) of Evamy et al. In 1978 was recognized when contrasted to delineate a late Oligocene age for this interval. The top of P624 is recognised in this well by the top occurrence of *Cicatricosisporites dorogensis at 4*60-feet depth though the top of this form may lie shallower, while the sub zonal base is designated at a depth of 940 feet and marked by the moderate concentrations of *Laevigatosporites* spp, *Verrucatosporites* spp, *Zonocostites ramonae*, and fungal spore. The sub-zone top of the P580 zone is characterized by the Top Occurrence of *Cicatricosisporites dorogensis* at 940 feet, while the sub-zone base is indicated by the Quantitative Base *Peregrinipollis nigericus* at 3,120 feet.

SUMMARY/ CONCLUSION

Palynological and sedimentological studies was carried out on the sixty ditch cutting rock samples from interval 460 to 4550 feets of VIC-97 well, located at OML 38, Northern Depo-belt, Niger-Delta, for the purpose of delineating the lithofacies units and the age of the rock succession penetrated by the well interval. Log signatures textural attributes of the ditch cuttings formed the basis for sedimentological interpretations while Standard methods of palynological sample analysis involving seversl stages of chemical treatments was used to disaggregate the palynomorphs from the rock matrix Sedimentological analysis defined two lithofacies units, delineated on the basis of their sand shale ratio, as follows: the transitional Unit (4,550 – 3,480) Feet with sand shale ratio of 80:20 and the continental Unit (3,480 – 460) Feet with sand shale ratio of 98:2 ascribed to upper Agbada and Benin Formation respectively. The shale is generally, dark grey in colour, platy to flaggy in texture, and moderately hard while the sand is generally thicker with milky white coloration, fine- to coarse-grained, granular, poorly to moderately sorted, sub-angular to sub-rounded in shape, and occasionally show rare ferruginous materials and carbonaceous detritus.

MIOSPORE ZONATION
THIS STUDY

Depth (m): 460, 580, 700, 820, 940, 1060, 1180, 1300, 1420, 1540, 1660, 1720, 1740, 1800, 1860, 1920, 1980, 2040, 2100, 2160, 2220, 2280, 2340, 2400, 2460, 2520, 2580, 2640, 2700, 2760, 2820, 2880, 2940, 3000, 3060, 3120, 3180, 3240, 3270, 3330, 3390, 3450, 3510, 3570, 3630, 3690, 3750, 3810, 3870, 3930, 3990, 4050, 4070, 4130, 4190, 4250, 4310, 4370, 4430, 4490, 4550

GR LOG


Lithology		Chronostratigraphy	ZONES	Depth (m)	ZONE	DESCRIPTION		Comparison with Evamy et al, 1978
Benin Formation	Continental	Late Oligocene	xiii	460-700	***Zonocostites ramonae***	FDO: P. diederixi, P. flexibilis, Laevigatosporites sp, Verrucatosporites sp, P. vancampoi, L. machaerophorum, B. braunii, R. irregularis, M. annulatus and Z. ramonae	P624	***Verrutricolporites rotundiporus***
			xii	700-940	***Cicatricosisporites dorogensis***	FDO: C. costatus, A. aureum, C. dorogensis, R. hians and P. nigericus		***Cicatricosisporites dorogensis***
			xi	940-1540	***Arecipites crassimuratus***	FDO: P. sapotaceae, A. crassimuratus, S. echinatus, P. indeterminate, Psilamonocolpites sp, Retimonocolpites sp., Canthiumidites sp., M. howardi, B. guinetii and LDO: L. machaerophorum	P580	
			x	1540-1920	***Retibrevitricolporites ibadanensis***	FDO Trilete spores, Polypodiaceoisporites sp., R. ituensis, Retistephanocolporites sp, S. bruni, R. ibadanensis, S. microbaculatus, M. foveolatus, Syncoporites sp., R. triangulatus, Protaecidites sp, Proxapertites cursus, E. echinatus, S. catatumbus, P. leavigatus, V. rotundiporus LDO: S. echinatus.		
			ix	1920-2220	***Praedapollis africanus***	FDO E. guineensis, Bombacacidites sp., E. estalae, Retitriporites sp., Echiperiporites sp., Bachutriporites sp., P. africanus and LDO: M. foveolatus.		
			viii	2220-2520	***Cyathidites minor***	FDO: C. minor		
	Transitional- Continental		vii	2520-2820	***Retimonocolpites asabaensis***	FDO: P. minor, C. crotonosculptus, Leiosphaeridea sp., R. asabaensis, Bacutriporites sp, P. vancampoi and LDO: C. minor		
			vi	2820-3120	***Ephedripites sp***	FDO: S. undertostriatus, Ephedripites sp, S. rectostriatus, Homotryblium sp, B. orluensis, P. onitshaensis and G. brevicolpites.		**Peregrinipollis nigericus**
		Early Oligocene	v	3120-3450	***Adenantherites simplex***	FDO: V. usmensis, Cyperaceaepollis sp., A. simplex, C. mulleri, C. varaadshooveni, Lejeunencysta sp., A. exilimuratus, LDO: Stereisporites sp., P. africanus, G. brevicolpites and E. echinatus	P560	
Agbada Formation	Parralic- Transitional		iv	3450-3750	***Retimonocolpites obaensis***	FDO: R. obaensis, LDO: M. howardi and S. nephroides		
			iii	3750-4050	***Lycopodium sp.***	FDO: Psilatriporites sp, T. americana and S. bellus, LDO: A. crassimuratus, Lycopodium sp Retistephanocolporites sp and Syncoporites sp.		
			ii	4050-4310	***Praedapollis flexbilis***	FDO: I. gemmatus, LDO: P. flexibilis, Verrutricolporites sp., A. exilimuratus, V. usmensis, P. indeterminate, Retimonocolpites sp., P. onitshaensis, C. costatus		
			i	4310-4550	**Retibrevitricolporites protudens/ obodoensis**	FDO: P. cooksoni, LDO P. diederixi, C. dorogensis, R.hians, P. nigericus, R. ibadanensis, V. rotundiporus, C. mulleri, Laevigatosporites sp, Verrucatosporites sp, Cyathidites sp., S. bruni, R. triangulatus		**Retibrevitricolporites obodoensis/ protudens**

Figure 4: Biozonation of ViC-97 Well in comparison with Evamy et al, 1978 zonation scheme.

Palynological analysis revealed that the retrieved palynomorphs were quite numerous and reasonably diversified, particularly in the lower portion (1,800-4,550 ft) of the sample interval, but a decrease in miospore proportion was seen, defining the top region of the Well (460–1,800 feet). The palynomorphs recorded a dominance of land derived lowland pollens such as *Psilatricolporites crassus* and *Psilastephanocolporites sapotaceae* and other significant palynomorphs such as *Cicatricosisporites dorogensis* and *Racemonocolpites hians.* The presence of other palynomorphs, such as the brackish water species *Acrostichumaureum* and pteridophyte spores like *Laevigatosporites* sp, and *Verrucatosporites* sp, was also significantly documented. Additionally, Botryococcus brauni and fungal spores, the wall lining of foraminifera, and spot occurrences of dinoflagellate cysts in very small quantities were all noted. Vic 97 Well's

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palynological zonation is based on the palynofloral assemblage of important species and their stratigraphic distribution in relation to the zonation scheme of (Evamy et al., 1978). On the basis of the first downhole occurrence and the last downhole occurrence of the palynomorphs found in the VIC-97 well, thirteen (13) informal biozones were recognised and compared with P 560, P580 and P624 of Evamy et al. In 1978, to delineate an early to late Oligocene age for the studied interval.

In conclusion, the study revealed two lithofacies units, recognized on the basis of sand shale ratio, the transitional and the continental units belonging to upper Agbada and Benin formation respectively, were delineated and dated early to late Oligocene age for the rock succession.

Plate 1

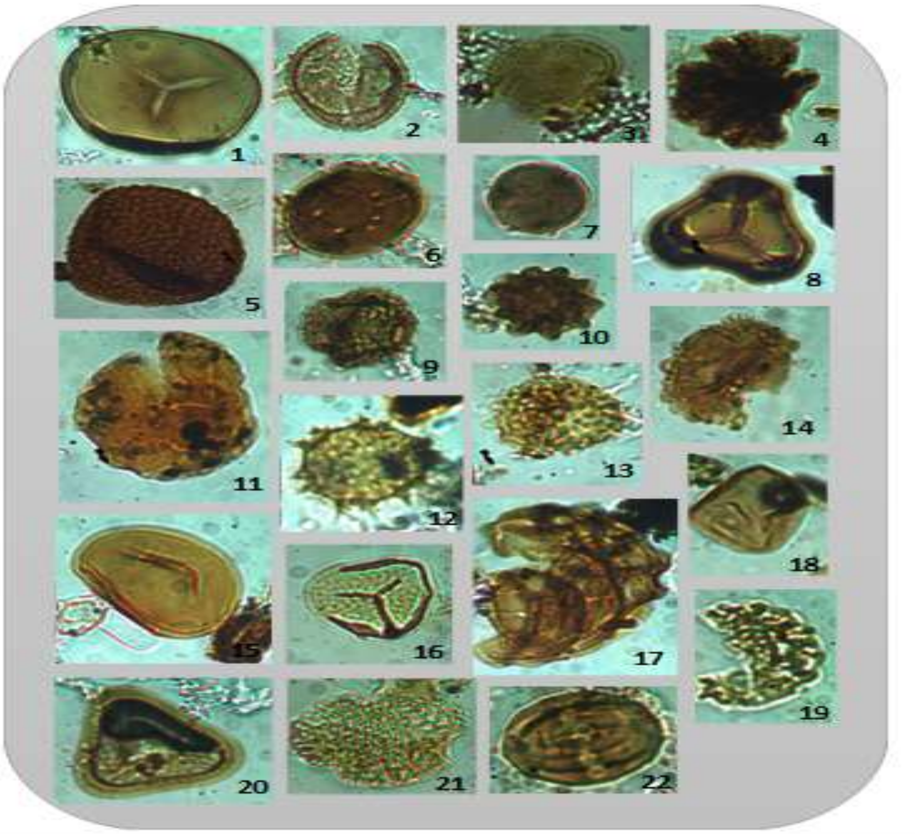

PLATE 1

1. *Acrostichumaureum*
2. *Arecipitesexilimuratus*
3. *Bombacaciditessp*
4. *Botryococcusbrauni*
5. *Cicatricosisporitesdorogensis*
6. *Cinctiperiporitesmulleri*
7. *Brevicolporitesguinetii*
8. *Cyathiditessp*
9. *Canthiumsp*
10. *Ctenolophoniditescostatus*
11. *Doualaiditeslaevigatus*
12. *Echistephanocolpitesechinatus*
13. *Echitriporitestrianguliformis*
14. *Gemmastephanocolpitesbrevicolpites*
15. *Laevigatosporites sp*
16. *Lycopodium sp*
17. *Magnastriatiteshowardi*
18. *Monoporites annulatus*

19.	*Peregrinipollisnigericus*	*20.*	*Polypodiaceoisporitessp*
21.	*Magocolporitesfoveolatus*	*22.*	*Psilastephanocolporitessapotaceae*

Plate 2

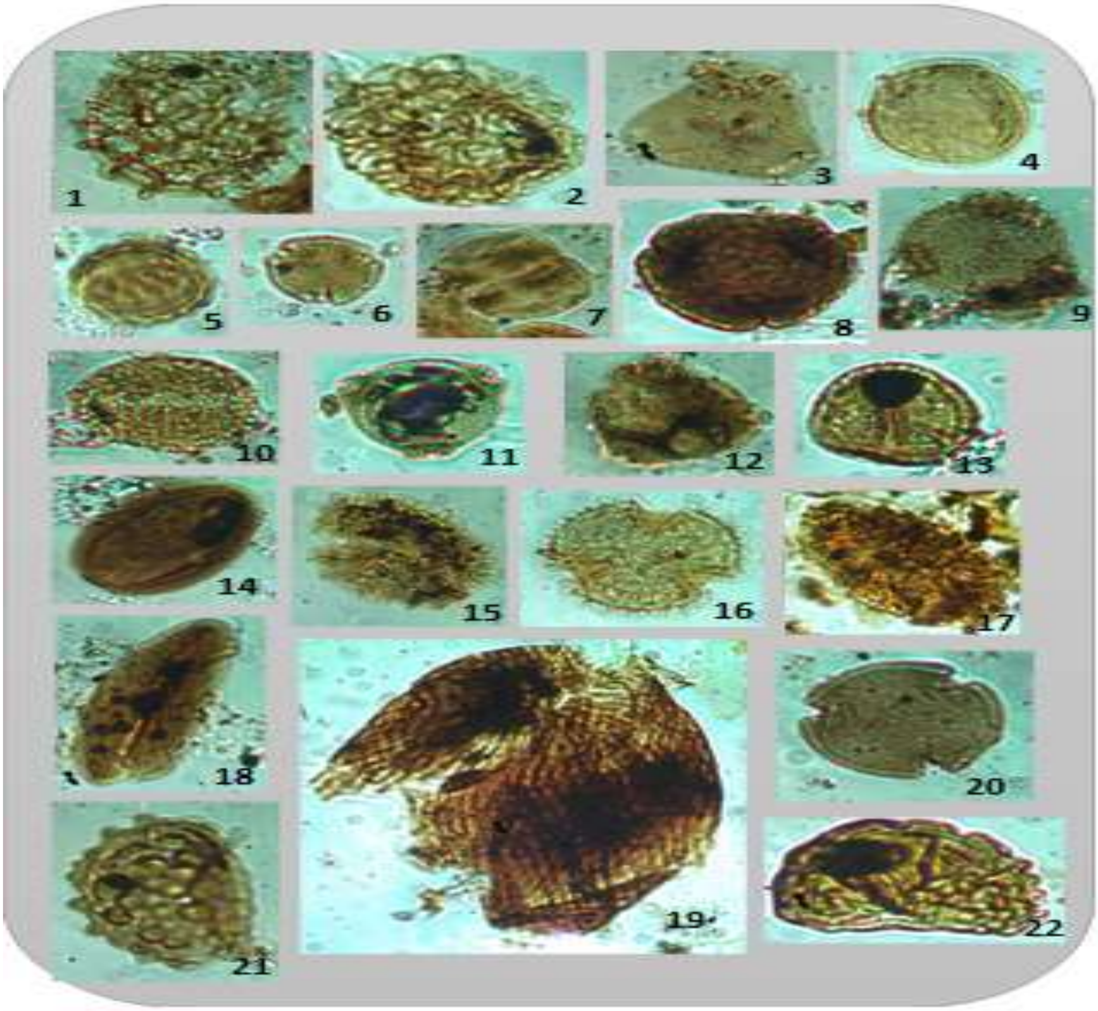

PLATE 2

Praedapollis africanus		2.	Praedapollisflexibilis
3	Proteaciditescooksonni	4.	Proxapertites cursus
5	Psilastephanocolporites minor	6.	Psilatricolporitesoperculatus
7	Psilatricolporitesonitshaensis	8.	Psilatricolporitescrassus
9	Retibrevitricolporitesibadanensis	10.	Racemonocolpiteshians,
11	Retibrevitricolporitesobodoensis	12.	Retibrevitricolporitestriangulatus
13	Retimonocolpitesasabaensis	14.	Retistephanocolporitessp
15	Retitricolpitesituensis	16.	Retitricolporitesirregularis
17	Retitricolporitesituensis	18.	Striamonocolpitesrectostriatus
19	Striatricolpitescatatubus	20.	Tiliaamericana
21	Verrucatosporitessp	22	Verrucatosporitesusmensis

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