

PALYNOLOGICAL AND CALCAREOUS NANNOFOSSIL BIOSTRATIGRAPHY OF OM-4 AND OM-A WELLS, WESTERN NIGER DELTA, NIGERIA

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Abstract

Palynological and calcareous nannofossil analyses were carried out on 50 ditch cutting samples each from two wells OM-4 and OM-A, western Niger Delta, Nigeria with the aim of establishing their biozones. Studied intervals in both wells ranged from 8200 – 11350 ft. Acid method was used for palynomorph processing while smear slide method was used for calcareous nannofossil. The palynomorphs yielded 51 and 44 species in OM-4 and OM-A wells respectively while the calcareous nannofossils had a poor yield of 1 species in OM-4 well and 17 species in OM-A well. Based on the contained diagnostic marker palynomorphs and calcareous nannofossils present in the wells, three palynomorph zones, *Retibrevitricolporites protudens/obodoensis* – *Verrutricolporites* sp Zone (T1), *Monocolpites* sp – *Magnastriatites howardi* Zone (T2) and *Crassoretitriteles vanraadshooveri* Zone (T3) were identified in OM-4 well, while an indeterminate Zone (T4), *Peregrinipollis nigericus* – *Cyperaceapollis* sp Zone (T5) and *Psilatirporites* sp – *Retitricolporites* sp Zone (T6) were identified for the OM-A well. The informal T1, T2 and T3 zones established in OM-4 well corresponded to the P650, P670-P680 and P720 subzones. Also, the three zones, T4, T5 and T6 established in OM-A well, corresponds to the P830, P840 and P850 subzones and the *Echitricolporites spinosus* pan tropical palynological zone. No calcareous nannofossil zone was established in OM-4 well due to very poor recovery, while *Discoaster quinquerramus* – *Discoaster berrigrenni* Zone (NN11) was identified in OM-A well. The wells were assigned Miocene Epoch based on the presence of Miocene markers.

Keywords: Biozones, Diagnostic marker, Palynomorphs, Miocene.

Introduction

The use of palynomorphs and calcareous nannofossils in present day studies based on their characteristics which include their rapid diversification, considerable resistance to obliterations by acids, ease to process and their abundance have made them relevant in biozonation and correlation, paleoenvironmental and paleoclimatic studies and biochronology of strata. This has encouraged the use of these fossils to carry out a detailed biostratigraphic study of OM-4 and OM-A wells. This study is aimed at carrying out a palynological and calcareous nannofossil biostratigraphy of OM-4 and OM-A wells by identifying the palynomorphs and calcareous nannofossils present in the strata penetrated by the two wells and establishing biozones based on palynomorphs and calcareous nannofossil assemblages for the strata penetrated.

Location and Geology of the Study Area

The Niger Delta lies between latitude 4° and 7°N and longitudes 3° and 9°E in the southern part of Nigeria. The studied OM-4 and OM-A wells are located on the onshore part of the Niger Delta, on latitude 4°38' N and longitude 6°48' E and 4°37' E and 6°47' E respectively (Figure 1). The Niger delta basin contains sediments of Paleogene to Holocene which are deposited in high order which include Benin Formation, Agbada Formation and Akata. Both wells fall within the Agbada formation within the coastal swamp depobelt.

Result and Discussion

Recovery of palynomorphs was good from both wells in terms of abundance, diversity and preservation at all depth (Figures 2 and 3) but was extremely poor for calcareous nannofossils, showing a lone species occurrence in OM-4 well and low abundance and diversity at two depths in OM-A well (Figures 4 and 5).

Palynomorph Distribution

The distribution of palynomorphs, (pollen, spores, dinoflagellates and algae) in the studied section varied from one depth to another in diversity and abundance. Pollen and spore preservation was fair in both wells with total species count of fifty-one and forty-four in OM-4 and OM-A wells respectively. The lists of the forms of palynomorphs as recovered from the ditch cuttings from both wells as plotted on the charts are as follows:

- (i) *Pollen and Spores*: *Zonocostites ramonae*, *Laevigatosporites* sp., *Monoporites annulatus*, *Cypereapollis* sp, *Peregrinipollis nigericus*, *Gemmamonoporites* sp, *Pachydermites diederixi*, *Psilatricolporites crassus*, *Racemonocolpites hians*, *Retibrevitricolporites protudens/obodoensis*, *Retitricolporites irregularis*, *Sapotaceoidaepollenites* sp, *Striatricolpites catatumbus*, *Tricolporite* sp, *Verrustephanocolpites complanatus*, *Verrutricolporites rotundiporus*, *Podocarpus* sp, *Acrostichum aureum*, *Crassoretitriletes vanraadshooveni*, *Magnastriatites howardi*, *Polypodiceoisporites* sp, *Selaginella myosurus*, *Verrucatosporites* sp, *Lycopodiumneogenicus*, *Magnastriatites* sp, *Alnus vera*, *Canthiumidites* sp, *Chenopodiaceae* sp, *Alnipollenites verus*, *Stereisporites* sp, Charred gramineae cuticle, Fungal spores and hyphae, *Inaperturopollenites* sp, *Monocolpites* sp, *Praedapollis flexibillis*, *Praedapollis* sp, *Proteacidites cooksonni*, *Bombacacidites* sp, *Ctenolophonidites costatus*, *Psilastephanocolporites minor*, *Retitricolporites bendeensis*, *Belskipollis* sp, *Corsnipollenites jussiaeensis*, *Echistephanoporites echinatus* and *Spirosyncolpites brunii*
- (ii) *Dinoflagellates*: *Leiosphaeridia* sp, *Dinocyst* indeterminate
- (iii) *Algae*: *Botryococcus braunii*

Calcareous Nannofossil Distribution

The ditch cuttings analysed for calcareous nannofossils from both wells yielded poor recovery in both abundance and diversity. OM-4 well contained a lone species, *Coronocyclus nitescens* at depth 6430 ft while a total of 17 species, *Discoaster quinquerramus*, *Discoaster bergrenii*, *Calcidiscus leptoporus*, *Calcidiscus tropics*, *Discoaster brouweri*, *Discoaster exillis*, *Discoaster loeblichii*, *Discoaster pentaradiatus*, *Discoaster* sp, *Discoaster variabilis*, *Helicosphaera carteri*, *Pontosphaera multipora*, *Reticulofenestra pseudoumbilicus*(5-7" and 7"), *Sphenolithus abies* and *Sphenolithus moriformis* were recovered in OM-A well. Highest diversity of the species occurred at 8440 ft, lone occurrence at 9760 ft.

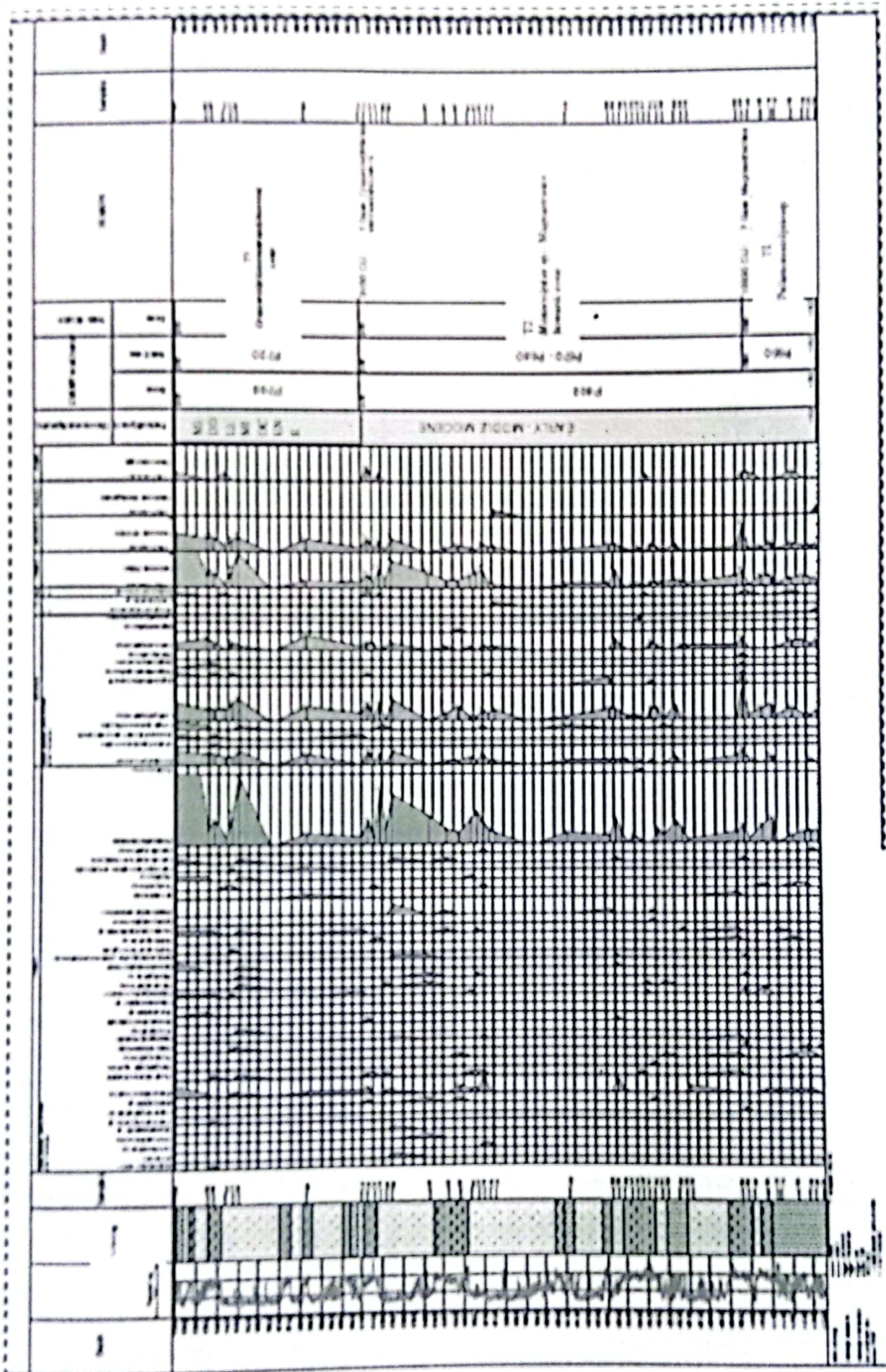


Figure 2: Palynomorph distribution of OM-4 well

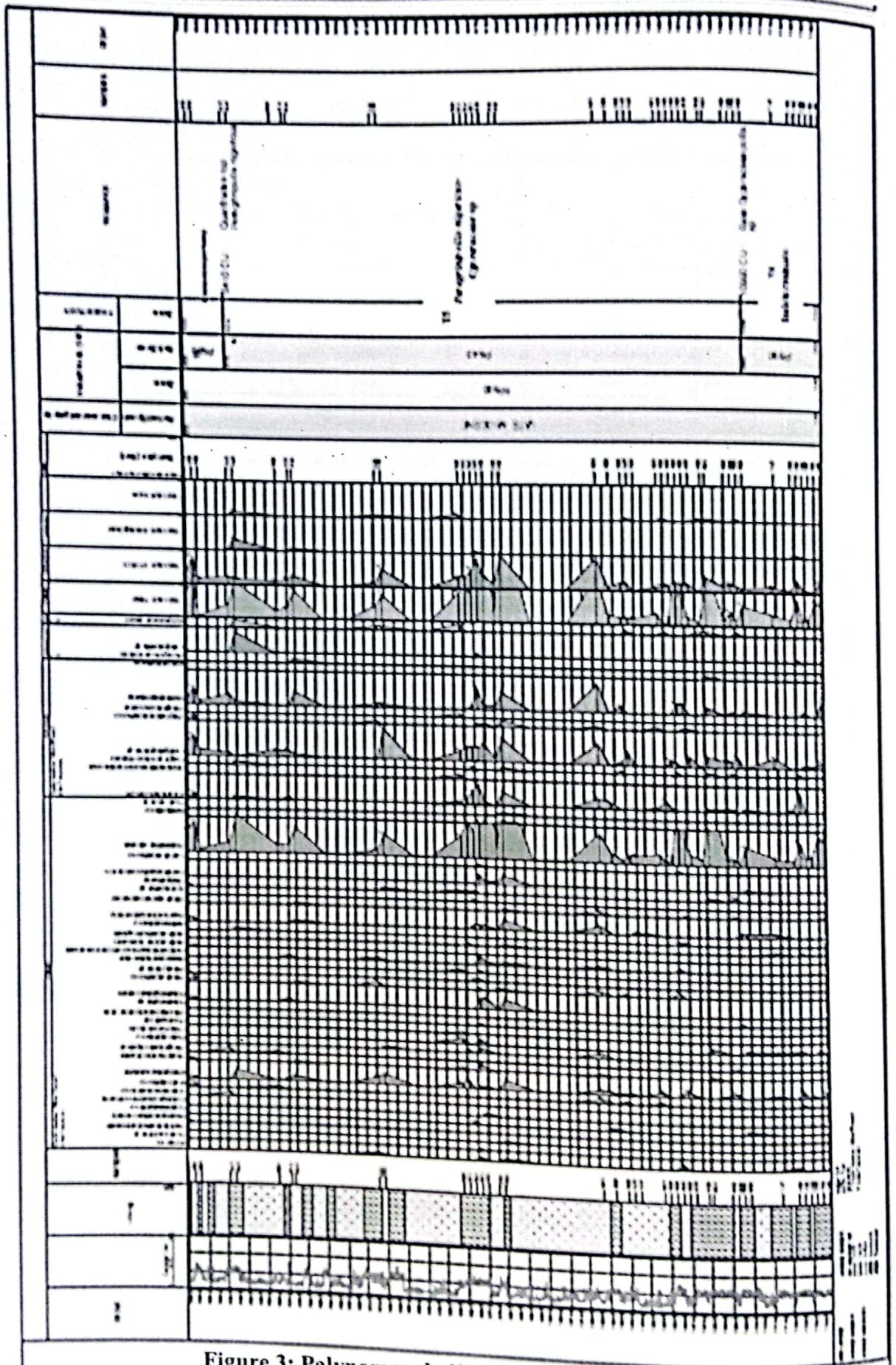


Figure 3: Palynomorph distribution of OM-A well

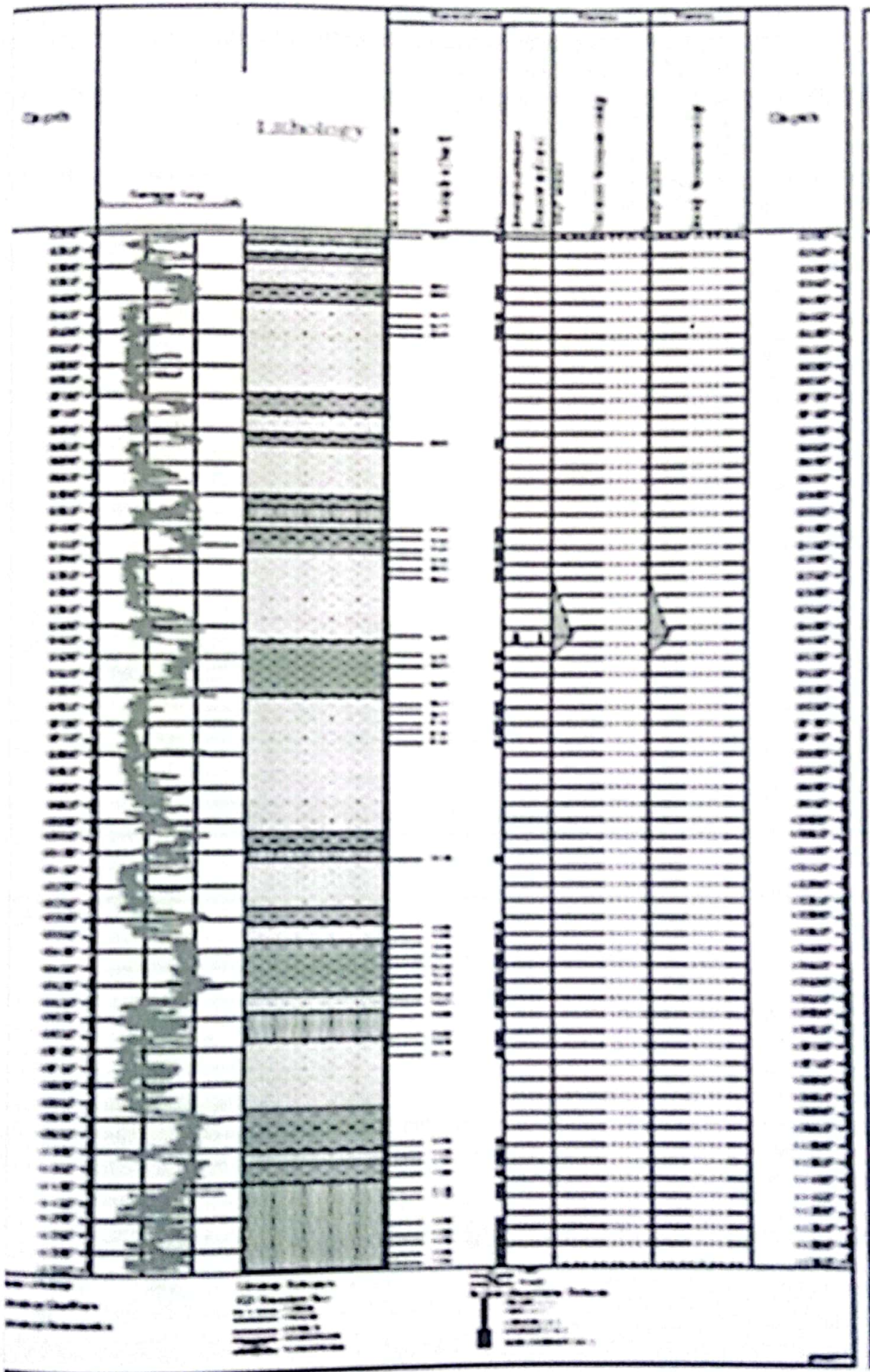


Figure 4: Calcareous nannofossils distribution of OM-4 well

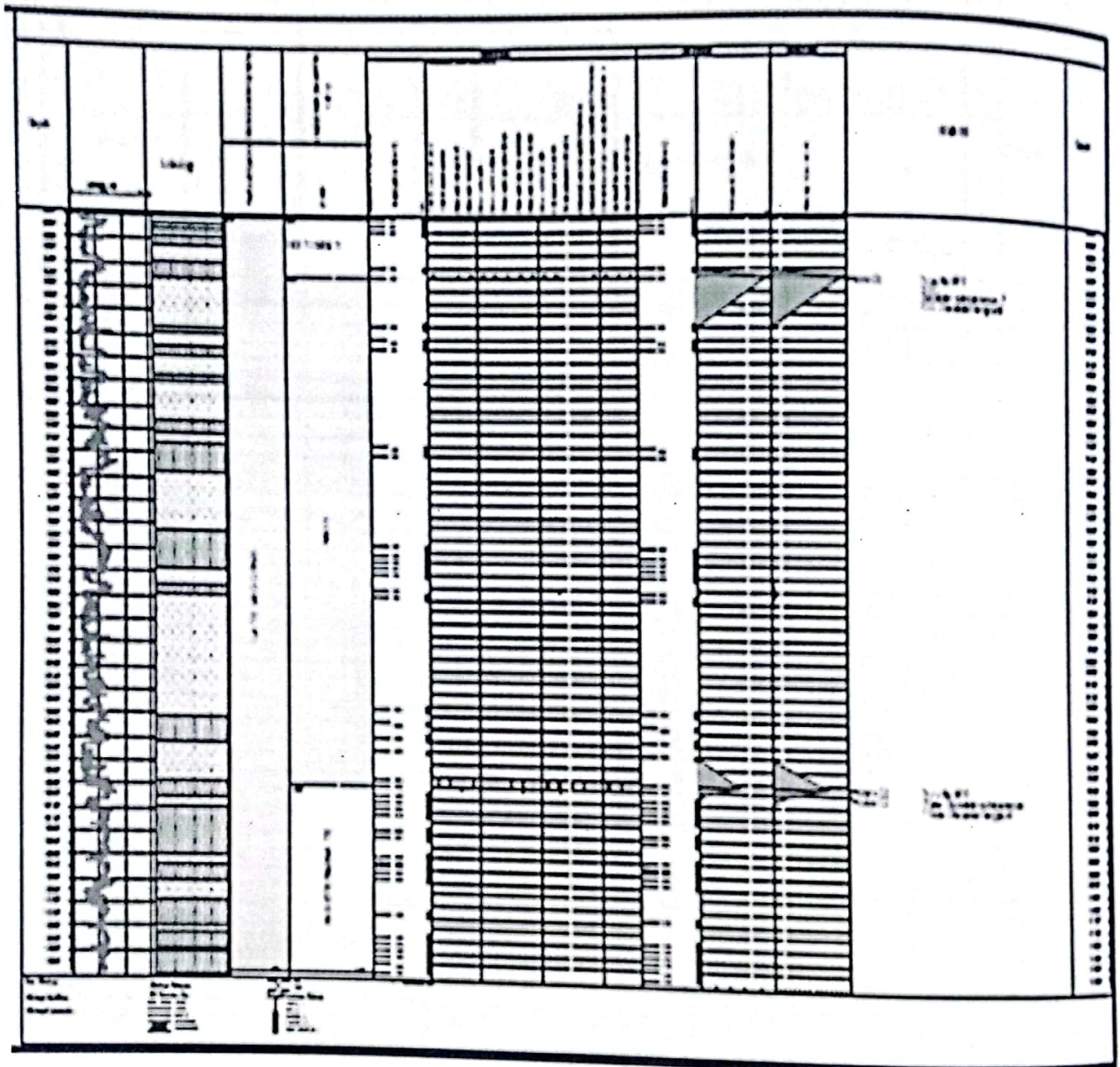


Figure 5: Calcareous nannofossils distribution of OM-A well

Palynomorph Biozonation

Palynomorph biozonations for both wells were defined by the first downhole occurrence (FDO) and last downhole occurrences (LDO) of one or more stratigraphically important species in biozones introduced as T3, T2 and T1 biozones were proposed in OM-4 and T6, T5 and T4 were proposed in OM-A well. The three biozone types established are the taxon range zone, concurrent range zone and interval zone.

ZONE T1: Retibrevitricolporites protudens/obodoensis – Verrutricolporites sp Zone

Zone type: Interval zone

Depth: 11350 - 10990 ft

Age: Early Miocene

This is an interval zone which has its base marked by the LDO of Verrutricolporites sp at 11350

ft and the top by the LDO of *Retibrevitricolporites protudens/obodoensis* at 10990 ft, both species having their only occurrences at these depths. The associated species within this zone are: *Monoporites annulatus*, *Zonocostites ramonae*, *Podocarpidites* sp, *Retitricolporites* sp, *Sapotaceoidaepollenites* sp, *Tricolporite* sp, *Psilamonocolpites* sp, *Stereisporites* sp, *Acrostichum aureum*, *Laevigatosporites* sp, *Verrucatosporites* sp, *Botryococcus braunii*, *Psilatirporites* sp. This zone corresponds with the P650 of (Evamy et al., 1978) which has the top of the zone marked with the LDO of *Magnastriatites howardi*.

ZONE T2: Monocolpites sp – Magnastriatites howardi Zone

Zone type: Concurrent range zone

Depth: 10990 - 9100 ft

Age: Early Miocene

This zone is marked at the base by the LDO of *Magnastriatites howardi* at 10900 ft and at the top by the FDO of *Monocolpites* sp at 9100 ft. Other associated species within the zone are *Pachydermites diderixi*, *Spirosyncolpites* sp, *Striatricolpites catatumbus*, *Podocarpus* sp, Fungal spores and hyphae, *Magnastriatites* sp. *Retibrevitricolporites protudens/obodoensis*, *Psilatricolporites crassus*, *Verrutricolporites rotundiporis*, *Praedapollis flexibillis*, *Proteacidites cooksonni*, *Polypodiaceoisporites* sp, *Selaginella myosurus*, *Stereisporites* sp and *Leiosphaeridia* sp (dinoflagellate). This zone corresponds with (Evamy et al., 1978) P670 - P680 zone which is marked at the top by LDO of *Crassoretiriletes vanraadshooveni* at the base by LDO of *Magnastriatites howardi*.

ZONE T3: Crassoretiriletes vanraadshooveni Zone

Zone type: Taxon range zone

Depth: 9100-8200 ft

Age: Middle Miocene

The zone is a taxon-range zone marked at the base and the top by the LDO and FDO of *Crassoretiriletes vanraadshooveni* at 9100 ft and 8200 ft. Other associated species within the zone include *Alnipollenites verus*, *Gemmamonoporites* sp, *Praedapollis* sp, *Proxapertites* sp, *Psilatricolporites* sp, *Psilatirporites* sp, *Racemonocolpites hians*, *Retitricolporites irregularis* and *Verrustephanocolpites complanatus*. This zone corresponds with the P720 of (Evamy et al., 1978), as it is bounded at the base by LDO of *Crassoretiriletes vanraadshooveni*.

ZONE T4: Indeterminate Zone

Depth: 11350 – 10990 ft

The zone was marked as "indeterminate" because there were no marker species occurring within the zone. This zone corresponds with that of (Evamy et al., 1978) P830 subzone as it is bounded at the top by the LDO of *Cyperaceaepollis* sp, which marks the base of P840 and the top of P830.

ZONE T5: Peregrinipollis nigericus- Cyperaceaepollis sp Zone

Zone type: Concurrent range zone

Depth: 10990 – 8410 ft

Age: Late Miocene

The base is marked by the LDO of *Cyperaceaepollis* sp at 10990 ft and the top of the zone by the quantitative FDO of *Peregrinipollis nigericus* at 8410 ft. Also marking the top of the zone is the LDO of *Gemmamonoporites* sp, while those marking the base of the zone are the LDO of *Verrutricolpites microporus*. Other species associated with the zone are *Monocolpites* sp, *Monoporites annulatus*, *Psilatricolpites* sp, *Pachydermites diderixi*, *Retitricolpites* sp, *Podocarpidites* sp, *Pollen indeterminate*, *Praedapollis* sp, *Psilastephanocolpites minor*, *Laevigatosporites* sp, *Polypodiaceoisporites* sp, *Selaginella myosurus*, *Verrucatosporites* sp,

Leiosphaeridia sp and Botryococcus braunii (algae).

This zone corresponds with the P840 subzone of (Evamy et al., 1978), which has the top marked by Peregrinipollis nigericus and at the base by Cyperaceaepollis sp.

ZONE T6: Psilatropites sp - Retitricolporites sp Zone

Zone type: Interval zone

Depth: 8410 – 8200 ft

Age: Late Miocene

The zone is an interval zone marked at the top by the FDO of Psilatropites sp at 8200 ft and at the base by the FDO of Retitricolporites sp, at 8410 ft. Other long ranging species running through the zone include: Monocolpites annulatus, Psilatricolpites sp, Retitricolporites bendeensis, Sapotaceoidaepollenites sp, Tricolpites sp, Zonocostites ramonae, Acrostichum aureum, Laevigatosporites sp, Polypodiaceoisporites sp, Verrucatosporites sp. The zone corresponds to pollen zone P850 of (Evamy et al., 1978) which has its base marked by the FDO of Peregrinipollis nigericus.

Table 1: Summary of Palynomorph Biozonation in both wells

Depth	Age	Palynomorph Zone and Informal name (Present Study)	Evamy et al., 1978 zones	Well	Biozone Type
9100-8200 ft		Psilatropites sp- T6	P850		Interval
10990-9100 ft	Late Miocene	Peregrinipollis nigericus - T5	P840		Concurrent Range
11350-10990 ft		Cyperaceaepollis sp Indeterminate T4	P830	OM-A	Indeterminate Taxon
9100-8200 ft	Middle Miocene	Crassoretitriletes vanraadshooveni T3	P720		
10990-9100 ft		Monocolpites sp - T2	P670-P680		Concurrent
11350-10990 ft	Early Miocene	Magnastrates howardi Retibrevitricolporites protudens/obodoensis - Verrutricolporites sp T1	P650	OM-4	Interval

Calcareous Nannofossils Biozonation

Diagnostic marker species within the wells formed the basis for biozonations for both wells. It is important to note that the poor yield of nannofossils made the division impossible in OM-4 well and broad in OM-A well.

The entire OM-4 well was completely barren of calcareous nannofossil except at 9430 feet where a lone occurrence of Coronocylus nitescens (which is long ranging species), was recorded. This made biozonation of calcareous nannofossil impossible in this well.

Recovery of calcareous nannofossils from OM-A well gave the total species count of seventeen (17) as seen in figure 4. Based on the assemblages of diagnostic species and notable nannofossil events, the FDO and LDO of 2 diagnostic species, Discoaster quinqueramus and Discoaster berggrenii at 8440 ft and 10600 ft was used to mark the top and the base of the zone. This zone corresponds with NN11 zone of (Martini, 1971), CN 9a and 9b of (Okada & Bukry, 1980) and NN11a and b subzones of (Ajayi & Okosun, 2012).

Conclusion

Six palynomorph zones (T1-T3 in OM-4 well and T4-T6 in OM-A well) were proposed in both wells and they correspond to the already established pollen zones of Evamy et al., 1978. These are Retibrevitricolporites protudens/obodoensis- Verrutricolporites sp Zone (T1),

Monocolpites sp – Magnastriatites howardi Zone (T2) and Crassoretitriletes vanraadshooveni Zone (T3) in OM-4 well, while an indeterminate Zone (T4), Peregrinipollis nigericus – Cyperaceaepollis sp Zone (T5) and Psilatiriporites sp – Retitricolporites sp Zone (T6) were identified for the OM-A well. The informal T1, T2 and T3 zones established in OM-4 well corresponded to the P650, P670-P680 and P720 subzones of Evamy et al., 1978. Also, the three zones, T4, T5 and T6 established in OM-A well, correspond to the P830, P840 and P850 subzones of (Evamy et al., 1978). Zones established by previous workers (Olajide et al., 2012; Adeigbe, 2013; Jennifer et al., 2014) which corresponds to the pollen zones within which these informal zones fall, have been used mainly in age determination and paleoenvironmental interpretations. No calcareous nannofossil zone was established in OM-4 well due to very poor recovery while Discoaster quinquerramus – Discoaster berrgrenni Zone (NN11) was identified in OM-A well which depth ranges did not have a clear correlation with any of the palynomorph zones.

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