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Research Article

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The Occurrences of Belskipollis Elegans and Magnastriatites Howardi: A Review of their Usage for Zonation in the Middle Miocene of the Niger Delta

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Abstract A high resolution palynological study was carried out on six (6) wells from onshore and offshore Niger Delta. The samples were subjected to standard palynological processing procedures and the analyses yielded diverse, moderately rich to abundant and fairly preserved palynomorphs. It was observed that the Top Regular Occurrence (TRegO) of *Belskipollis elegans* can be used to delineate the P770/P740 boundary, where the Top Rich Occurrence (TRiO) of the same marker species, an already published event, cannot be defined. Similarly, the Downhole Increase Occurrence (DhIO) of *Magnastriatites howardi* was found to be effective in delineating the P740/P720 boundary, where the Base Rich Occurrence (BRiO) of *Belskipollis elegans,* an already published event, cannot be established. These bioevents are useful where there are inconsistencies in the occurrences of *Belskipollis elegans* within the Middle Miocene. These inconsistencies in some parts of the delta may be attributed to transportation from its natural habitat which is the montane forest in the hinterland to long distances away offshore. On the other hand, *Magnastriatites howardi* has its natural habitat in freshwater swamp and therefore is easily transported and deposited in reasonable quantities in deeper marine sediments. These recognised bioevents are useful in providing high resolution definition and correlation of the reservoirs within this age interval to enhance the exploratory/ exploitation activities in the Middle Miocene of the Niger Delta, where most of the oil producing reservoirs have been identified. Palynology is a valuable tool in oil and gas exploration when it is integrated with other geoscience data sets.

Keywords Palynomorphs, microflora, bioevents, biozonation, Miocene

Introduction

The Niger Delta is a Tertiary miogeosyncinal wedge, which is one of the World's largest Tertiary delta systems and an extremely prolific hydrocarbon province in the Gulf of Guinea. It is situated on the West African continental margin at the apex of the Gulf of Guinea, which formed at the site of a triple junction during continental break-up in the Late Jurassic to Cretaceous times [1]. The delta developed by accumulating sediments from the Niger, Benue and Cross rivers, which drained more than 10^6 km^2 of continental lowland savannah. Its present morphology is that of a wave-dominated delta, with a smoothly seaward-convex coastline traversed by distributary channels. From apex to coast, the sub-aerial portion stretches more than 300 km, covering an area of 75 000 km^2. Below the Gulf of Guinea, two enormous lobes protrude a further 250 km into deeper waters.

The evolution of the modern Niger Delta commenced in the Early Tertiary times when clastic river input increased [2]. At the beginning of the Cenozoic, seas transgressed over much of the southern Nigeria depositing the Imo shale and terminating at the development of the Cretaceous proto-delta. Subsequently, the Cenozoic

Niger Delta complex was developed as regressive offlap sequences. The entire sedimentary wedge in the Niger Delta were laid down sequentially in five depobelts, each about 30-60 km wide and lengths of up to 300km, with the oldest lying further inland and the youngest located offshore (Figure 1).

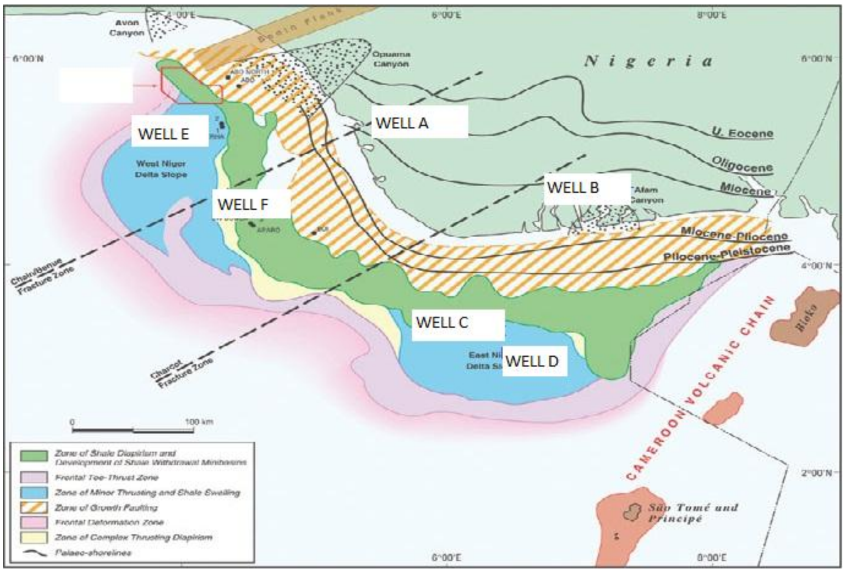

Figure 1: Location Map showing the studied wells

The six (6) wells used in this study are located in the onshore (Wells A and B) and offshore (Wells C, D, E and F) of Niger Delta as shown in the location map (Figure 1).

The palynostratigraphy and biozonation of Middle Miocene sediments of the Niger Delta have been carried out by various researchers [3-7]. Palynological studies in the Niger delta show the limitation in the use of *Belskipollis elegans* in delineating the P770/P740 and the P740/P720 boundaries due to its inconsistent occurrences, especially in deep marine settings.

This study is aimed at showing the relevance and the usage of another bioevent; the Top Regular Occurrence (TRegO) of *Belskipollis elegans,* in place of the Top Rich Occurrence (TRiO) of the same marker species in the delineation of the P770/P740 boundary. Similarly, the down hole increase in occurrence of *Magnatriatites howardi* can be used to delineate the P740/720 boundary in place of the Base Rich Occurrence (BRiO) of *Belskipollis elegans* where the occurrences of *Belskipollis elegans* are inconsistent. The usage of these bioevents against the established ones of the same marker species is the crux of this publication.

Materials and Method

A total of forty seven (47) composited ditch cutting samples, interval (4400 – 8393ft) for Well A; eighty eight (88) composited ditch cutting samples, interval (5650 – 12,050ft) for Well B; one hundred and twenty seven (127) composited ditch cutting samples from interval (11770 – 19240ft) for Well C; one hundred and six (106) composited ditch cutting samples from interval (15,120 – 15,280ft) for Well D; one hundred and nineteen (119) composited ditch cutting samples from interval (2382m – 4732m) for Well E and eighty four (84) composited ditch cutting samples intervals (5230 – 10210ft) for Well F, were subjected to standard palynological processing procedures (conventional acid maceration, alkali treatment and staining methods) as adopted in recent works [3].

About 40 grams of samples were treated with 10% HCl acid for carbonate digestion. Removal of silicates was achieved by treating with concentrated Hydrofluoric acid Oxidation of the samples was done by treating with Nitric acid. The breakdown of humic acid was done by treating with 10% solution of Potassium hydroxide (KOH). Heavy liquid separation to concentrate palynomorphs was achieved by floatation technique using zinc bromide solution. The residues were sieved, stained, transferred into 15ml vials, mounted on slides and cleaned for analysis [8-10].

Accu-scope transmitting light microscope was used for identification and counting of the palynomorphs as well as the photomicrographs of selected marker species. The counting and logging were done by straight transects across each slide and coordinates for important markers taken and recorded quantitatively as actual counts where necessary.

The wells yielded fairly rich and relatively well preserved assemblages of pollen, spores, dinoflagellate cysts and freshwater algae. The identified microfloral taxa were presented in a distribution chart using Stratabug software. Palynomorph abundance and diversity key bioevents made biozonation possible.

Results

The results show that the studied wells yielded rich and diverse assemblages of pollen and spores. The microfloral assemblages were predominantly land derived with marine indicator palynomorphs being scanty/ poor throughout the entire well sections. These results are presented in the palynological distribution charts labelled figures 2 to 7. The onshore wells penetrated only the P700 palynological superzone [3] from Middle to Late Miocene ages, whereas three palynological superzones P800, P700 and P600 [3] were established for all the offshore wells studied from Early, Middle to Late, Miocene ages. However, only sections of interest with respect to this study are presented in the distribution charts. The areas highlighted in the charts as yellow and green represent the zones delineated by the Top Regular Occurrence (TRegO) of *Belskipollis elegans* and the Downhole Increased Occurrence (DhIO) of *Magnastriatites howardi*, respectively.

Well 'A' (Onshore)

In Well A, the analysed section penetrated the palynological superzone, P700 [3] of Middle Miocene age. This palynological superzone was further subdivided into P770, P740 and P720 zones based on their palynofloral characteristics (Figure 2). The delineation of the P770/P740 boundary in this study well was achieved using the already published bioevent {Top Rich Occurrence of *Belskipollis elegans*}[3], while the P740/ P720 subzone was also delineated using the already published bioevent {Base Rich Occurrence of *Belskipolis elegans*}.

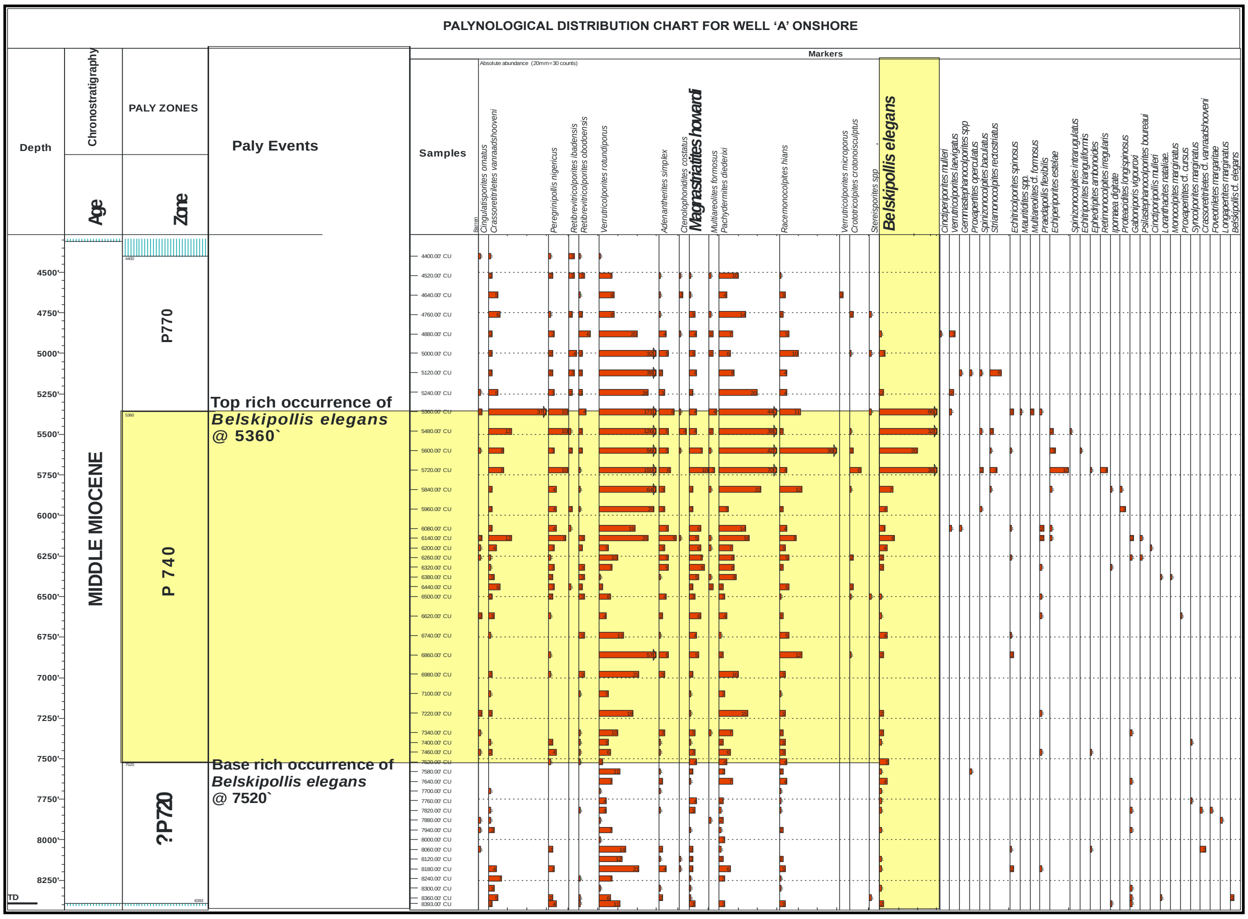

Figure 2: Palynological Distribution Chart for Well 'A'

Well 'B' (Onshore)

Well B was also found to have penetrated the palynological superzone, P700 of Middle – Late Miocene ages, and was further subdivided into? P780, P770 and P740 zones based on their palynonofloral characteristics (Figure 3).

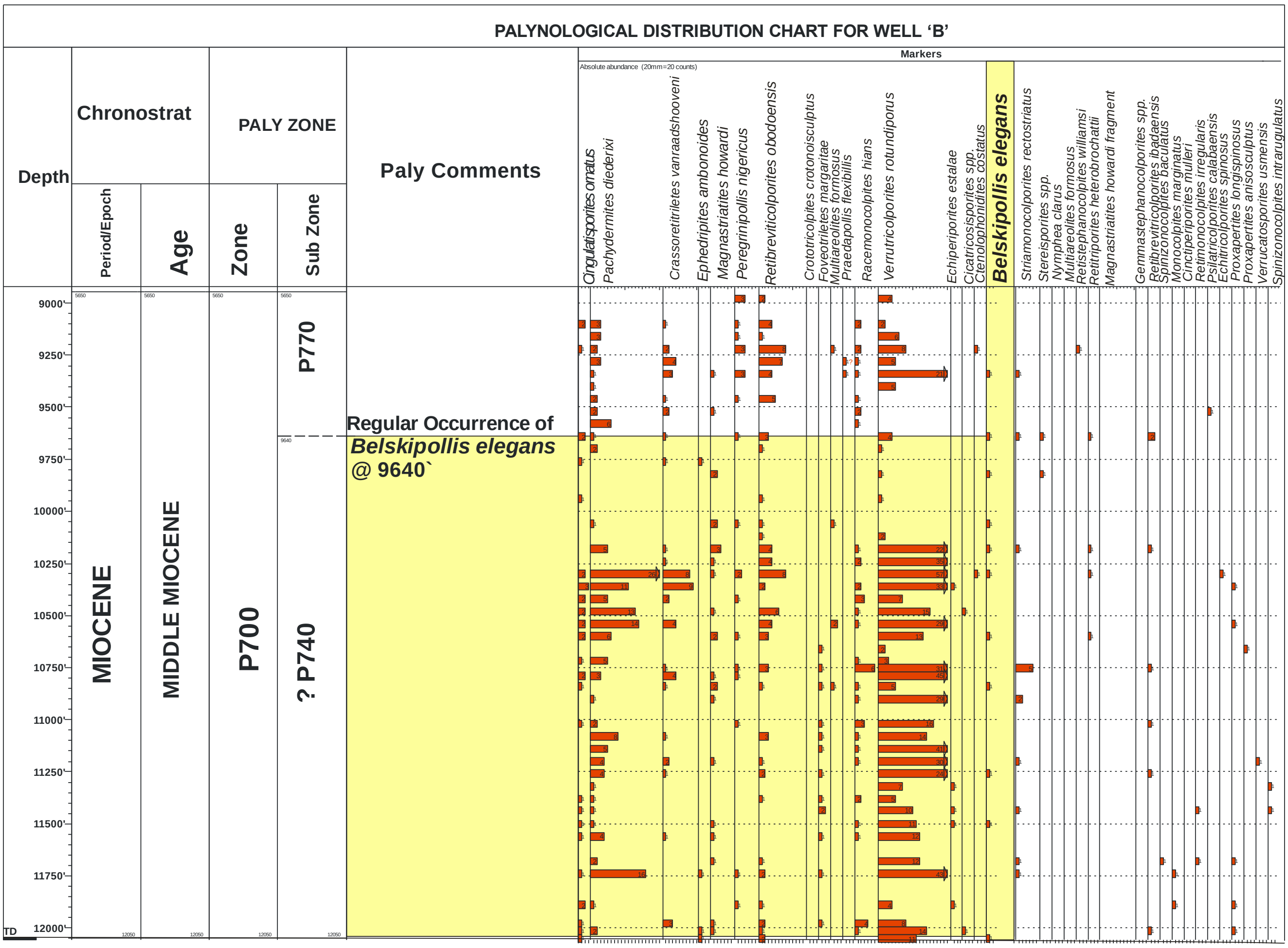

Figure 3: Palynological Distribution Chart for Well 'B'

These wells yielded moderately rich and diverse assemblages of pollen and spores. The microfloral assemblages are predominantly land derived, while the marine indicator palynomorphs had scanty to low recovery throughout the well sections. The delineation of the P770/P740 boundary in this study well could not be achieved using the already published bioevent {Top Rich Occurrence of *Belskipollis elegans*}[3] due to the irregular occurrence of the marker species. The Top Regular Occurrence of the same marker species was utilized instead in delineating this boundary (Figure 3).

Well 'C' (Offshore)

In Well C, the superzones were subdivided into P830-P820 undifferentiated, P780, P770, P740, P720, P650-P630 undifferentiated and P620 based on their palynofloral characteristics. The delineation of the P770/P740 boundary was not achieved using already published bioevent {Top Rich Occurrence of *Belskipollis elegans*}[3] due to inconsistency in occurrence of the marker species. The Top Regular Occurrence of the same marker species was utilized instead in delineating the boundary. On the other hand, the already published bioevent {Base Rich Occurrence of *Belskipollis elegans*}[3] used in delineation of P740/P720 boundary could not be used; instead the Downhole Increased Occurrence of *Magnastriatites howardi* was used (Figure 4). This was as a result of the irregularities in the occurrences of *Belskipollis elegans* observed within this well.

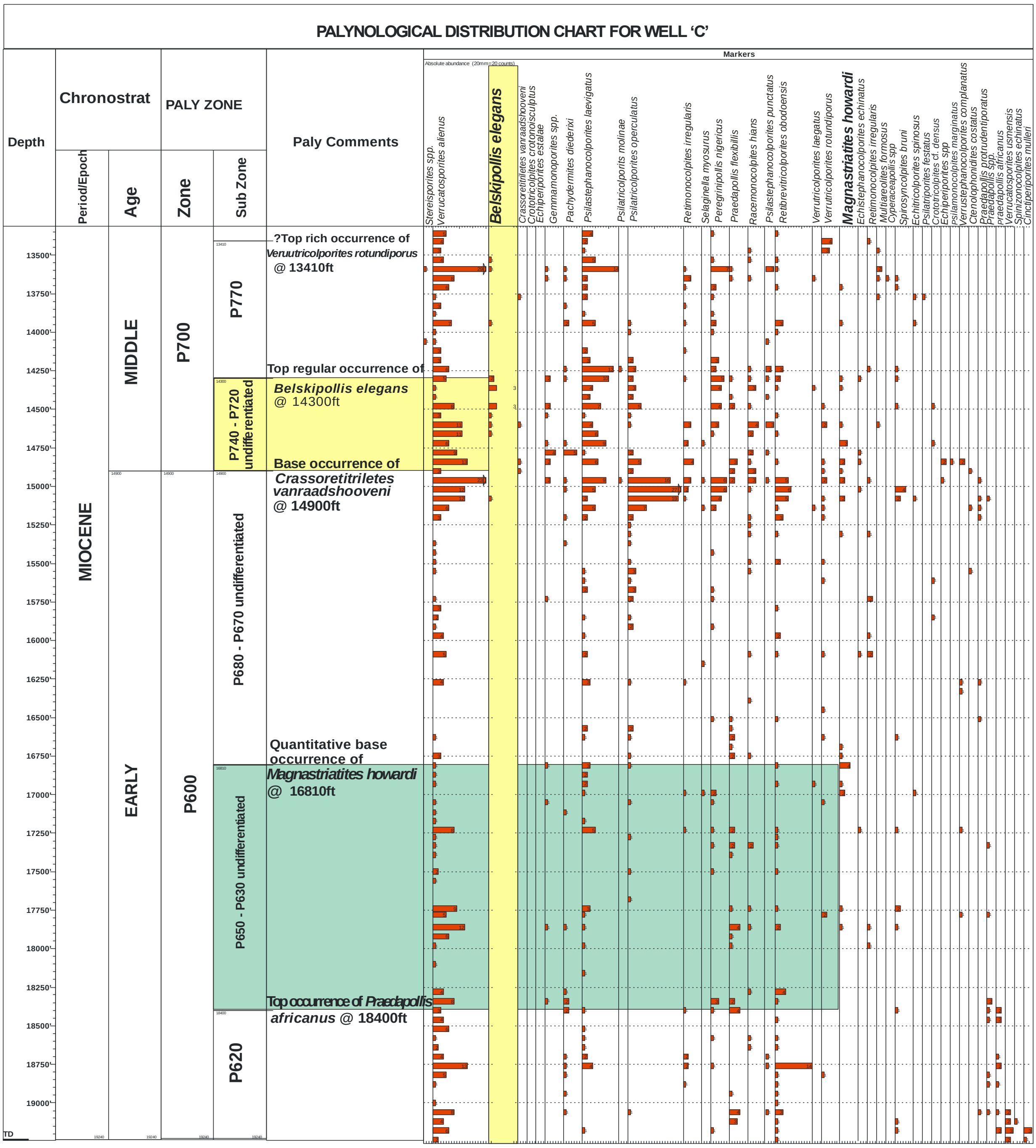

Figure 4: *Palynological Distribution Chart for Well 'C'*

Well 'D' (Offshore)

In Well D, the superzones were subdivided into P840, P830, P820 - P780, P770, P740, P720 and P680 zones. The delineation of P770/P740 boundary in this study was achieved using the already published bioevent {Top Rich Occurrence of *Belskipollis elegans*}[3]. The Top Regular Occurrence of the same marker species was observed two depths above where this bioevent was observed. On the other hand, the already published bioevent {Base Rich Occurrence of *Belskipollis elegans*}[3] commonly used to delineate the P740/P720 boundary could not be applied in this well and the Downhole Increased Occurrence of *Magnastriatites howardi* was used instead (Figure 5). This was as a result of the inconsistency in the occurrences of *Belskipollis elegans* observed within this study well.

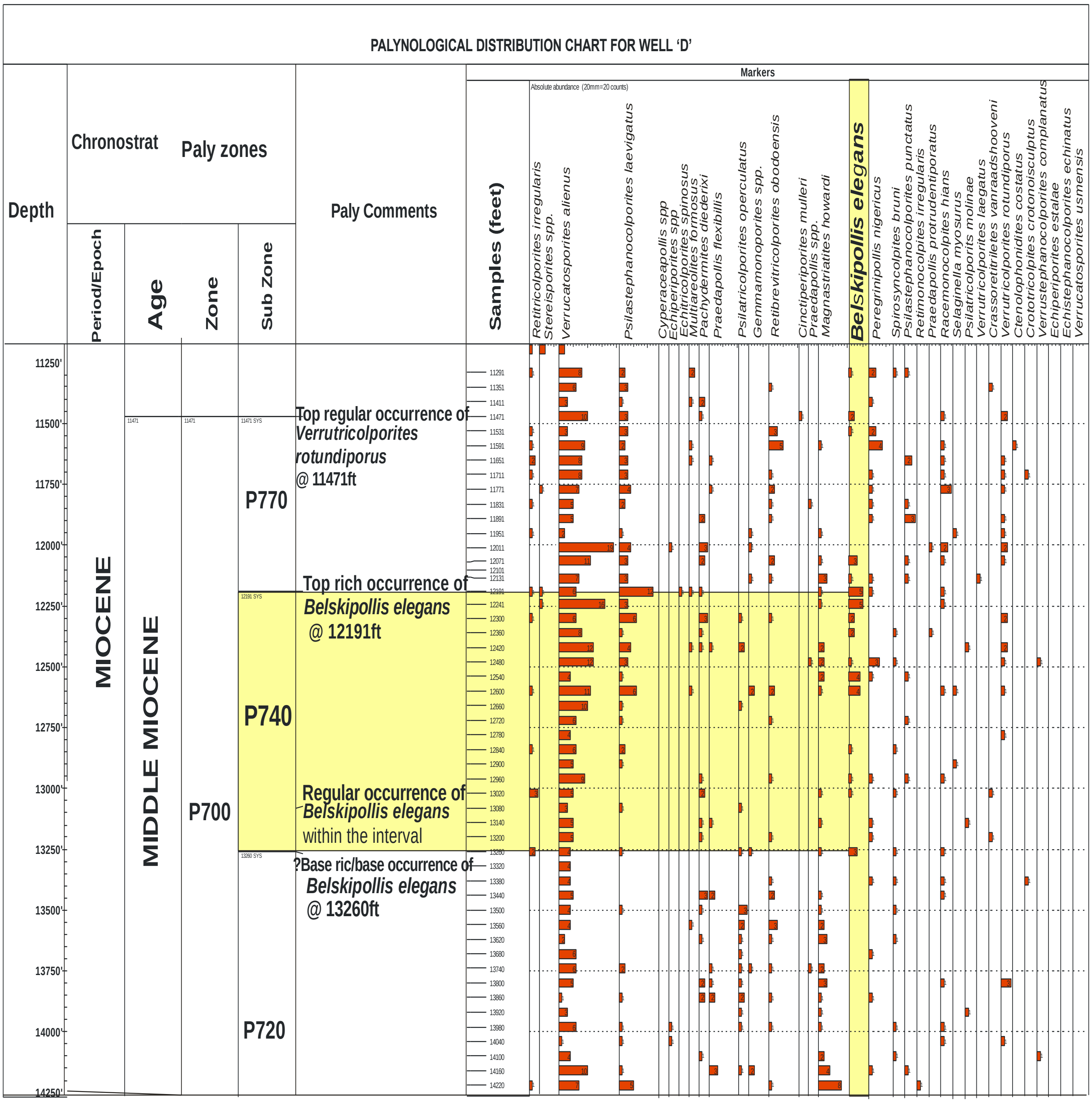

Figure 5: Palynological Distribution Chart for Well 'D'

Well 'E' (Offshore)

The superzones P800, P700 and P600 [3] penetrated in Well E were further subdivided into the P820, P780, P770, P740, P720 and P680 - ?P670 zones. The delineation of the P770/P740 boundary in this study well could not be achieved using the already published bioevent {Top Rich Occurrence of *Belskipollis elegans*}[3] due to the inconsistent occurrence of the marker species with the published event. The Top Regular Occurrence of the same marker species was utilized instead in delineating this boundary (Figure 6). Similarly, due to this inconsistency, the already published bioevent {Base Rich Occurrence of *Belskipollis elegans*}[3] could not be used and the Downhole Increased Occurrence of *Magnastriatites howardi* was used instead in the delineation of the P740/P720 boundary.

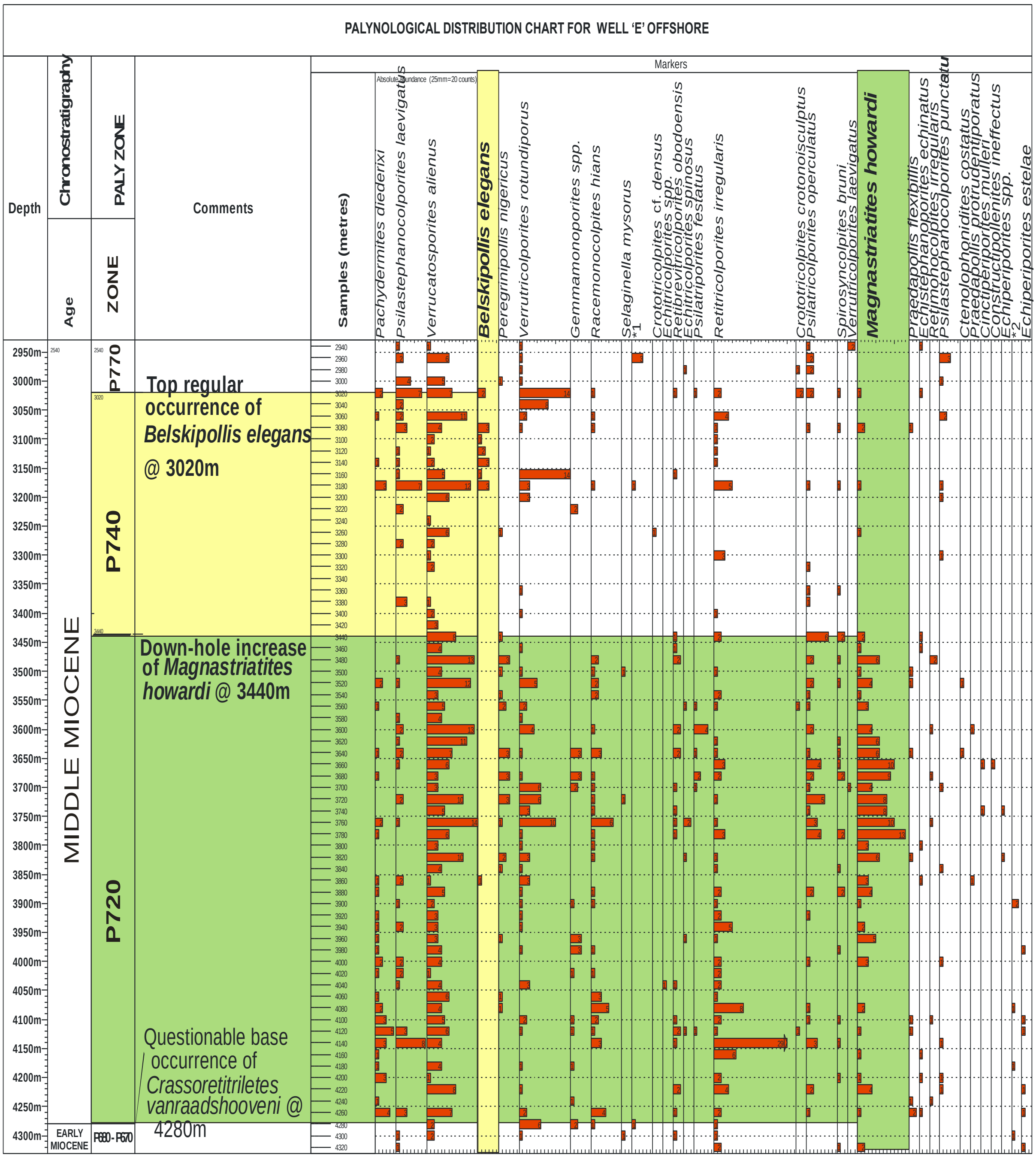

Figure 6: Palynological Distribution Chart for Well 'E'

Well 'F' (Offshore)

In Well F, the superzones were also subdivided into P870, P860, P850 – P840, P830, P820, P780 - P770, P740 and P720 - P680 zones based on their palynofloral characteristics. The delineation of the P770/P740 boundary in this study well was achieved using the already published bioevent {Top Rich Occurrence of *Belskipollis elegans*}[3]. On the other hand, the Base Rich Occurrence of *Belskipollis elegans* [3] utilized for the delineation of the P740/P720 boundary co-occurred with a notable Downhole Increased Occurrences of *Magnastriatites howardi* at the same depth (10,000ft) (Figure 7). The co-existence of these bioevents lends credence to the usage of Downhole Increased Occurrences of *Magnastriatites howardi* for delineating the P740/P720 boundary.

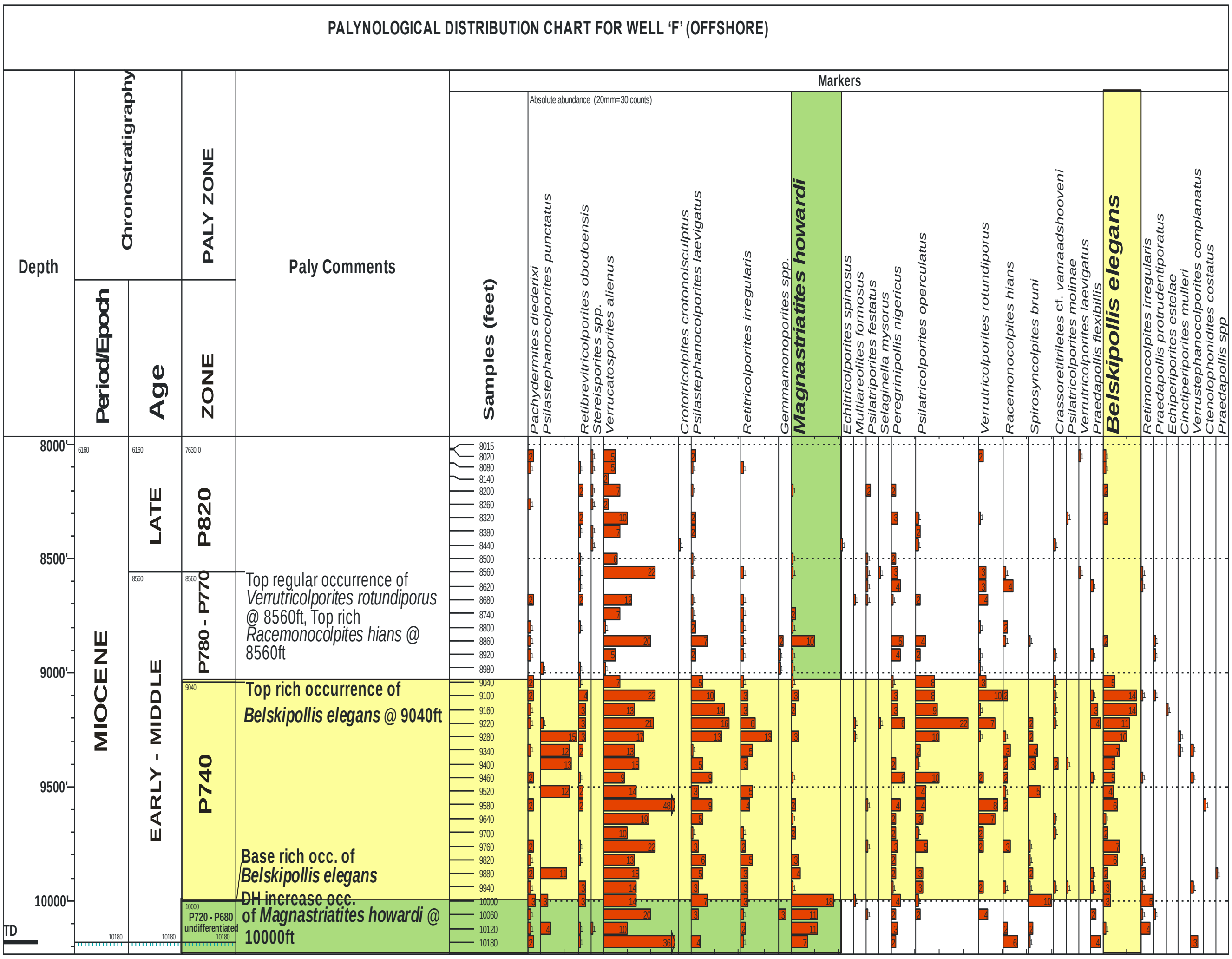

Figure 7: Palynological Distribution Chart for Well 'F'

Discussions

The delineation of the P770/P740 boundary in all the studied wells could not be achieved using the already published bioevent, "Top Rich Occurrence of *Belskipollis elegans"* [3]. However, the Top Regular Occurrence of the same marker species was utilized in delineating this boundary in wells 'B', 'C' and 'E'. On the other hand, the already published bioevent "Base Rich Occurrence of *Belskipollis elegans"* [3] could only be used in delineating the P740/P720 boundary in Wells 'A' and 'D'. Instead, the "Downhole Increased Occurrence of *Magnastriatites howardi*" was used for the other wells ('B', 'C', 'E' and 'F'). This was as a result of the inconsistency in the occurrences of the marker species *Belskipollis elegans* observed in most of the studied wells. These trends were observed mostly in wells located in the offshore Niger Delta.

In some of the studied wells (D and F), it was observed that the already published bioevent "Top Rich Occurrence of *Belskipollis elegans"* used in delineating the P770/P740 boundary co-occurred with the Top Regular Occurrence of the same marker species. Similarly, the commonly used, "Base Rich Occurrence of *Belskipollis elegans"* [3] utilized for the delineation of the P740/P720 boundary co-occurred with a notable Downhole Increased Occurrence of *Magnastriatites howardi* at the same depth. The co-existence of these observed palynological events with the already published events lends credence to the application of these bioevents within the Middle Miocene age in the Niger Delta.

The irregular occurrences of *Belskipollis elegans* within some parts of the delta may be attributed to the transportation distance from its natural habitat which is montane forest in the hinterland to the point of deposition offshore (Figure 8).

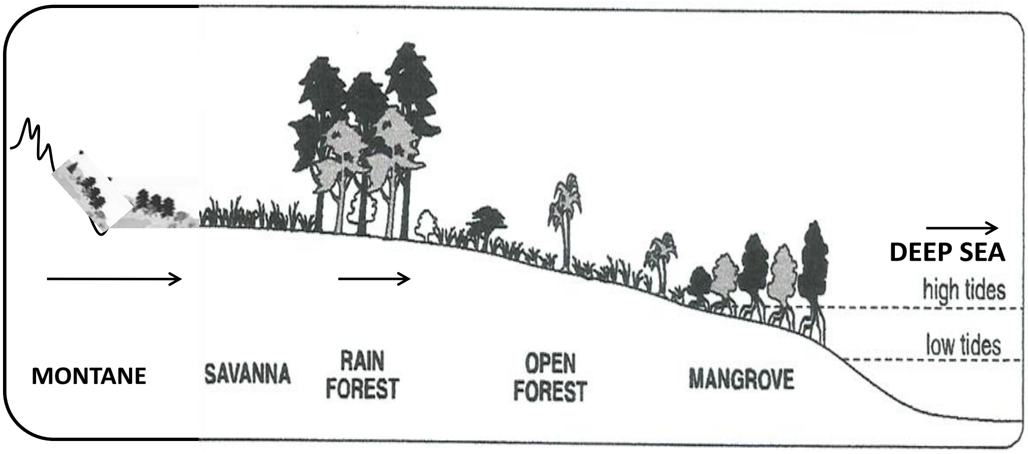

Figure 8: Ecological habitat of the plants species (Redrawn from Poumot, 1989)

On the other hand, *Magnastriatites howardi* has its natural habitat in freshwater swamp, thus it is easily transported and deposited in reasonable quantities in deeper marine sediments. Some key palynomorphs markers encountered in this study are presented in Figure 9.

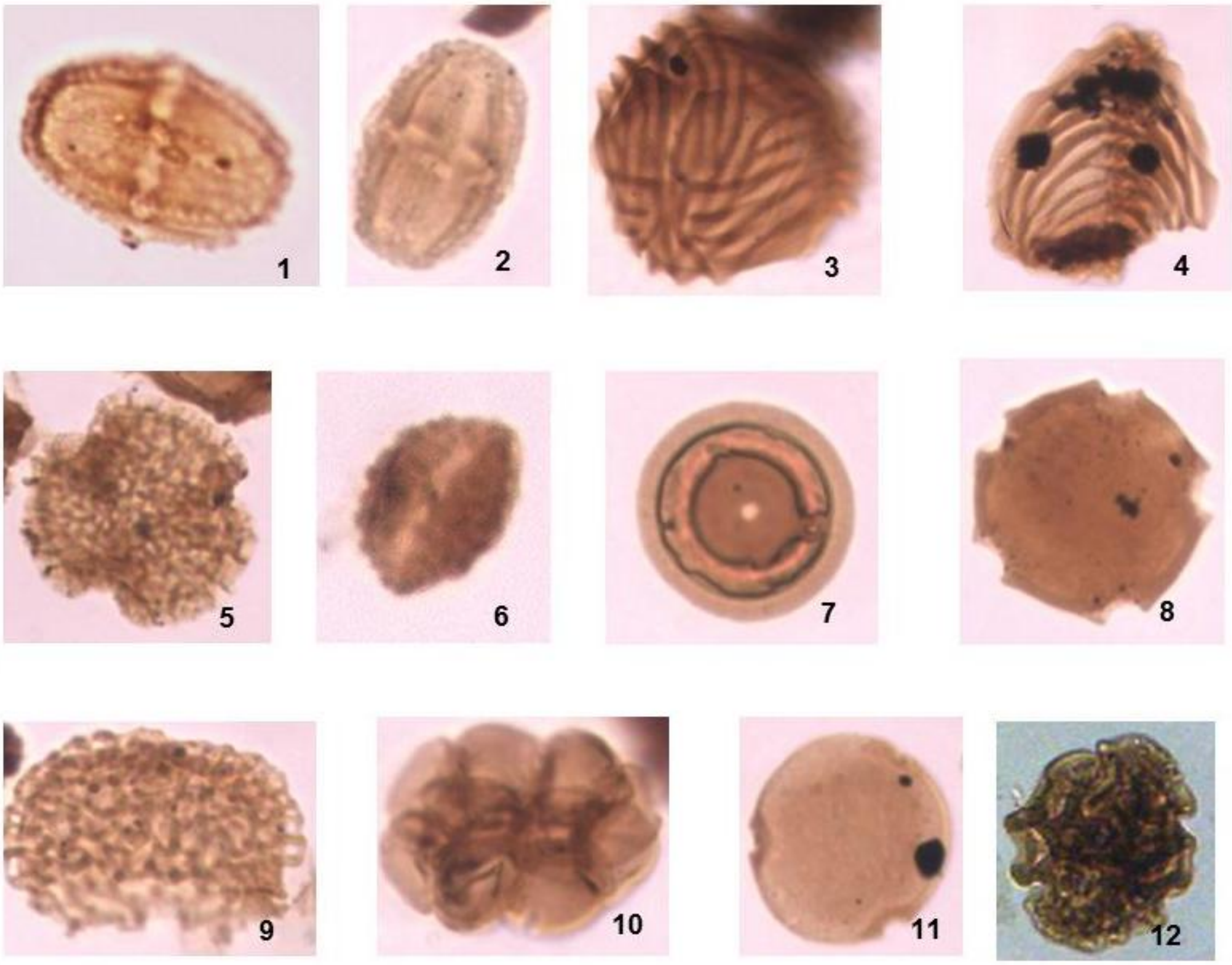

Figure 9: Key palynomorph markers- Belskipollis elegans (1, 2); Magnastriatites howardi (3, 4), Margocolporites rauvolifii (5); Verrutricolporites rotundiporus (6); Numulipolis neogenicus (7); Pachydermites diederixi (8); Spirosyncolpites bruni (9); Polyadopollenites vancampoa (10), Brevicolporites guinetti (11) and Peregrinipollis nigericus (12)

Conclusions

This study provides alternative bioevents in defining the P770/P740 and P740/P720 palynological zones, especially in the deep offshore Niger Delta, where we have inconsistencies in the recovery of *Belskipollis elegans.* Also, the results of this study could be used to further refine the palynological zonations in the Middle Miocene age, thereby enhancing detailed stratigraphic correlations for hydrocarbon exploration activities in the Niger Delta Basin.

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