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Semi-Quantitative Analyses and Paleoecology of Palynomorphs from Kuri-1, Western Niger Delta Nigeria

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ABSTRACT

Fifty-two ditch cutting samples between 6138m and 7717m in Kuri-1 Well, western Niger Delta were collected and processed for sedimentological and palynological analyses. Basically two lithologic units were identified which are sandstones and shaly sandstone. A total of Twenty seven species of palynomorphs were recovered, photographed and identified. The diagnostic palynomorphs recovered were used in the zonation and dating of the analyzed section. Two major palynological zones were established: P700 and P800 zones. The P700 zone contains only P780 subzone with the top placed at 6806m and its base at 7717m; this is marked by the top regular occurrence of *Racemonocolpites hians*. The P800 zone contains two subzones of P820 and P830, the top of P820 is placed at 6400m defined by the quantitative base occurrence of *Stereiosporites* spp. and its base is placed at 6806m marked by the top regular occurrence of *Racemonocolpites hians*. The top of P830 is placed at 6138m and its base at 6400m defined by the quantitative base occurrence of *Stereiosporites* spp. Based on the index taxa recorded, these zones correlate with the broad Pan-tropical zone of *Echitricolporites spinosus*. The flora recovered suggests Middle to Late Miocene age and a littoral to inner neritic environment of deposition.

1. Introduction

The Niger Delta is a prolific oil province within the West Africa subcontinent. The Tertiary Niger Delta Basin is one of the sedimentary basins formed by the rift faulting of the Nigeria Precambriam rock. This delta is characterized by arcuate sediment wedge of the destructive -wave dominated type (Evamy et al, 1978). It is important because of its hydrocarbon resources, which started to evolve in Eocene period, and deposition is still on offshore. The development of the delta is depended on the interplay between sediment supply and subsidence rate. Larger amount of data from several thousands of drilled wells have led to a considerable understanding of the stratigraphy and regional geology of the delta. Some information have been published on petroleum, sedimentology, geophysical and biostratigraphy of the delta development.

2. Geologic Setting and Stratigraphy

The Niger Delta is a prograding depositional complex found within the Cenozoic Formation of the southern Nigeria. The Niger Delta is bounded in the west by the Benin Flank; the subsurface continuation of the West Africa shield; in the east by Calabar Flank; the subsurface continuation of the Oban massif, to the North by Abakaliki Anticlinorium and the post Abakaliki/Anambra basin, and the Atlantic Ocean to the south (Murat, 1972). The combination effect of subsidence and the deposition has resulted in a succession of transgressive and regressive sequence and a 250km shoreline advance in the sourthwest direction in the Niger Delta (Oomkens, 1974). The accumulated result of these events is the deposition of between 9,000m to 12,000m thick transgressive/regressive depositional sequences, which is very similar to the United State Gulf Coast Tertiary section (Curtis, 1970). Short and Stauble (1967) divided the subsurface Niger Delta into three stratigraphic units stating from the top to the bottom; they are Benin, Agbada and Akata Formations. The study area is shown below.

Ditch cutting samples from Kuri-1 Well from an interval of 6140-7850m. Fifty-two (52) composited samples ranging from interval 6138-7717m were used for both palynological and sedimentological studies. For sedimentological processing, about 80g of each sample was crushed and soaked with hot water and detergent for about 24 hours. The soaked samples were washed under a distilled water spigot tap using a 63µm sieve mesh. The retained samples on 63µm sieve were dried over hot plates. Lithological descriptions of the samples were done by examining them under a binocular microscope.

The essential parameters studied were the textural characteristics such as the colour, grain size, shape (roundness), spericity, presence of accessory minerals, fauna and flora content. Fifty two composited ditch cuttings samples mainly dark gray to black shale, sandstone and claystone were analyzed for palynological process. About 20gm of each sample was soaked in hydrofluoric acid (HF) to remove silicates, and dilute hydrochloric acid (HCl) to remove the carbonates. This is followed by sieving process with 5µm mesh. The retrieved debris of the samples was slightly oxidized, followed by heavy mineral liquid separation of the macerals using Zinc bromide ($ZnBr_2$) at 2.1g/cc). The collected residue was mounted on glass slides with DPX mountant. This

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preparation method was in accordance with standard methods (Traverse 1988; Faegri and Iversen, 1989).

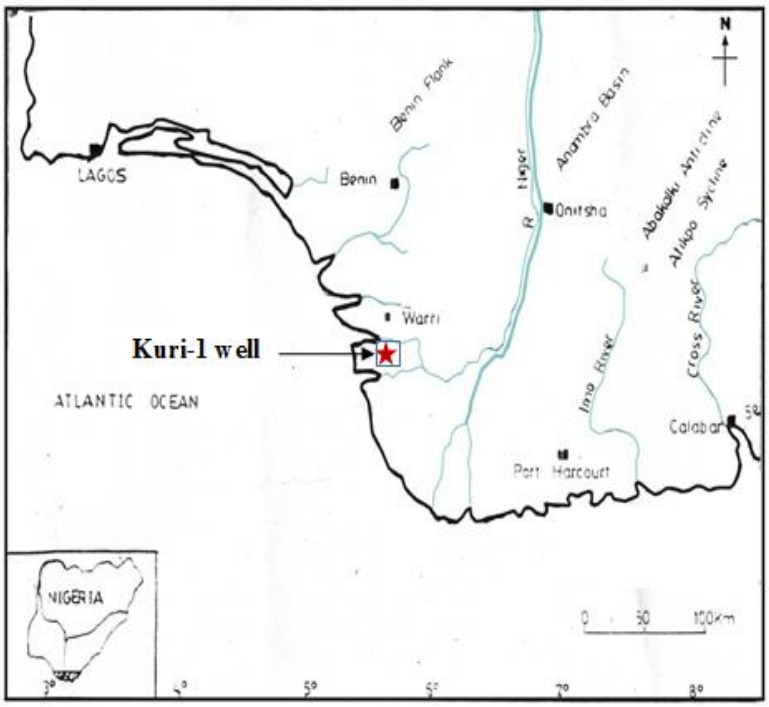
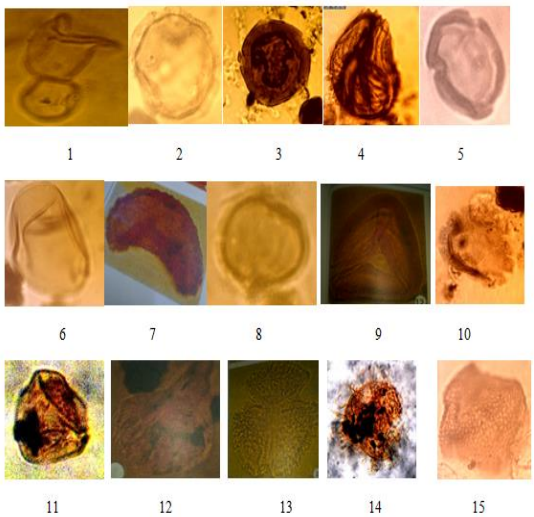


Figure 1. Location map of Kuri-1 Well western Niger delta Basin (Modified from Aturamu and Ojo, 2015)

Frequency count of pollen, spores, fungal spores, and other diagnostic marker species present were determined for each sample using a palynological microscope. All palynomorphs recovered were identified under the microscope and were recorded on a scale of 1:5000 using Stratabug biostratigraphic software. This was interpreted by comparison with established works. However, diagnostic species photomicrographs were taken with Nikon Coolpix P6000 digital camera (see plates 1and 2). The results obtained were used in delineating the various palynozones within the sedimentary sequence penetrated by the well as indicated by the index palynomorphs present. The different pollen and spores were identified by comparison with local palynological catalogues of Legoux (1978); Germeraad et al., (1968); Clarke and Frederickson (1968); Evamy et al., (1978); Salard-Cheboldaeff (1979, 1990).

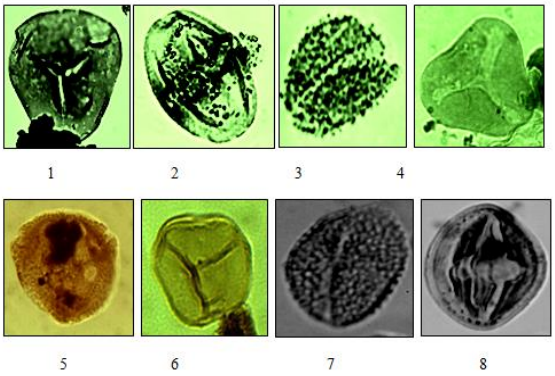
Plate 1



Magnification X800

1. Cyperaceaepollis spp. *2. Monoporites annulatus*
3. Pachydermites diederixi, *4. Magnastriatites howardi*
5. Zonocostites ramonae, *6. Laevigatosporites spp.*
7. Verrucatosporites spp. *8. Psilatricolporites crassus*
9. Pteris spp. *10. Retistephanocolpites gracilis*
11. Spore indeterminate *12. Botryococcus braunii*
13. Retitricolporites irregularis *14. Pollen indeterminate*
15. Longapertites spp.

Plate 2



Magnification X800

1. Acrostichum aureum
2. Sapotaceae
3. Racemonocolpites hians
4. Elaeis guineensis
5. Retribrevitricolporites protrudens
6. Stereisporites spp.
7. Retimonocolpites spp.
8. Psilatricolporites spp.

4. Results and Discussion

i. Lithologic Description

Lithologically, the well show is made up of alternating sand and shaly sandstone including appreciable silty particles. Glauconitic pellets are very rare with ferruginous materials and mica flakes present. The sand and silt particles are commonly brownish to grayish in colour. Texturally, they are coarse to fine grained, sometimes pebbly, angular to sub-angular indicating that the sediments were deposited close to the source. They also show poor to moderate sorting in some of the samples examined. The shaly sandstone on the other hand is commonly dark gray to black. They are generally medium to fine grained with very few feldspars and mica flakes in some samples. Based on sedimentological analysis; the interval study in Kuri-1 Well belongs to the Paralic Agbada Formation as indicated in figure 2 below.

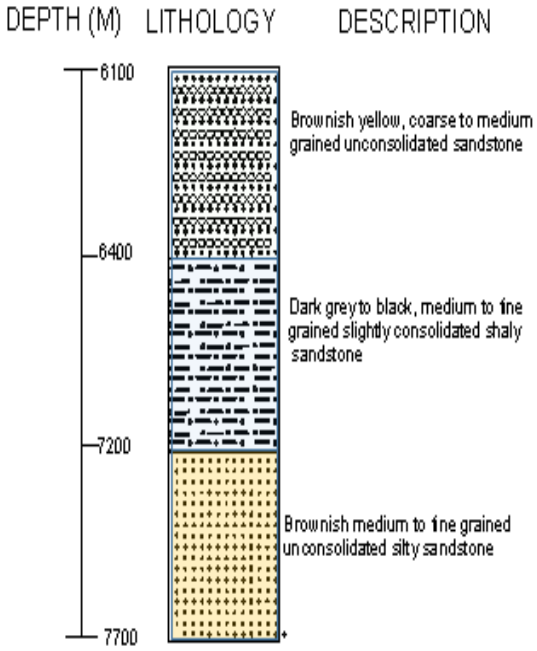


Figure 2. Lithologic description of Kuri-1 well, Niger Delta.

ii. Palynological Assemblage

Thirty (30) different species of palynomorphs were recorded in the fifty-two (52) ditch cutting samples obtained from Kuri-1Well. Among the palynomorphs recovered: were low quantities of land-derived sporomorphs with few fresh water algae. Except at depths 7344m and 7533m were no recorded palynomorphs, others contain at least one species of palynomorphs with varying frequencies. The samples are composed essentially of pollen, spores, fungal spores and algae.

The pollen identified within the studied section includes: *Monoporites annulatus, Zonocostites ramonae. Concentricystis spp., Retimonocolpites spp., Praedapollis flexibilis, Psilatricolporites crassus, Retibrevitricolporites potrudens, Retistephanocolpites*

gracilis. Sapotaceae, Retitricolporites irregularis. Pachydermites diederixi, Elaeis guineensis, Psilamonocolpites spp., Longapertites spp., Racemonocolpites hians, Psilatricolporites spp., Cyperaceaepollis spp.

While spores identified within the studied section include *Laevigatosporites spp., Verrucatosporites spp., Stereiosporites spp., Acrostichum aureum, Pteris spp., Mangnastriatites howardii, Selaginella myosorus*. The fresh water algae identified is only *Botryococcus braunii.* This is displayed in a chart as figure 3. Few shell fragments (broken gastropods and possibly foraminifera) were also encountered. Based on the recovered palynomorphs, the palynological assemblage of Kuri-1 well falls within the within the *Echitricolporites spinosus* zone of Germeraad et al (1968) and the P700 and P800 zones of Evamy et al (1978) with subzones of P780, P820 and P830 respectively.

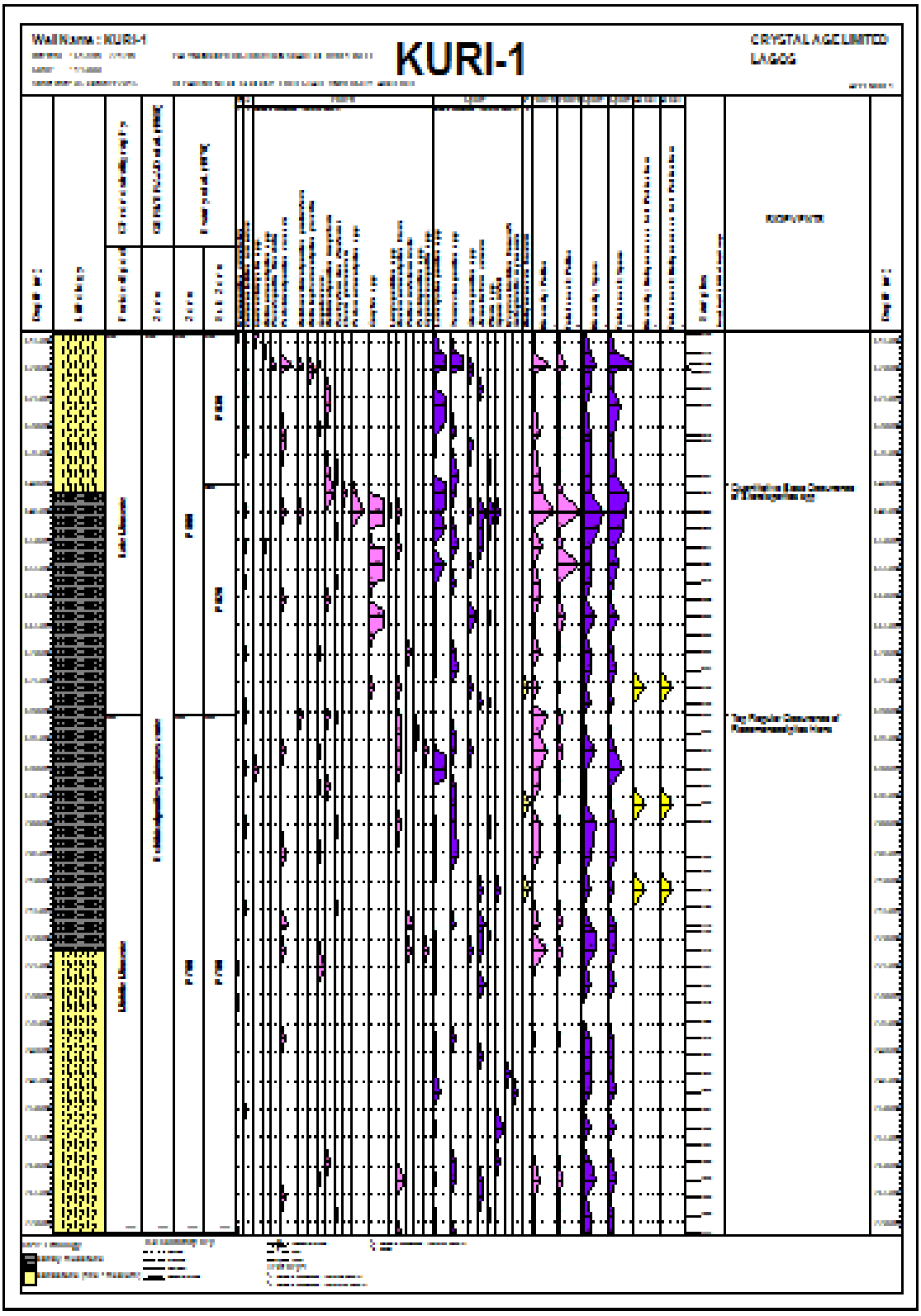


Figure 3. Chart showing the Distribution of Palynomorphs from Kuri-1 Well.

iii. Palynological Zones-: Zone: P700

Subzone: P780

The base of this subzone is placed at depth 7717m which marks the first appearance and the acme of the species *Racemonocolpites hians*, the base of this zone is undefined; it is assume to be the base of the studied interval and the top is placed at 6806m which marks its disappearance. Other diagnostic marker species include the abundance of *Laevigatosporites* spp., *Verrucatosporites* spp. and *Acrostichum aureum*. With fungal spores and algae in abundance. This subzone is dated Middle Miocene based on the first appearance and acme of *Racemonocolpites hians*.

Zone: P800

Subzone: P820

The base of this subzone is placed at 6806m which marks the disappearance of *Racemonocolpites hians* and by the first disappearance of *Stereisporites* spp with the top placed at 6400m.

This interval is characterized by the abundant occurrences of *Zonocostites ramonae, Retitricolporites irregularis, Pachydermites diederixi, Verrucatosporites* spp and *Laevigatosporites* spp with a very low percentage fungal and algae content. This zone is dated Late Miocene based on the first and last appearance of *Stereisporites* spp.

Subzone: P830

The base is placed at 6400m which is defined by the last appearance of *Stereisporites* spp with the top placed at 6138m which marks the beginning of the section. This thin interval is characterized by the abundance of some pollen such as *Zonocostites ramonae, Psilatricolporites crassus and Retitricolporites irregularis*. It also has low percentage fungal and algae content. The P830 subzone is dated Late Miocene based on the occurrence of *Stereisporites* spp. This is shown in figure 4.

Paleoenvironment of deposition

The depositional environments identified were based on the recovered flora assemblage, frequency and diversity at various depths. The presence of mangrove pollen and sporomorphs including *Zonocostites ramonae, Monoporites annulatus, Retitricolporites irregularis, Retimonocolporite* spp., *Verrucatosporites* spp. and *Sapothceaidaepollenites* spp. with few freshwater algae like *Botryococcus braunii* and the absence of dinoflagellates cysts is an indication of sedimentation in an environment which is permanently immersed at low and high tides which is possibly a littoral to neritic zone. The palynomorphs frequency percentage distribution shows that there are more pollen and spores than any other floral species in the palynomorphs sum in each of the identified zones. This means that the study section is largely composed of terrestrially derived miospores indicating that the source of organomaceral are plants and the environment of deposition is deduced to be littoral to inner neritic.

<table>
<tr><td rowspan="2">Depth(m)</td><td rowspan="2">Age</td><td rowspan="2">Germeraad et al., (1968)</td><td colspan="2">Evamy et al., (1978)</td><td rowspan="2">Marker species</td></tr>
<tr><td>Zone</td><td>Sub-zone</td></tr>
<tr><td>6138</td><td rowspan="3">Late Miocene</td><td rowspan="4">Echinotricolporites spinosus zone</td><td rowspan="3">P800</td><td>P830</td><td rowspan="3">First occurrence of Stereisporites spp.</td></tr>
<tr><td>6400</td><td rowspan="2">P820</td></tr>
<tr><td>6806</td></tr>
<tr><td></td><td rowspan="2">Middle Miocene</td><td>P700</td><td>P780</td><td>First occurrence and acme of Racemonocolpites hians</td></tr>
<tr><td>7717</td><td></td><td></td><td></td></tr>
</table>

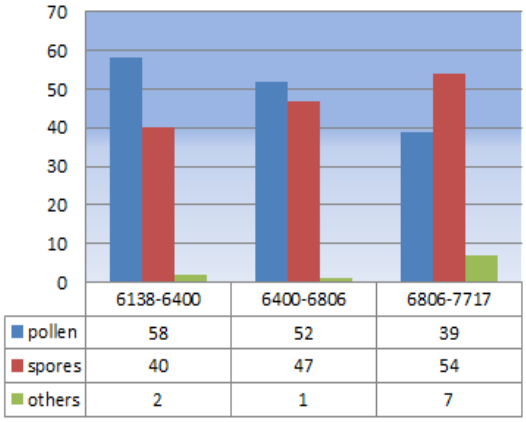
Table 4. Palynozones recognized in the studied Kuri-1 well, Niger Delta Basin.

Semi quantitative Analysis

This is based on the frequencies of occurrences of the pollens, spores and others as comparatively indicated on a comparative bar chart. The statistical data results is used to determine paleoenvironment of deposition and the effect of ecological changes.

Palynological investigation was carried out Kuri-1 Well samples located in the western Niger Delta Basin with the aim at determining the lithology, palynological zones, age and paleoenvironment of deposition of the study section. Sedimentological study of the indicated intervals showed that the well penetrated a paralic Agbada Formation in the Niger Delta Basin. The lithologic units identified were sandstone and shaly sandstones. Biostratigraphic zoning of the studied section was based on the presence of diagnostic floral that distinguished each zone/subzone. Abundance of land-derived palynomorphs were recovered with few freshwater algae. The paleoenvironment of deposition varies from littoral to inner neritic based on the abundance of terrestrially derived miospores. It was observed that there are more spores at shallow depths than at greater depths, this correlate

with that of Stainforth (1953) that states that spores of terrestrial plants are liable to occur in abundance in continental deposits. In lesser quantities they may occur in marine sediments, since they were subject to aeolian distribution. They are of value as climatological indices, at least within the geological range of Recent floras. This is indicated in figure 5.



	6138-6400	6400-6806	6806-7717
pollen	58	52	39
spores	40	47	54
others	2	1	7

Figure 5. Comparative Bar Chart of the percentage of Miospores in Kuri-1 well, Niger Delta.

5. Conclusions

A total of 23 miospores were identified out of 300 encountered. The palynological assemblage was dominated by pollen and spores. The studied sediments are of Middle Miocene-Late Miocene age based on the recovery of *Racemonocolpites hians* and *Stereisporites* spp. There is a downward decrease of pollens while that of spores is an upward increase except that for others which is not regular. The abundance of spores and pollens, which forms the bulk of the assemblage, suggests a terrestrially derived miospores. With the upward increase in spores, it suggests that spores of terrestrial plants are liable to occur in abundance in continental deposits. In lesser quantities they may occur in marine sediments, since they were subject to aeolian distribution. They are of value as climatological indices, at least within the geological range of Recent floras.

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