

PALAEOENVIRONMENTAL AND HYDROCARBON EXPLORATION ASSESSMENT OF DAJ FIELD SEDIMENT IN NIGER DELTA BASIN, NIGERIA

Ekundayo Jacob Adeboye^{*}, Tope Shade Alege, Jeremiah Ayok

Department of Geology, Federal University Lokoja, Kogi State, Nigeria

^{*}Corresponding author: dayoadeboye1@gmail.com

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Abstract

The Niger Delta Basin ranks among the most prolific hydrocarbon provinces in the world, and its complex sedimentary architecture, shaped by fluvio deltaic and shallow marine processes, continues to reward integrated subsurface study. Accurate palaeoenvironmental reconstruction remains central to understanding hydrocarbon generation, migration, and accumulation, particularly in data limited settings where conventional cores are unavailable. This study investigated the palaeoenvironment and hydrocarbon prospectivity of sediments from the DAJ Field through integrated lithologic, lithofacies, palynofacies, and palynostratigraphic analyses. Sixty six ditch cuttings samples recovered from ER-51 Well between 2360 and 4340 feet were composited into thirty three representative samples for detailed laboratory investigation. Lithologic and lithofacies analyses revealed a predominance of fine grained sedimentary units, with two lithofacies, namely shale and argillaceous shale, indicating deposition within a low energy setting favourable for the preservation of organic matter. Palynofacies analysis identified four palynomaceral groups, PM-1, PM-2, PM-3, and PM-4, together with structureless organic matter, and the assemblage was dominated by PM-1 and PM-2 with moderate PM-4 and minor PM-3. The consistently high abundance of phytoclasts indicates a strong terrestrial organic matter input and a proximal depositional position, and the sediments are interpreted to record a terrestrial rainforest to brackish water swamp palaeoenvironment reflecting alternating continental and marginal marine influence. Biostratigraphic evaluation, based on diagnostic palynomorph events, assigns the studied interval a Middle to Late Miocene age spanning the Langhian to the Tortonian. The integrated dataset provides useful insight into the depositional history, stratigraphic framework, and hydrocarbon significance of the DAJ Field, and the abundance of terrestrially derived organic matter, together with favourable preservation conditions, points to appreciable potential of the succession for hydrocarbon generation and accumulation.

Keywords: palaeoenvironment; hydrocarbon exploration; biostratigraphy; Niger Delta Basin; Miocene; lithofacies; palynofacies

1. Introduction

The Niger Delta Basin of southern Nigeria is one of the world's most important petroleum provinces, accounting for the greater proportion of the country's hydrocarbon reserves and production (Williams et al., 2024). Its evolution began in the early Tertiary, a time of regression and increased clastic sedimentation, when the basin developed at the centre of a triple junction and produced a trough as the failed arm of a rift system linked to the separation of the South American and African plates (Alege et al., 2020b; Obaje, 2009; Mascle, 1976). The basin occupies the coastal, ocean facing region of the Benue Trough, which ties its geological development to this larger sedimentary complex (Ogbahon et al., 2019). Its formation is intimately associated with tectonic processes, sedimentation, and eustatic sea level changes. Amogu et al. (2011) emphasised the role of extensional tectonics and faulting in shaping the structural framework, and the importance of faults in hydrocarbon accumulation and redistribution across the basin.

The Niger Delta Basin hosts growth faults, antithetic faults, shale diapirs, collapsed crest structures, and rollover anticlines, features that can be delineated using three dimensional seismic data and well logs to map potential reservoirs and trapping geometries (Obasuyi et al., 2019). These structures record a history of crustal deformation and basin subsidence that influenced sedimentation patterns and hydrocarbon entrapment. Following Short and Stauble (1967), the lithostratigraphic fill of the basin is divided into the upper sandy Benin Formation, an alternating sandstone and shale unit known as the Agbada Formation, and the lower shaly Akata Formation, with ages ranging from Tertiary to recent (Nton and Ogungbemi, 2011).

Understanding the depositional history and palaeoenvironmental evolution of sedimentary successions is paramount to petroleum exploration, because depositional environments exert a strong influence on lithofacies distribution, reservoir architecture, organic matter preservation, and stratigraphic heterogeneity. Reconstructing palaeoenvironments therefore offers insight into sediment provenance, accommodation changes, and the distribution of potential reservoir, seal, and source rock facies. Integrated palaeoenvironmental studies have consequently become indispensable for reducing exploration risk and improving reservoir characterisation in mature hydrocarbon provinces such as the Niger Delta (Bustin, 1988; Reijers, 2011).

Palynology and palynofacies analysis retain a high standing among the most effective approaches for reconstructing ancient depositional settings, especially where core material is not readily available. Palynomorph assemblages, together with terrestrial and marine particulate organic matter, carry valuable information on palaeosalinity, water depth, terrestrial input, redox conditions, and relative proximity to the shoreline. Such

datasets are widely used to establish chronostratigraphic frameworks, infer depositional environments, and evaluate the nature and preservation of organic matter relevant to hydrocarbon generation (Tyson, 1995; Batten and Stead, 2005).

Earlier work by Alege and Joseph (2024) investigated the palaeoenvironment of Miocene sediments in the onshore Niger Delta Basin using palynology, while Olatunji (2022) applied palynofacies analysis to the offshore depobelt, concentrating on the relative abundance and types of organic matter. Onyeachonam and Fregene (2021) employed palynofacies and organic thermal maturation to determine kerogen types in Upper Cretaceous to Paleocene rocks of the Benin Flank, Anambra Basin. Despite the extensive exploration history of the Niger Delta, many producing and marginal fields still require integrated sedimentological and palaeoenvironmental characterisation to improve understanding of facies architecture and hydrocarbon potential (Onwuka et al., 2021). The DAJ Field represents one such area, where integrated analysis of ditch cuttings can yield reliable information on depositional processes and organic matter distribution.

Because ditch cuttings are routinely available from exploration wells, they constitute a cost effective source of geological information capable of supporting palaeoenvironmental reconstruction and exploration decisions when properly analysed against established sedimentological and palynological techniques. The present study integrates lithofacies observation, palynological analysis, and palynofacies characterisation of ditch cuttings from ER-51 Well to reconstruct the palaeoenvironmental evolution of sediments within the DAJ Field. It further evaluates the hydrocarbon significance of the sediments within the limits of lithofacies and palynofacies evidence, thereby contributing to an improved understanding of depositional controls on hydrocarbon prospectivity in the study area.

2. Materials and Methods

2.1 Lithologic and Lithofacies Analysis

Sixty six ditch cuttings samples, composited into thirty three at sixty foot intervals, were collected from ER-51 Well within the DAJ Field and processed for lithofacies analysis. A comprehensive sample by sample lithologic description was conducted for the samples, which are dominated by shale and clay, and the results were represented graphically to determine primary and secondary rock types, colour, texture, and accessory minerals (Weber and Daukoru, 1975; Billman, 1992; Idakwo et al., 2013; Alege et al., 2020a; Aigbadon et al., 2023; Alege et al., 2024).

2.2 Palynological and Palynofacies Analysis

Sixty six ditch cuttings samples from ER-51 Well, spanning depths of 2360 to 4340 feet and composited to thirty three at sixty foot intervals, were processed and analysed for palynomorph content. A palynological maceration

technique adapted from Traverse (2007) was applied. Samples were ground into fragments, and twenty five grams of each were treated alternately with dilute hydrochloric acid, concentrated hydrofluoric acid, and nitric acid to eliminate carbonate and silicate minerals while concentrating the palynomorphs (Odoma and Aigbadon, 2024). The reaction was neutralised with potassium hydroxide and distilled water, after which the palynomorph rich residue was mounted on labelled glass slides using Norland medium for microscopic examination.

Photomicrographs of the palynomorphs were captured, and Strataburg software was employed for statistical plotting to determine the age and probable palaeoenvironment of deposition. For palynomaceral recovery, the same preparation procedure was retained except that the oxidation step involving nitric acid was excluded to prevent bleaching of the palynodebris. The recovered organic material was distributed evenly on cover slips, allowed to dry, and mounted permanently using Loctite Impruv medium before observation under an Olympus binocular transmitted light microscope. The palynomaceral slides underwent quantitative analysis for the types PM-1, PM-2, PM-3, and PM-4, together with structureless organic matter. Identification followed published palynological albums and the works of Ajaegwu et al. (2012), Chukwuma-Orji et al. (2019), and Alege and Joseph (2024).

For the palynofacies assemblage, the relative abundance of each palynomaceral group was computed from counts of two hundred specimens per type per slide. The relative proportion of each group is expressed as:

$$PM_i (\%) = (\Sigma PM_i / \Sigma PM_{total}) \times 100 \quad (1)$$

where PM_i is the count of a given palynomaceral type and PM_{total} is the summed count of all types. To characterise the balance between structured terrestrial debris and degraded organic matter, the phytoclast and amorphous organic matter proportions were derived as:

$$\text{Phytoclast } (\%) = [(PM1 + PM2 + PM3) / POM] \times 100 \quad (2)$$

$$\text{AOM } (\%) = [(PM4 + SOM) / POM] \times 100 \quad (3)$$

where POM denotes the total particulate organic matter counted per interval. These ratios provide a quantitative basis for interpreting proximity to sediment source, depositional energy, and the redox conditions governing organic matter preservation.

3. Results and Discussion

3.1 Lithologic Description and Lithofacies of ER-51 Well

Only two lithofacies units were identified and characterised in ER-51 Well on the basis of colour, texture, and accessory minerals, following the approach of Idakwo et al. (2013), Olabode and Mohammed (2016), Aigbadon et al. (2023), and Alege et al. (2024). The well ranges in depth from 2360 to 4340 feet, giving a penetrated thickness of 1980 feet, and the summary of the lithofacies characterisation is presented in the lithofacies log (Figure 1).

The shale lithofacies is fissile to moderately fissile with a minor clay component, grading from grey to brownish grey at the top and bottom and displaying dark brown coloration at intervals of 3200 to 3260 feet and 3320 to 3380 feet. This coloration suggests the presence of ferruginous material, and the unit is dominated by shale, constituting about eighty per cent of the interval. The argillaceous shale facies occupies the 3080 to 3200 foot and 3680 to 3740 foot intervals, with a combined thickness of about 180 feet. It comprises roughly sixty per cent shale intercalated with about forty per cent clay, is fossiliferous and grey in colour, and is moderately fissile. The dominance of fine grained, low energy lithologies through the succession favours the settling and retention of particulate organic matter and establishes a depositional backdrop conducive to organic matter preservation.

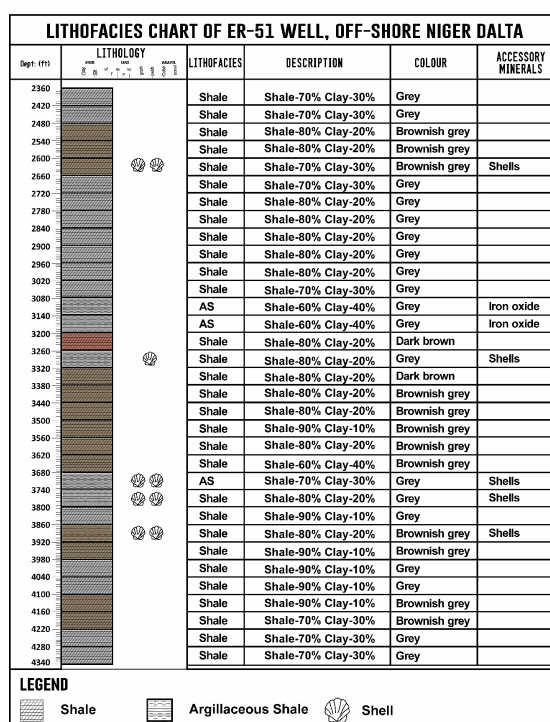


Figure 1: Lithofacies chart of ER-51 Well showing the vertical distribution of shale and argillaceous shale units, with lithology, description, colour, and accessory minerals across the 2360 to 4340 foot interval. Source: Authors' lithologic logging of ditch cuttings.

3.2 Palynomorph Distribution

Palynomorph analysis was carried out on thirty three ditch cuttings samples of ER-51 Well between 2360 and 4340 feet. A total of fifty nine palynomorph species were recovered, comprising twenty five pollen species, eighteen spore species, and sixteen dinoflagellate cyst species, together with diatom frustules, fungal spores, and the freshwater alga *Pediastrum*. The relative proportions were 42.4 per cent pollen, 30.5 per cent spores, 13.5 per cent dinoflagellate cysts, 13.5 per cent diatom frustules, and trace occurrences of fungal spores and freshwater algae (Figure 2 and Table 1). The interval was characterised by poor to moderately abundant and diverse palynomorphs, dominated by terrestrial species such as *Laevigatosporites* sp., *Zonocostites ramonae*, *Acrostichum aureum*, *Psilatricolporites crassus*, *Retitricolporites irregularis*, *Verrucatosporites* sp., *Sapotaceae*, and *Striatricolporites catatumbus*. Low to common records of fungal spores and the freshwater alga *Botryococcus braunii* were prevalent, while sparse dinoflagellate cysts including *Lingulodinium machaerophorum*, *Spiniferites* sp., and *Operculodinium centrocarpum* were also identified.

The overwhelming dominance of terrestrially derived pollen and spores, which jointly account for close to three quarters of the recovered assemblage, points to a depositional system fed persistently by continental vegetation. The subordinate but consistent record of dinoflagellate cysts and diatom frustules indicates episodic marine incursion, so that the palynomorph signal integrates a mixed but proximally terrestrial provenance. The downhole variation in total palynomorph abundance (Figure 3) shows recurrent maxima that coincide with the more clay rich intervals, consistent with enhanced preservation where finer sediment limited oxygenation of the substrate.

Table 1: Recovered palynomorph groups and their relative proportions in ER-51 Well.

Palynomorph group	Species recovered	Relative proportion (%)	Palaeoenvironmental affinity
Pollen	25	42.4	Terrestrial (rainforest to mangrove)
Spores	18	30.5	Terrestrial (pteridophytic, swamp)
Dinoflagellate cysts	16	13.5	Marginal marine incursion
Diatom frustules	–	13.5	Brackish to marine
Fungal spores	–	<0.1	Terrestrial, humid
Freshwater algae (Botryococcus, Pediastrum)	–	<0.1	Continental, freshwater

Source: Authors' palynological analysis of ER-51 Well.

The proportional structure of the assemblage is summarised in Figure 2. The strong terrestrial dominance provides the first independent line of evidence for a proximal, land influenced depositional setting, later reinforced by the palynofacies and phytoclast data.

Recovered palynomorph assemblage, ER-51 Well

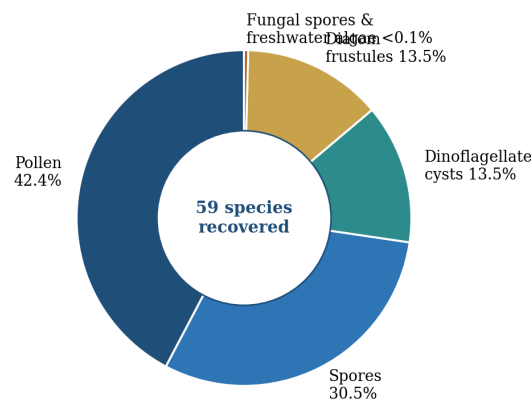


Figure 2: Proportional composition of the recovered palynomorph assemblage in ER-51 Well, dominated by terrestrially derived pollen and spores. Source: Authors' palynological analysis.

Downhole palynomorph abundance, ER-51 Well

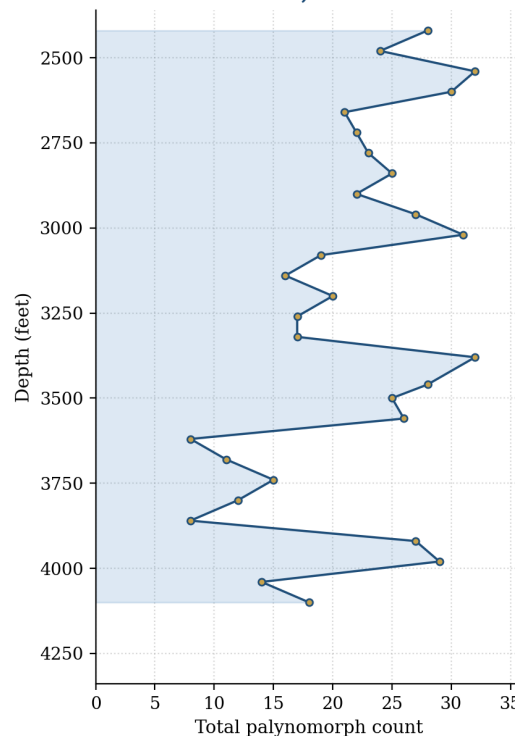
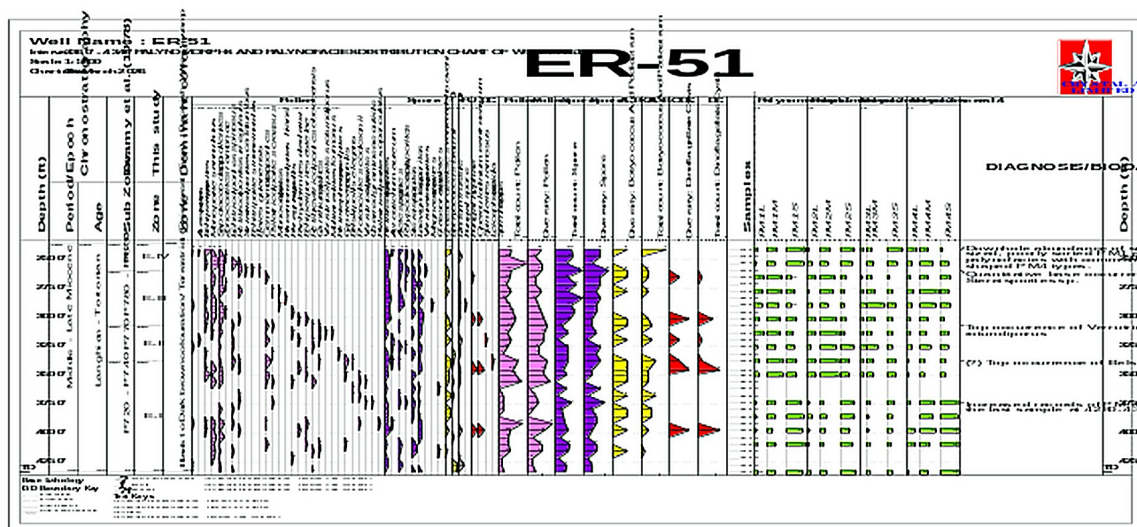


Figure 3: Downhole variation in total palynomorph abundance across the studied interval of ER-51 Well. Source: Authors' palynological counts.

3.3 Palynofacies Analysis

Palynomaceral 4 (PM-4): black, equidimensional, blade or needle shaped material that is uniformly opaque and structureless, including coal, charcoal, and geothermally fusinised debris. Highly buoyant and resistant to degradation, PM-4 is transported over long distances and generally indicates brackish water swamp and fluvio marine settings. It constitutes about 19 per cent of the plant material.

The quantitative composition of the palynomacerals is summarised in Figure 5, and the interval by interval phytoclast and amorphous organic matter counts are given in Table 2, with the detailed maceral breakdown in Table 3. Phytoclasts, comprising PM-1, PM-2, and PM-3, dominate every interval, and the systematic downhole partition of phytoclast against amorphous organic matter (Figure 6) shows that the deeper intervals below about 3680 feet carry a comparatively larger amorphous fraction. This upward decrease in amorphous organic matter, matched by an upward increase in structured phytoclasts, records a gradual shallowing and a stronger terrestrial imprint toward the top of the succession.



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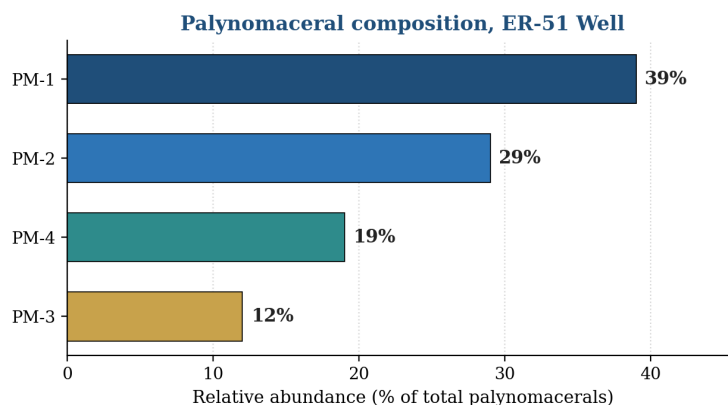


Figure 5: Relative abundance of palynomaceral groups PM-1 to PM-4 in ER-51 Well. Source: Authors' palynofacies counts.

Table 2: Phytoclast, amorphous organic matter, and palynomorph counts by depth interval, ER-51 Well.

Interval (ft)	Phytoclast (PM1+PM2+PM3)	AOM (PM4+SOM)	Palynomorphs
2360–2420	160	40	28
2480–2540	145	55	56
2600–2660	150	50	51
2720–2780	145	55	45
2840–2900	145	55	47
2960–3020	161	39	58
3080–3140	166	34	35
3200–3260	155	45	37
3320–3380	178	22	49
3440–3500	161	39	63
3680–3740	122	78	26
3800–3860	135	65	20
3920–3980	105	95	56
4040–4100	130	70	32
4160–4220	135	65	25
4280–4340	137	63	36

Source: Authors' palynofacies analysis (counts per 200 specimens).

Table 3: Distribution of palynomaceral types and derived phytoclast and palynomorph percentages, ER-51 Well.

Interval (ft)	PM1	PM2	PM3	PM4	Phytoclast	AOM (%)	Phytoclast (%)	Palynomorph (%)
2360–2420	70	55	35	25	160	20.0	6.9	4.3
2480–2540	70	50	25	35	145	27.5	6.2	8.6
2600–2660	75	60	15	28	150	25.0	6.4	7.8
2720–2780	80	40	25	44	145	27.5	6.2	6.9
2840–2900	62	33	50	40	145	27.5	6.2	7.2
2960–3020	75	62	24	19	161	19.5	7.0	8.9
3080–3140	78	68	20	22	166	17.0	7.1	5.4
3200–3260	50	70	35	30	155	22.5	6.7	5.7
3320–3380	80	68	30	15	178	11.0	7.6	7.5
3440–3500	66	70	25	23	161	19.5	7.1	8.1
3680–3740	65	42	15	48	122	39.0	5.0	3.9
3800–3860	70	55	10	40	135	32.5	5.7	3.0
3920–3980	60	35	10	68	105	47.5	4.5	8.6
4040–4100	80	40	10	54	130	35.0	5.6	4.8
4160–4220	72	48	15	40	135	32.5	5.7	3.8
4280–4340	71	54	12	39	137	31.5	5.8	5.5

Source: Authors' palynofacies analysis. Phytoclast = PM1+PM2+PM3; AOM = PM4+SOM.

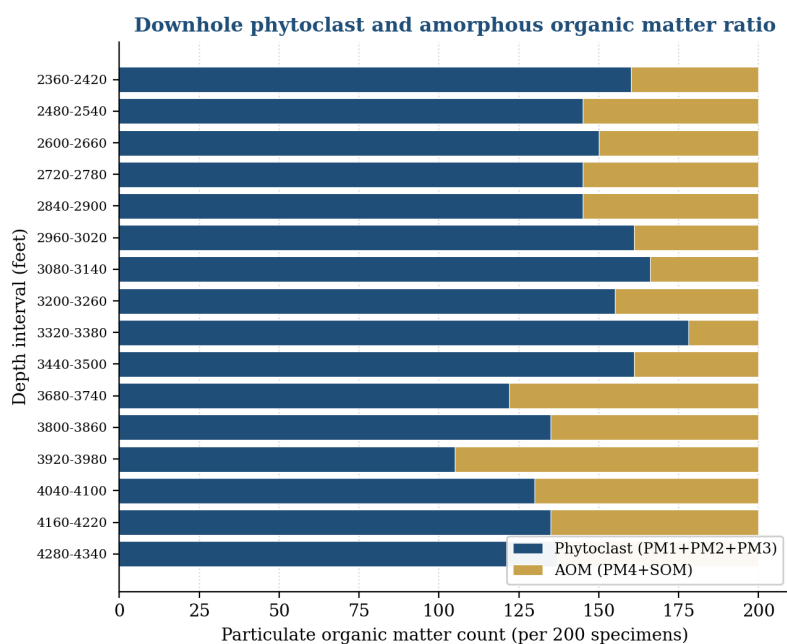


Figure 6: Downhole partition of phytoclast against amorphous organic matter, ER-51 Well, showing an upward increase in structured terrestrial debris. Source: Authors' palynofacies counts.

3.4 Palaeoenvironmental Interpretation

The interval between 2360 and 4340 feet is dominated by abundant dark brown to black, poorly to moderately sorted, small and medium sized PM-1, which forms about 39 per cent of the total plant material, together with PM-2 at about 29 per cent and lath shaped PM-4 at about 19 per cent, in association with PM-3 at about 12 per cent and subordinate structureless organic matter (Table 3). This assemblage points to a predominantly terrestrial rainforest to brackish water swamp palaeoenvironment. The interpretation is reinforced by the abundance of mangrove and rainforest pollen such as *Zonocostites ramonae*, *Sapotaceoidaepollenites* sp., *Retitricolporites irregularis*, *Psilatricolporites crassus*, and *Striatricolporites catatumbus*, and of pteridophytic spores including *Acrostichum aureum*, *Verrucatosporites* sp., *Polypodiaceoisporites* sp., and *Laevigatosporites* sp.

On the ternary kerogen classification of Tyson (1993), the study interval plots between palynofacies fields VII and VIII (Figure 7), which corresponds to a distal dysoxic to anoxic and distal dysoxic to oxic shelf environment. This setting reflects low energy offshore marine conditions and fluctuating bottom water oxygenation ranging from oxygen deficient to moderately oxygenated. The moderate amorphous organic matter present in this position indicates enhanced preservation of marine organic matter under reduced oxidation, while the distal location minimised terrestrial sediment influx. These conditions favour accumulation of oil prone type II kerogen and indicate a depositional environment conducive to the generation and preservation of hydrocarbon source facies (Tyson, 1995). This inference, however, becomes definitive only when complementary organic geochemical analysis is undertaken.

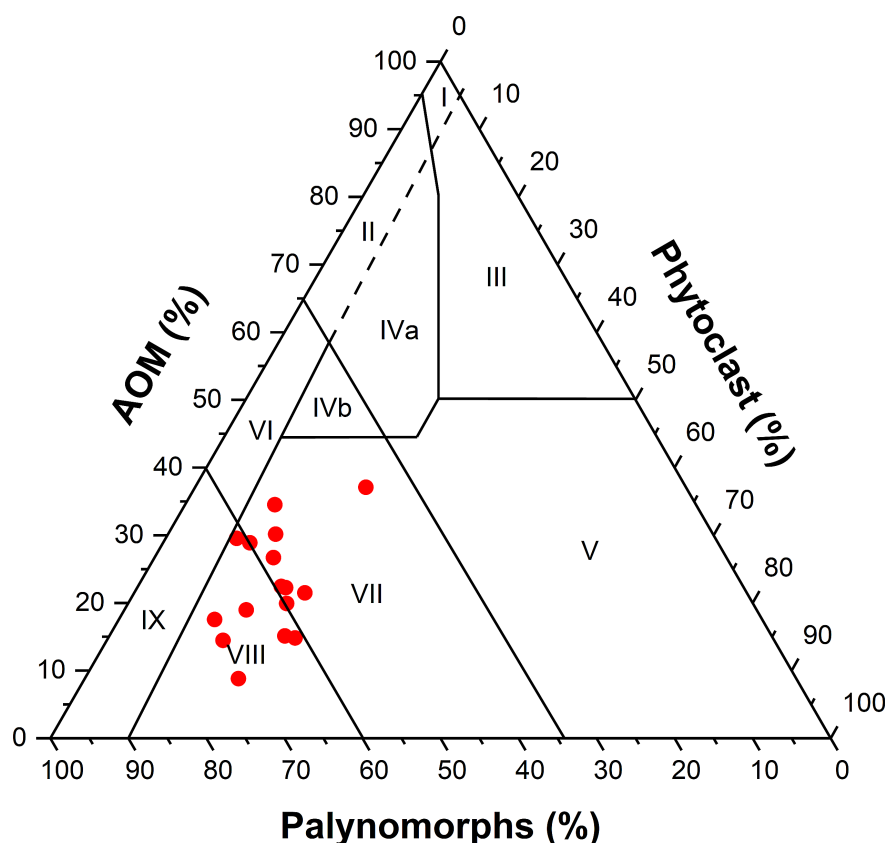


Figure 7: Ternary kerogen classification diagram (modified after Tyson, 1993) showing the ER-51 Well samples plotting between palynofacies fields VII and VIII. Source: Authors' plot.

3.5 Palynostratigraphy and Zonation

Marker species and their associated palynoflora assemblages were used to constrain the age of the penetrated sediments. Four informal biozones, E-I to E-IV, were recognised using marker taxa such as *Stereisporites* sp., *Verrutricolporites rotundiporus*, and *Belskipollis elegans*. These zones correlate with the P720 to P740 combined, P770, P780 to P820 combined, and P830 subzones of Evamy et al. (1978), and lie within the *Echitricolporites spinosus* pantropical zone of Germeraad et al. (1968). The studied section is accordingly dated Middle to Late Miocene, spanning the Langhian to the Tortonian. The zonation is summarised in Figure 8 and Table 4.

Zone E-I (3320–4340 ft): its base coincides with the last analysed sample at 4340 feet and was not fully penetrated, while its top is defined by the top occurrence of *Belskipollis elegans* at 3320 feet. Diagnostic events include low records of *Crassoretitritetes vanraadshoveni* and *Psilatricolporites operculatus* with common *Zonocostites ramonae* and *Sapotaceoidaepollenites* sp. The interval correlates with the P720 to P740 combined subzone and is dated Middle Miocene, Langhian to Serravallian.

Zone E-II (3020–3320 ft): the base is defined by the top occurrence of *Belskipollis elegans* at 3320 feet and the top by the top occurrence of *Verrutricolporites rotundiporus* at 3020 feet. Common *Zonocostites ramonae* and *Psilatricolporites crassus* with rare *Psilatricolporites operculatus* characterise the interval, which correlates with the P770 subzone and is interpreted as Middle Miocene, Serravallian.

Zone E-III (2540–3020 ft): the base is defined by the top occurrence of *Verrutricolporites rotundiporus* at 3020 feet and the top by the quantitative base occurrence of *Stereisporites* sp. at 2540 feet. Additional events include *Recemonocolpites hians*, *Echitricolporites spinosus*, *Pachydermites diederixi*, *Retibrevitricolporites obodoensis*, and *Echiperiporites stelae*. The interval correlates with the P780 to P820 combined subzone and is dated Middle to Late Miocene, Serravallian to Tortonian.

Zone E-IV (2360–2540 ft): the youngest zone recognised, with its base defined by the quantitative occurrence of *Stereisporites* sp. at 2540 feet and its top coinciding with the first sample at 2360 feet. It correlates with the P830 subzone and is dated Late Miocene, Tortonian.

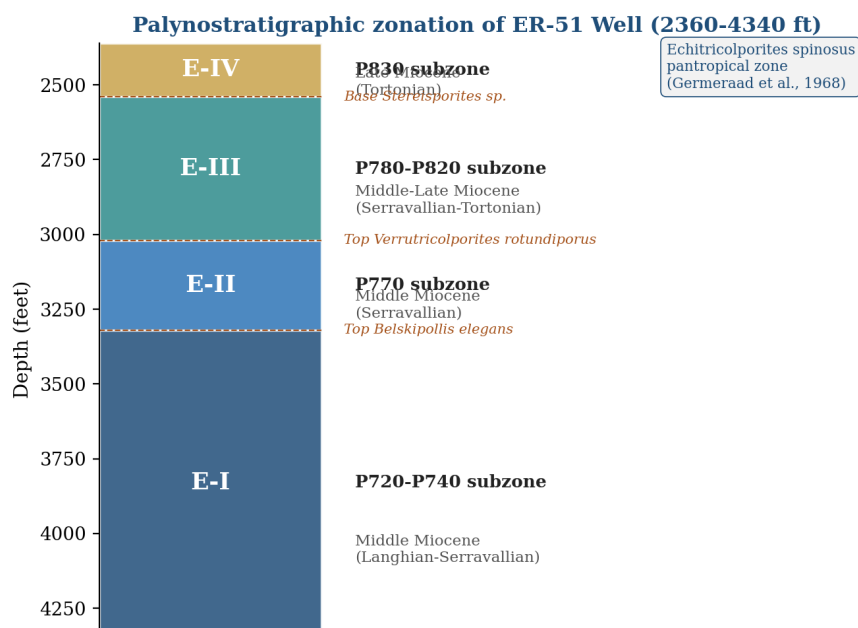


Figure 8: Palynostratigraphic zonation of ER-51 Well showing the four informal biozones, their bounding marker events, correlative Evamy et al. (1978) subzones, and inferred ages. Source: Authors' biostratigraphic analysis.

Table 4: Summary of the palynological zones identified in ER-51 Well (2360–4340 ft).

Zone	Depth (ft)	Defining marker events	Evamy et al. (1978) subzone	Inferred age
E-IV	2360–2540	Base of first sample to quantitative <i>Stereisporites</i> sp.	P830	Late Miocene (Tortonian)
E-III	2540–3020	Top <i>Verrutricolporites rotundiporus</i> to base <i>Stereisporites</i> sp.	P780–P820	Middle–Late Miocene (Serravallian–Tortonian)
E-II	3020–3320	Top <i>Belskipollis elegans</i> to top <i>Verrutricolporites rotundiporus</i>	P770	Middle Miocene (Serravallian)
E-I	3320–4340	Base not reached to top <i>Belskipollis elegans</i>	P720–P740	Middle Miocene (Langhian–Serravallian)

Source: Authors' biostratigraphic analysis, correlated after Evamy et al. (1978) and Germeaad et al. (1968).

3.6 Implication for Hydrocarbon Exploration

The hydrocarbon significance of the studied sediments was evaluated exclusively from their palynofacies characteristics. Palynofacies analysis provides information on the origin, composition, transport, and preservation of particulate organic matter, and thereby serves as an important tool for the preliminary assessment of sedimentary organic matter and its preservation history (Tyson, 1995; Batten, 1996). Because the present study did not include organic geochemical analyses, the interpretation is limited to palynofacies evidence and does not infer kerogen type, thermal maturity, or hydrocarbon generating capacity.

The palynofacies assemblages are dominated by phytoclasts, accompanied by subordinate palynomorphs and varying proportions of amorphous organic matter. The predominance of phytoclasts indicates that terrestrial plant debris was the principal source of organic matter to the depositional system, an assemblage characteristic of deltaic and marginal marine settings where fluvial processes transport abundant higher plant material into the basin (Tyson, 1995; Batten, 1996). The abundance of pollen and spores reinforces this interpretation and reflects sustained continental input during sedimentation.

The occurrence of amorphous organic matter, although subordinate to phytoclasts, carries valuable information on organic matter preservation. Amorphous organic matter generally represents material that has undergone extensive degradation and gelification prior to burial, and its preservation is favoured under relatively oxygen restricted conditions (Tyson, 1995; Traverse, 2007). Intervals with comparatively higher amorphous proportions, such as those below 3680 feet in Table 2, may therefore record episodes of reduced bottom water oxygenation that enhanced the preservation of labile constituents. Conversely, intervals rich in oxidised phytoclasts and poor in amorphous matter indicate stronger oxidation and degradation before final burial.

The close association between phytoclast rich palynofacies and fine grained lithologies indicates that organic matter preservation was governed by depositional energy and sediment texture. Fine grained sediments limit physical reworking and restrict oxygen penetration after deposition, thereby favouring accumulation and preservation of particulate organic matter (Batten, 1996; Traverse, 2007). Vertical variation in palynofacies composition therefore reflects changing terrestrial supply, depositional energy, and preservation conditions rather than a change in the primary organic source. Overall, the succession

contains appreciable preserved terrestrial organic matter and records intervals during which conditions favoured its accumulation, so that the sediments display characteristics commonly associated with organic matter preservation in sedimentary basins. Palynofacies analysis alone cannot determine the abundance, quality, maturity, or petroleum productivity of the preserved organic matter (Tyson, 1995); the present results should thus be read as a preliminary indication of organic matter preservation, to be confirmed by organic geochemical investigation of organic carbon content, thermal maturity, and generation indices.

4. Conclusion

The integrated palaeoenvironmental and hydrocarbon assessment of sediments from ER-51 Well in the DAJ Field yields important insight into the depositional history, palaeoenvironment, and hydrocarbon significance of the succession. Two lithofacies, shale and argillaceous shale, were identified alongside clay in varying proportions, together with shell fragments and ferruginous accessory minerals. The depositional environment varied from terrestrial rainforest to brackish water swamp, and biostratigraphic analysis based on pollen zonation and biomarker events dates the sediments to the Middle to Late Miocene, spanning the Langhian to the Tortonian.

The palynofacies record, dominated by phytoclasts with subordinate amorphous organic matter, indicates warm and humid conditions with combined continental and marginal marine influence and points to favourable conditions for the accumulation and preservation of terrestrially derived organic matter. Within the limits of palynofacies evidence, the succession displays characteristics commonly associated with hydrocarbon source potential, although confirmation requires organic geochemical study. The work enhances understanding of the geology of the DAJ Field and provides a framework to guide subsequent oil and gas exploration in the study area.

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Competing Interests

The authors declare that no competing interests exist.

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