Palynological Studies of Wells A-1 and B-1, Western Niger Delta, Nigeria

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Abstract

Palynological analyses were carried out on wells A-1 and B-1, western Niger Delta Nigeria. The intervals studied range from 6425 to 7160 feet and 7625 to 8045 feet in A-1 and B-1 wells respectively. The standard method of palynological analyses was used. Nine hundred and twenty two (922) palynomorph counts were identified from both wells. The studied intervals are dated Late Oligocene to Middle Miocene for well A-1 and Late Eocene to Early Oligocene for well B-1, using the recovered age diagnostic species. The palynozones identified are *Pachydermite diederixi* and *Verrutricolporites* spp (taxon range) zones in well A-1 which is equivalent to P500 – P600 and P700and upper to lower part of *Magnastriatites howardii* while *Retibrevitricolporite protrudens / obodoensis* (taxon range) zone and *Longapertites* sp – *Monocolpites* sp (concurrent range) zone are identified in B-1 well which is equivalent to P400 – P500 and *Verrucatosporites usmensis* and *Magnastriatites horwardii*.

Keywords: Palynomorphs, Palynozones, downhole occurrence, diversity, diagonstic and non-diagonstic sp, spp

Introduction

Palynology has become important tool in exploration for hydrocarbon and basin analysis in the sedimentary basin. Palynology is the study of micro- organic material such as spores, pollen, dinoflagellates and microfossils that are highly resistance to most forms of decay other than oxidation. In modern research for petroleum, palynology has become important method of resolving age and facies correlation problems. It also provides a chronostratigraphic framework for mapping of sedimentary facies and for stratigraphic predictions. It also finds application in paleoclimatology. All these are possible because of the durability, diversity and statistical value of palynomorphs. The Niger Delta Basin has been the subject of continuous, consistent and extensive geologic investigations both for academic and economic purposes. Of recent, there has been a growing concern among the petroleum explorationists working in the basin that the oil exploration effort no longer yields expected results which rise to new challenges, thus the need to revisit the geology of the basin (Ojo, 2008).

Location of the Study Area

The studied wells lie in the south-western part of Niger Delta and they are bounded by latitude 6°42'N and longitude 5°44'E for well A-1and latitude 6°00'N and longitude 6°30'E for well B-1 (Figure 1).The wells lie within the oil prolific belt of Niger Delta.

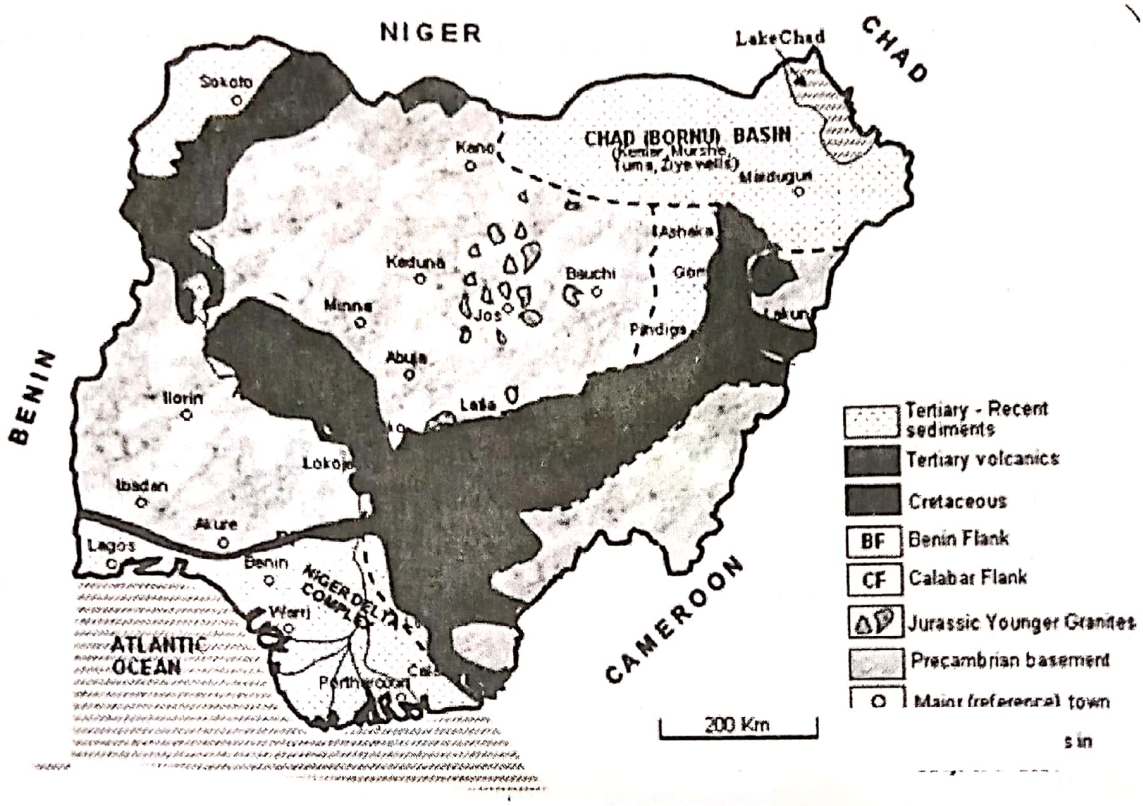


Figure 1: Sedimentary basin in Nigeria showing the Niger delta basin and the studied wells.

Geological Setting of Niger Delta

The Tertiary Niger Delta is situated in the Gulf of Guinea on the west coast of Central Africa. It lies between latitude 4^0 and 6^0 N and longitude 3^0 and 9^0 E in the southern part of Nigeria. The stratigraphy of the Niger Delta is a direct product of the various depositional processes prevalent in the area. The delta displays a concentric arrangement of terrestrial and transitional depositional environments (Reijers, 1996). The environment can be broadly categorized into three distinct facies belt. These are: (1) Continental delta top facies (2) The paralic delta front facies and (3) Pro-delta facies. Fluvial process controlled sedimentation in the lower floodplain of the delta top environment, while from the mangrove swamp coastward, tidal influence prevails.

The Niger Delta basin consists of a series of depocenters or belts (Short and Stauble, 1967; Chiaghanam *et al.*, 2014). Major structure building growth fault determine the location of each depobelt. The entire sedimentary wedge was laid down sequentially in five major

depobelts each 36 – 60 km wide, with the oldest lying further inland and the youngest located offshore (Reijers, 1996). Three main subdivisions have been recognized in the subsurface of the Niger Delta complex (Frankl and Cordy, 1967; Stacher, 1995; Weber and Daukoru, 1975). The basal unit is the whole marine shale, the Akata Formation, overlain by the paralic Agbada Formation with the topmost unit as the Benin Formation (Figure 2).

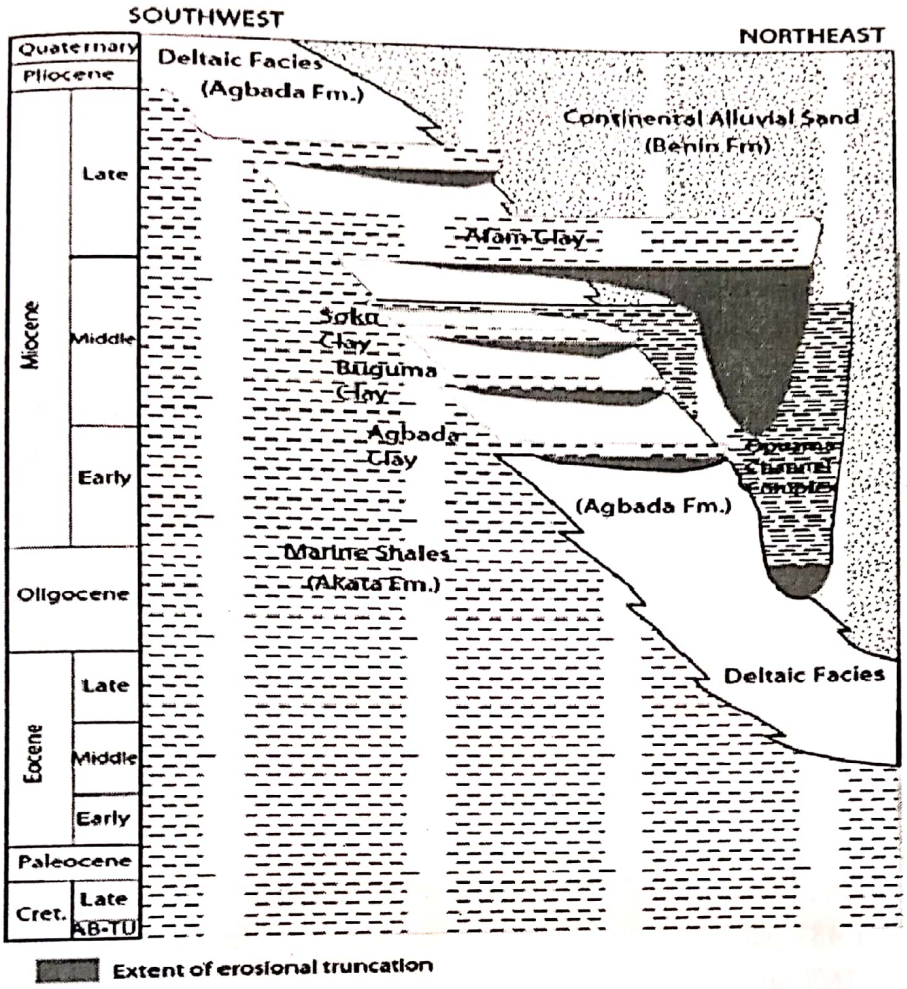


Figure 2: Stratigraphic column showing Formations of the Niger Delta (Doust and Omatsola, 1990).

Materials and Methods

The ditch cutting samples used for this study were from A-1 and B-1 wells, western Niger Delta and were provided by Nigeria Petroleum Development Company (NPDC). A total number of one hundred samples were used for this study. They were collected from depth ranging from 6425 feet – 7160 feet for A-1 well and 7625 feet – 8045 feet for B-1 well.

The samples were arranged in numerical order from lower depths to higher depths and were selected at 15 feet intervals for this study. They samples were ditched equally into well labeled plastic cups at 10 grams each and arranged in a fume cupboard that channeled the released fume to the atmosphere. Carbonates were removed from the samples with the aid of 10% Hydrochloric acid (HCl). The beakers were well labeled and the digested samples were

poured gently into the beakers while 10% hydrochloric acid was applied to each sample. The beakers containing the samples were then arranged on hot plate and heated for 25-30 minutes. The samples were decanted at an interval of one hour each for three times.

Hydrofluoric acid (HF) was gently applied to each sample and properly stirred for digestion overnight. The samples were filled with distilled water the next day for an hour and decanted. Brason sonifier was used with the aid of 5 micron sieve size to filter away the remaining silicate, mud and clay (inorganic matters) and remove the organic matters. The sieved residue was given controlled oxidation using concentrated Nitric acid (HNO_3).

The sample residue was then prepared for microscopic study in the form of strewn mount on a glass slide. The mounting medium used was LOCTITE (impruv). Staining of the slides using infranin O were done inorder to enhance the visibility of dinocysts.. The palynological slides were examined using transmitted light microscope under times forty (X 40) dry and times one hundred (X 100) oil immersion objective lenses. The slides were studied under binocular microscope, moving in defined directions until the slide was fully analysed, stratigraphic markers observed and noted, and photomicrographs of the observed palynoforms were taken.

Results and Discussions

Palynomorphs

A total count of 922 palynomorphs were recorded in wells A-1 and B-1 of the Western Niger Delta. For well A-1 samples, 435 palynomorphs were obtained; out of which pollen consist of 55.6%, spores 22.8%, dinoflagellate cysts 15.6% and algae 6.0% (Figure 3). For well B-1 samples, a total of 487 palynomorphs were obtained; out of which pollen consists of 63%, spores 20%, algae 16% and dinoflagellate cysts 1.0% (Figure 4).

The palynological analysis results are shown in distribution charts (Figures 5 and 6) while plates I and II show photomicrographs of the palynomorphs found in the studied wells. The palynomorphs discovered from the researched wells included: *Verrucatosporites* sp., *Psilatricolporits crassus, Striatricolpites catatumbus, Monoporites annulatus, Lavigatosporites* sp., *Crassoretitrilete vanraadshooveni, Botryococcus branunii, pachydermites diederixi, Proxapertites cursus, Polypodiaceoisporites* sp., *Verrucatosporites usmensis, Grmsdalea polygonalis, Doualaidites laevigatus.*

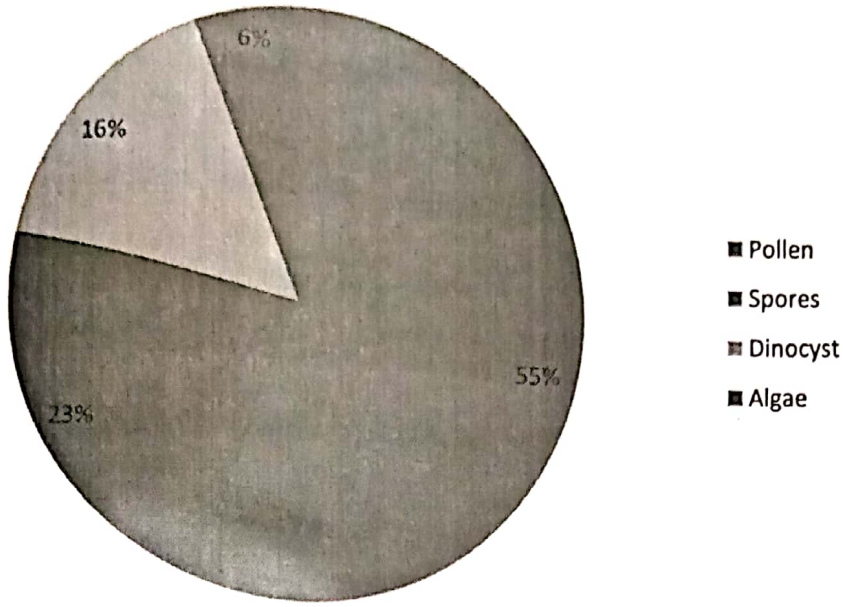


Figure 3: Well A-1 pie chart of the Palynomorph counts.

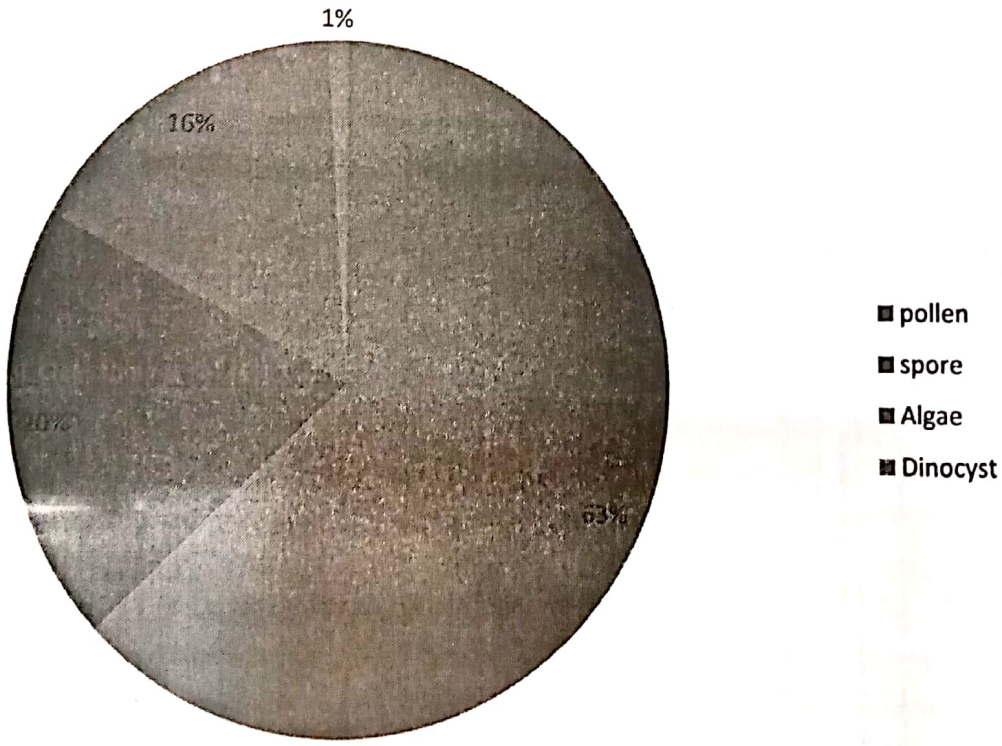


Figure 4 : Well B-1 pie chart of the Palynomorph counts.

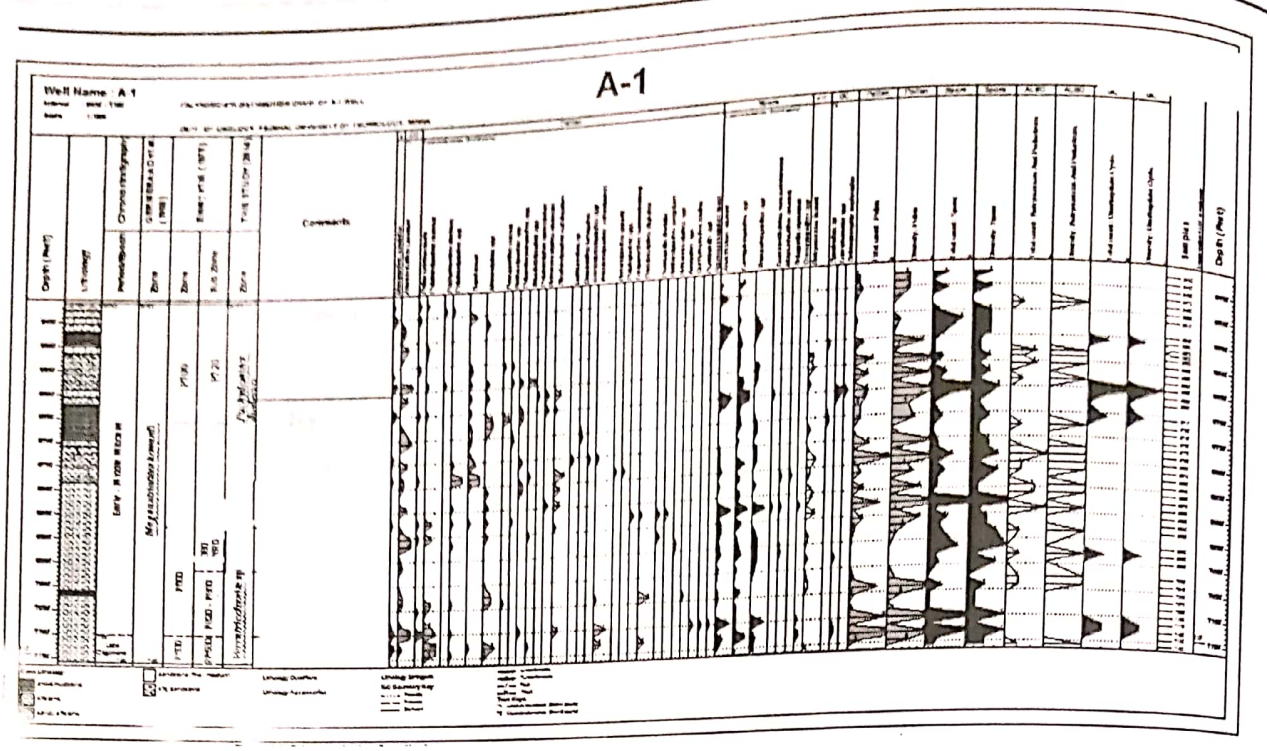


Figure 5: Palynomorph distribution chart of well A-1.

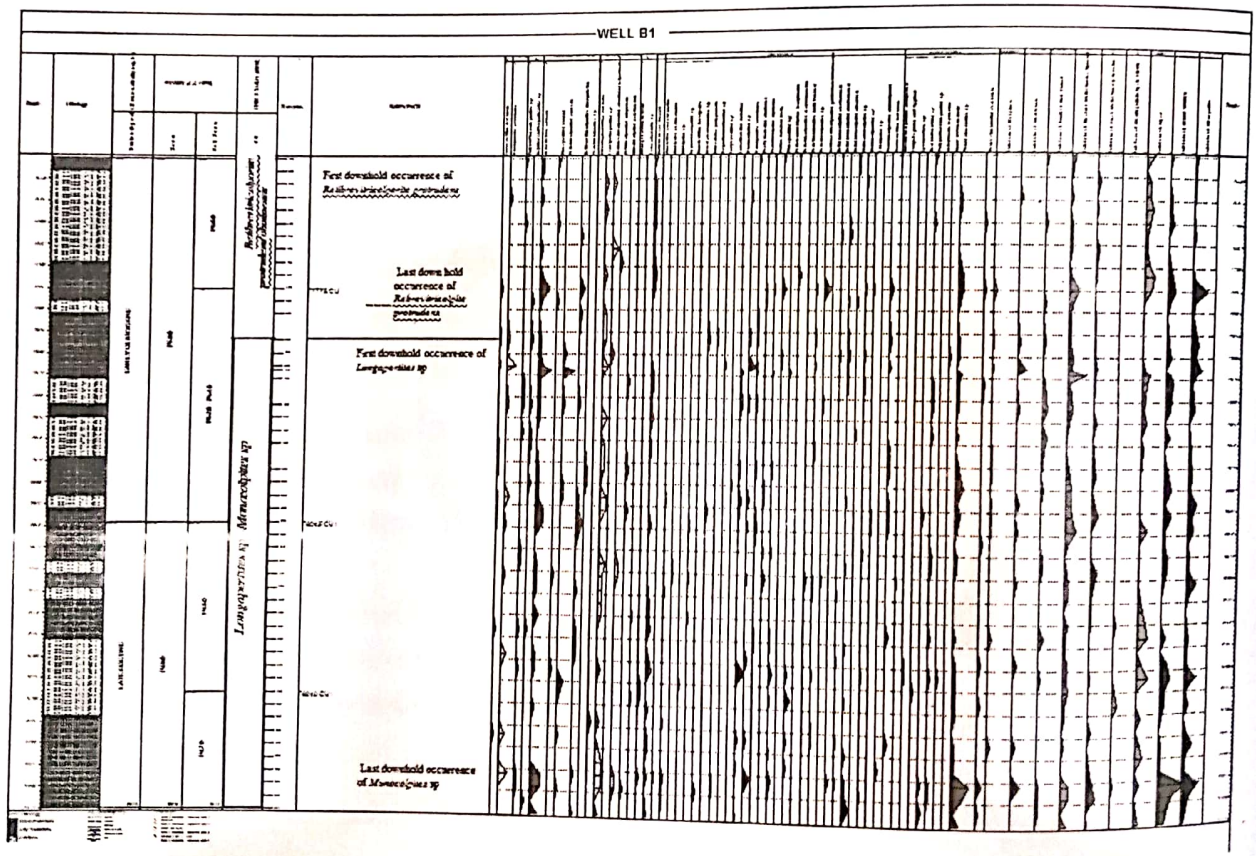


Figure 6: Palynomorph distribution chart of well B-1.

Biostratigraphy

The palynological results show the abundance and diversity of the recovered palynomorphs. Majority of the pollen and spores observed from this study such as *Verrutricolporites* sp, *Pachydermites diederixi, Monoporites annulatus, Zonocostites ramonae, Psilatricoporites crassus, Areciapites* sp. have been recorded in Nigeria sedimentary basins (Evamy *et al.*, 1978; Frankl and Cordry, 1967) The studied wells have been subdivided into two zones (Tables 4.1 and 4.2) and (Figures 5 and 6). These zones are based on (Evamy *et al.*, 1978; Germerad *et al.*, 1968).

Zone I for Well A-1 (*Pachydermites diederixi Zone*)
Type of Zone: Taxon Range Zone
Interval: 6425 - 6590feet
Age: Middle Miocene
Characteristics: The top and base of the zone is defined by first and last downhole occurrence of *Pachydermite diederixi.* The zone is also associated with *Zonocostites ramonae*, *Monoporites annulatus*, *Psilatricolporites crassus*, *Psilatricolporites* spp, *Monocolpites* spp, *Acrostichum aureum*, *Laevigatosporites* spp, *Verrucatosporites* spp. Algae such as *Botryococcus branunii* and dinocyst such as *Spiniferities* sp were also associated with the zone.

Zone II for Well A-1 (*Verrutricolporites* spp Zone)
Type of Zone: Taxon Range Zone
Interval: 6590 - 7160 feet
Age: Late Oligocene – Early Miocene
Characteristics: This zone is defined by the first and last downhole occurrence of *Verrutricolporites* spp. Diagnostic palynomorphs for the zone include *Verrutricolporites rotundiporus, Perfotricolpites digitatus, Striatricolporites catatumbus, Osmundacidites* spp, *Polypodiaceoisporites* spp, *Retimonocolpites obaenesis, Lanthiumdites* spp, *Doualaidites laevigatus, Gemmamonoporites* spp, *Verrutricolporites rotundiporus, Brevicolporites guinetii, Psilatriporites* spp, *Longapertites vaneenderiburgi, Retitricolporites irregularis, Retimonocolpites* spp, *Arecipites* spp, *Cinctiperiporites muller, Racemonocolpites hians, Crassoretitriletes vanraadshooveni, Magnastriatites howardi.* This zone is also associated with other palynoforms such as *Zonocostites ramonae, Monoporites annulatus, Psilatricolporites crassus, Psilatricolporites* spp, *Acrostichum aureum*, *Laevigatosporites* spp, *Verrucatosporites* spp. Algae such as *Botryococcus branuii*, dinoflagellete cysts such as *Spiniferites* sp, *Leiosphaeridia* sp, *Selenopemphix nephroides* cut across the analyzed depth.

Table 1: Palynomorphs Biozones identified in well A -

DEPTH (FEET)	PERIOD	EPOCH	GERMERAD et al. (1968) ZONE	EVAMY et al. (1978) ZONES	THIS STUDY (2014)	BIOCOMMENTS
TD 6425						
6659					*Pachydermites diederixi*	First downhole occurrence of *Pachydermites diederixi*
6800	TERTIARY	EARLY - MIDDLE MIOCENE	MAGNASTRIATITES HOWARDI	P600	P670 – P680 P620 – P650	Last downholeoccurrence of *Pachydermites diederixi*
6875						First downhole occurrence of
6900						First downhole occurrence of *Verrutricolporites* spp
7100					*Verrutricolporites* spp	
7130		? LATE OLIGOCENE		P500		Last downhole occurrence of *Verrutricolporite*
7160						

1. TD

Zone I for Well B-1 (*Retibrevitricolporites Protrudens/ obodoensis*)
Type of Zone: Taxon Range Zone
Interval: 7660 - 7850 feet
Age: Early Oligocene
Characteristics: The first and last downhole occurrences of *Retibrevitricolporite protrudens/ obodoensis* mark the top and Base of the zone. The only diagnostic palynoform of this zone is *Psilatricolporites margnoporatus*.Other palynoforms includes*Laevigatosporite* sp, *Acrostichum aureum, Retitricolporites* sp, *Ctenolophonidites costatus, Verrutricolporites Arecipites crassimuratus, Arecipites exilimuratus, Doualaidites laevigatus, Gemmamonoporites, Cicatricosisporite dorogensis, Zonocostites ramonae, Monoporites annulatus, Sapotaceoidae pollenites, Pachydrmite diederixi, Verrucatosporite usmensis.* Algae such as *Botryococcus braunii*, and dinoflagellete cysts such as dinocyst indeterminate, *Leiosphaeridia* sp occur within the zone.

Zone II for Well B-1 (*Longapertites* sp – *Monocolpites* sp)
Type of Zone: Concurrent Range Zone
Interval: 7850 – 8375 feet
Age: Late Eocene
Characteristics: This zone is defined by the first lone occurrence of *Longapertites* sp at the top as First Downhole Occurrence and Last Downhole Occurrence of *Monocolpites* sp at the base. The zone is associated with diagnostic palynoforms such as *Psilamonocolpites marginatus*, *Striatricolpites catatumbus*, other non-diagnostic palynoforms within the zone includes *Monoporites annulatus, Pachydermites diederixi, Acrostichum aureum, Psilatricolporites crassus, Laevigatosprites* sp, with rare occurrence of *Psilatricolporites magnoporatus, Arecipites crassimuratus, Cyperaceaepollis* sp, *Loranthacites nataliae;* other palynomorphs include *Verrucatosporites* sp, *Retimonocolpites obaensis, Zonocostites ramonae, Perfotricolpites;* algae such as *Botryococcus braunii* and dinoflagellate cysts such as Dinocyst indeterminate and *Leiosphaeridia* sp, fungal spore and hypae also occurred within the zone.

Table 2: Palynomorphs Biozones identified in well B -1

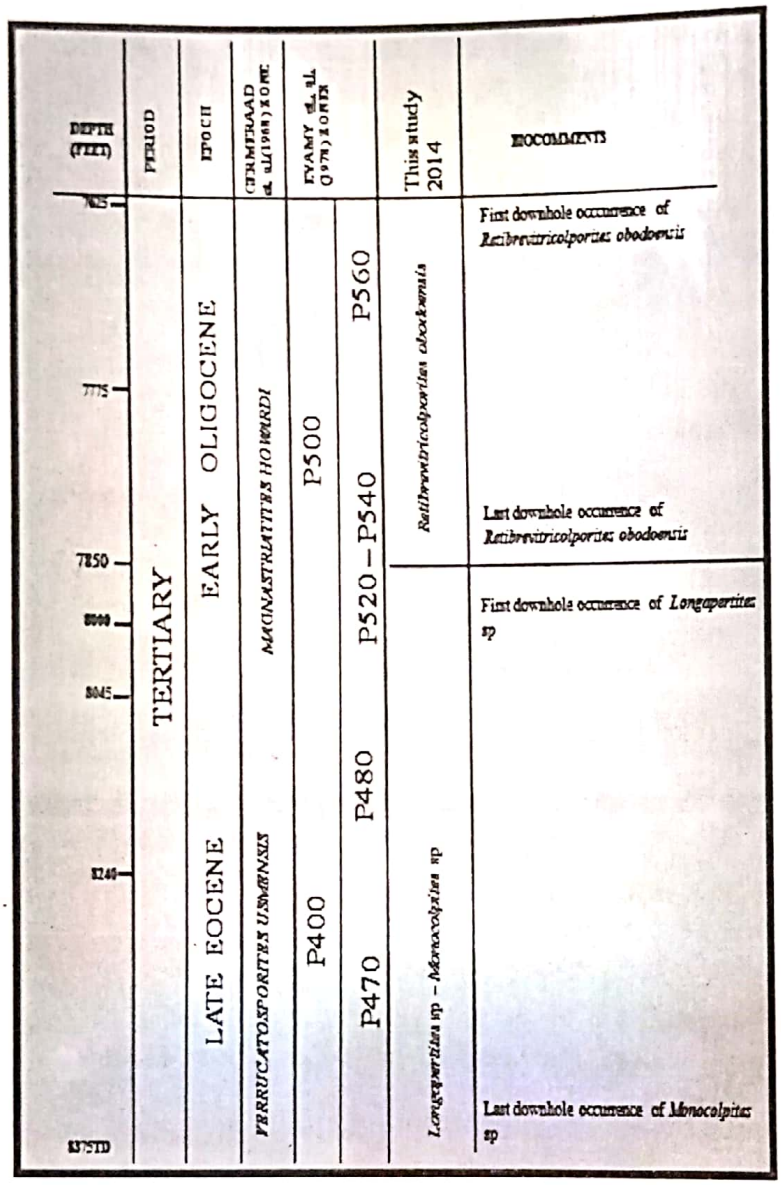
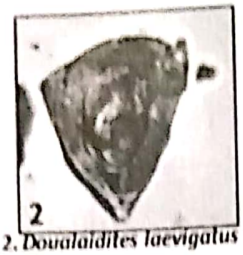


Plate I: Photomicrograph of palynomorphs in well A-1.

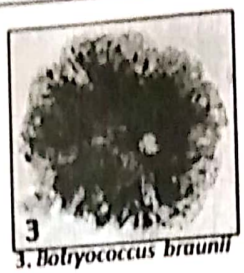
All magnifications are X1000

1. *Verrucatosporites* sp
2. *Psilatricolporites crassus*
3. *Striatricolpites catatumbus*
4. *Monoporites annulatus*
5. *Laevigatosporites sp*
6. *Crassoretitriletes vanraadshooveni*
7. *Verrutricolporites rotundiporus*
8. *Sapotaceoidae pollenites*
9. *Retitricolporites irregularis*

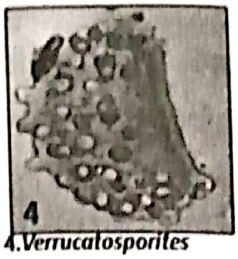
1. Grimsdalea polygonalis



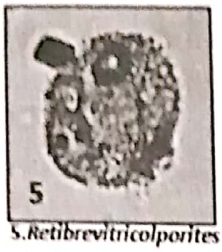
2. Doualaldites laevigatus



3. Botryococcus braunii



4.Verrucatosporites usmensis

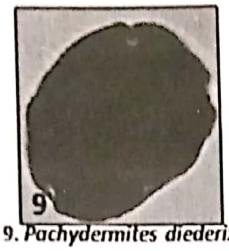


5.Retibrevitricolporites obodoensis


6. Polypodiaceoisporites sp.

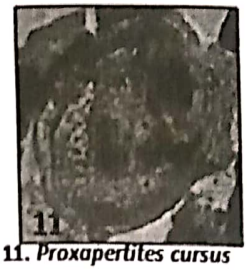
7.Psilamonocolpites marginatus


8. Retibrevitricolporites triangulatus



9. Pachydermites diederixi

10. Retibrevitricolporites ibadanensis



11. Proxapertites cursus

Plate II: photomicrographs of palynomorphs in well B-1.

All Magnifications are X1000

1. *Grimsdalea polygonalis*
2. *Doualaldites laevigatus*
3. *Botryococcus braunii*
4. *Verrucatosporites usmensis*
5. *Retibrevitricolporites obodoensis*
6. *Polypodiaceoisporites sp*
7. *Psilamonocolpites marginatus*
8. *Retibrevitricolporites triangulates*
9. *Pachydermites diederixi*
10. *Retibrevitricolporites ibadaensis*
11. *Proxapertites cursus*

Conclusions

The results of the analyses have shown that the sediments of the two wells (A-1 and B-1) show diverse and well preserved palynomorphs that were in most cases identified. The studied wells are moderately rich in palynomorphs that allows some useful deductions like age and zone. It was obtained from the study that microfloral content and diversity in the two wells are essentially similar and hence was interpreted as concurrent range zone or taxon range zones. In well A-1, the sections penetrated are two. Both are the taxon range zones (*Pachydermites diederixi* Zone, and the *Verrutricolporites* spp Zone), and dated Late Oligocene – Middle Miocene; whilein well B-1, the section is zoned into two zones, the upper taxon range zone (*Retibrevitricolporites protrudens/ ibadensis)* and the lower concurrent range zone (*Longapertites* sp –*Monocolpites* sp) and dated Late Eocene – Early Oligocene.

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