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QUANTITATIVE PALYNOFACIES AND PALEOECOLOGICAL INTERPRETATION OF SOME CORE SAMPLES FROM BONNY IN NIGER DELTA

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ABSTRACT: *Fifteen core samples were collected for palynofacies and pale environmental analyses in Bonny area, which provided a critical tool for understanding coastal swamp development and response to perturbations, such as sea-level rise and tropical storms, particularly in area like Bonny, where high rates of wetland loss threaten an ecologically and economically important ecosystem. Analysis of sediment cores from Bonny identify sediment deposition from storm surge and show that diatom assemblage of sediments are dissimilar from non-storm sediments and have the potential for examining the percentage distribution of palynomorphs. Lateral and vertical accretion rates showed a constant sedimentation and indicate that swamp rates of vertical distribution are generally higher than regional estimates of mean sea-level rise, despite recent hurricane deposition. Polymorphs from 15 samples located throughout the bonny area were examined to test the relationship between diatom assemblage and pale environmental parameters. Results showed that diatom assemblage was strongly influenced by salinity, but less strongly by water level, and organic matter. Analyses which partition the kerogen distribution indicate a significant overlap between diatom and organic matter, while water level explains a portion of diatom variability independent of the environment influence. OM was significant only for samples10-30cm, but demonstrates a possible problem for studies where samples are closer in proximity. The age of the well can be determined with the presence of some diagnostic palynomorph which in clued Aspitianodulifer, Thalassiosira ferelinate, Thalassiosiraoestriupii, Chactoceros, Nitzschiapaerenheildii and Actinocyculusundulotus, which is a diagnostic form of Miocene to Pliocene and their paleoenvionments ranges from coastal swamp to near shore marine environments.*

INTRODUCTION

Palynofacies, as defined by Combaz (1964), encompasses the total complement of acid-resistant organic matter recovered from a sediment or sedimentary rock by palynological processing techniques, using hydrochloric and hydrofluoric acid, as seen under a microscope. Powell,(1992)redefined the term as a distinctive assemblage of palynoclasts whose composition reflects a particular sedimentary environment. Palynofacies analysis involves the study of the preservation of particulate organic matter and palynomorphs, which provides information on the depositional environment of sediments and depositional pale environment of sedimentary rocks. The analysis was carried out on fifteen (15) ditch cutting samples cuttings retrieved from Bonny in the Niger Delta environment. The Niger delta is an oil province of Nigeria located on the West African continental margin popularly called the Gulf of guinea. During the past few decades, there has been an upsurge of interest in the way the composition of sedimentary organic matter (SOM) can be used to aid the interpretation of depositional environments as well as indicate the potential of a particular stratum as a generator of hydrocarbons. Palynofacies is a powerful tool when used in conjunction with geological and geophysical information, and can be employed by palynologists, organic petrographers or geochemists, depending on the degree of precision demanded, for both environmental and source potential assessments.

This work aimed at carrying out palynofacies, pale ecological, deducing the pale environmental reconstruction of the sediments based on diatom distribution analysis of samples obtained from Bonny.

GEOLOGY OF NIGER DELTA

The Niger Delta is situated on the Gulf of Guinea on the west coast of Central Africa (Figure 1.2). During the tertiary it built out into the Atlantic Ocean at the mouth of the Niger-Benue River System, and catchments area span about a million square kilometres of predominantly savannah-covered lowland (Merki, 1972). The Delta is one of the world's oil provenances with the sub-aerial portion covering about 75 000 km^2 and extending more than 300 km from apex to mouth (Figure 1.2), (Short, et al1967). The regressive wedge of clastic sediments which it comprises is thought to reach a maximum thickness of u 12 km (Murat, 1972). Accumulation of marine sediments in the basin probably commenced in Albian time, after the opening of the South Atlantic Ocean between Africa and South America Continent. True delta development, however started only in the Late Paleocene/ Eocene, when sediments began to build up beyond troughs between basement horst blocks at the northern flank of the present delta area (Ogbe, 1982).Since then, a delta plain prograded southward on to oceanic crust gradually assuming a convex to the sea morphology (Doust and Omatsola, 1990).

Throughout the geological history of the delta, its structure and stratigraphy have been controlled by the interplay between rate of sediments supply and subsidence (Murat, 1972). Important influences on sedimentation rate have been ecstatic sea level changes and climatic variations, initial basement morphology and differential sediment loading on unstable shale (Whiteman, 1982). The delta sequence is extensively affected by synsedimentary and post sedimentary normal faults, the most important of which can be traced over considerable distance along strike (Merki, 1972).

STRATIGRAPHY OF THE NIGER DELTA

The tertiary lithostratigraphic sequence of the Niger Delta consists in ascending order Akata, Agbada and Benin Formations (Fig 1.4), which make up an overall massive clastic sequence of about 30000-39000ft (9000- 12000m) thick (Evamy et al, 1978).

AKATA FORMATION

The basal major time-transgressive litho logical unit of the Niger Delta complex is the Akata Formation. It is composed mainly of marine shales but contains sandy and silty beds, which are thought to have been laid down as turbidites and continental slope channel fills above (Merki, 1972). The Akata Formation is characterized by a uniform shale development as evident in gamma ray and spontaneous potential logs (Merki, 1972). These pro-delta shales are grey to dark grey, medium-hard or soft at some places and sandy or silty. The shales are under-compacted and may contain lenses of abnormally high pressured siltstone or fine-grained sandstone (Merki, 1972). Furthermore, the Akata Formation is thought to be the main source for Niger Delta complex oil and gas. The Akata Formation may be continuous with the outcrops of the Imo Shale, but continuity between the two type sections which are of very different ages is not yet proved. The known age of the Akata Formation ranges from Eocene to Recent (Murat, 1972).

1.6.2: AGBADA FORMATION

The Agbada Formation is believed to be the hydrocarbon prospective sequence in the Niger Delta. It is represented by alteration of sands, silt and clays in various proportions and thicknesses, representing cyclic sequences of off lap units (Murat, 1972). These paralicclastics are the truly deltaic portion of the sequence and were deposited in a number of delta-front, delta-top set and fluvio-deltaic environments (Whiteman, 1982).The alternation of fine and coarse clastics provide multiple reservoir-seal couplets (Murat, 1972). As with the marine shale, the paralic sequence is present in all deponents, and ranges in ages from Eocene to Pleistocene (Merki, 1972). Most exploration wells in the Niger Delta have bottomed in this lithofacies, which reaches a maximum thickness of more than 3000m (Doust and Omatsola, 1990).

METHODOLOGY

Fifteen core samples samples were used for both palynological and sediment logical studies. Litho logic description of the samples was done by examining them under the binocular microscope by noting the textural characteristics such as color, grain size, shape (roundness), sorting, effect of ferruginization, and fossil content in terms of plant remains. Palynological slides were prepared by subjecting the samples to initial digestion by adding dilute hydrochloric acid into them in order to remove calcium carbonate (CaCO3) that might be present. This is followed by hydrofluoric acid (HF) digestion overnight for proper liberation of the organic macerals present in the samples. Recovered macerals from sieving with nylon sheet of 10μm in order to remove clay particles present is followed by oxidation, heavy liquid separation and mounting of the residue on glass slides with D. P. X. mountant, ready for palynological analysis. The method of preparation conforms to international standard. Taxa counts were made to determine the relative frequency of each species in each sample, after which the diagnostic species photographs were taken using Koolpix camera 6000 model.

RESULTS AND DISCUSSION

SEDIMENTOLOGICAL

Characteristics derived from the detailed description of the ditch cutting samples include litho logy, type of rock, texture and fauna content. (Figure 1)

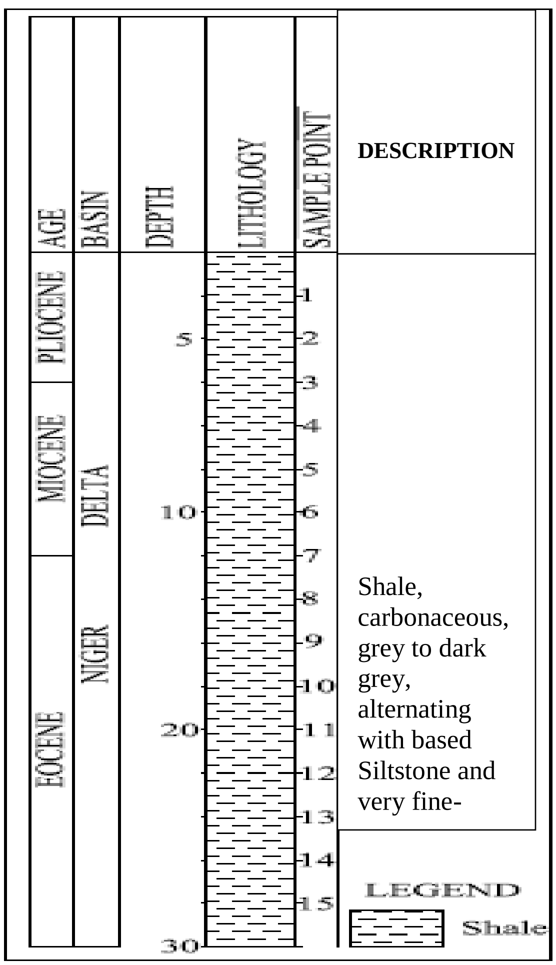

Figure1: Litho logy Description of the Study Area.

PALYNOFACIE INTERPRETATION

From the trend of the Palynofacie analysis that was carried out, it is obvious that from the sediment to extensive marine environment of the younger sediments yielded the data from figure 3.2. The analysis shows the percentages distribution of palynofacie.

From sample 1-3 with depth 2-6cm marks an increase in equidimensional black debris with a little decrease in equidimensional brown debris and also an increase abundant in micro fossils within these depths on large small scale, there was a little deposit of bladed black shape debris; the presence of organic matter helped in the pale environmental interpretation of the study area. The palynomorphs within these depth includes; *Nitzschiareinholdii*, *Thalassiosira eccentric*, *Azpeitianodulifer*, *Chaetoceros* and *Thalassiosiralineata* which is associated with pollen and spore; Cingulatisporites sp. The pollen and spore, in addition to the presence of abundant plant debris, probably indicate a swamp environment and the presence of fungal probably further confirm a swampy depositional environment.

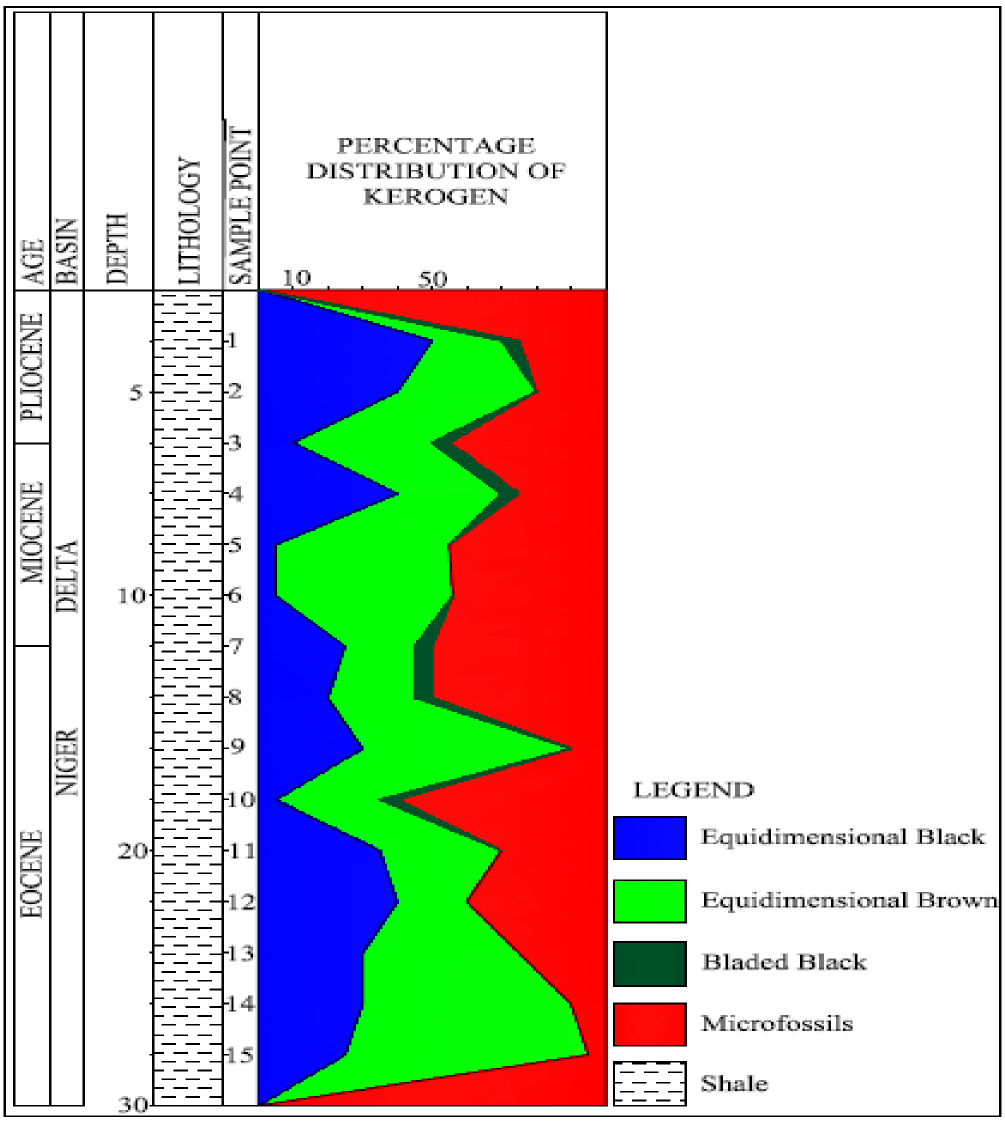

Figure 2: Percentage Distributions of Kerogen within the Study Area.

Sample 4-10 within depth 8-20cm show a decrease in equidimensional black debris with a little decrease in equidimensional brown debris and also an increase abundant in micro fossils within these depths on a very large small scale, there was a little fluctuation deposit of bladed black shape debris; the presence of organic matter helped in the pale environmental interpretation of the study area. There are presences of diatom in pollen and spore deposit which include; *Coscinodiscusradiates*, *Actinoptychussenarius*, *Thalassiosira lineate*, *Aspitianodulifer*, *Thalassiosiraferelinate*, *Thalassiosiraoestriupii*, and *Thalassiosira lentigonosa* which are associated with pollen and spore; *Cingulatisporitessp*, *Poropollentiessp* and *Trilete spore*. The pollen and spore, in addition to the presence of abundant plant debris, probably indicate a swamp environment and the presence of fungal probably further confirm a swampy depositional environment.

In sample 11-15 within the depth of 22-30cm marks an increase in equidimensional black debris up to sample point 13 but with a little decrease in equidimensional brown debris within sample point 11-12, and an increase in equidimensional brown debris from sample point 12-15, with abundant in micro fossils and also an absence of bladed black. The palynomorphs found within these depth includes; *Aspitianodulifer*, *Thalassiosira lineate, Aspitianodulifer, Thalassiosiraferelinate, Thalassiosiralentigonosa* and *Auliscussculptus* with the associated of pollen and spore which also include; *Aletepollenitessp* and *Retidiporites sp*. The pollen and spore, in addition to the presence of abundant plant debris, probably indicate a swamp environment and the presence of fungal probably further confirm a swampy depositional environment.

PALEOENVIRONMENTAL INTERPRETATION

The pale environmental and palynofacie history of bonny area are shown based on the diatom range chart diagram in fig 4.3 is associated with organic matter content, sedimentary texture and during this period, sedimentation occurred in a shallow estuarine environment, with strong hydrodynamic energy. The shale was subject to an intense erosive process, with substratum exposed to wave and tide actions, therefore unfavorable for colonization by herbaceous plants, as shown by the low and high OM contents observed in the fig 4.2 of the cores. This environmental condition was corroborated by the presence of the diatom species *Aspitianodulifer* and *Thalassiosira lineate*, which dominated the diatom assemblage showed in (Figure.4.2, 4.3 and 4.4). Garcia (2006) also reported as having an *Aspitianodulifer* and *Thalassiosira lineate* in Warangal Bay in South Brazil. The low richness of plank tonic diatom species and the low abundance was also observed within sample 4-10. The presence of fungal within this sample point probably further confirms a swamp depositional environment. This is probably due to the low resistance of the diatom valves to abrasion and dissolution with more hydrological energy. The presence of diatoms was observed in the entire core due a high permeability of shale deposit preventing the algal preservation (Vélez et al., 2001). The same situation was also observed within depth 26-30, with high shale content and low organic content, attributed to a high energy depositional environment (Vélez et al., 2005).It also showed that the sampling stations with the lowest numbers of organisms were those located near the area with substrate disturbance by wave action, and therefore, with more depositional energy. The shale sample showed a probably short event situated at 28-30 cm depth, representing a calm sedimentary environment, with minimum influence ofwaves and

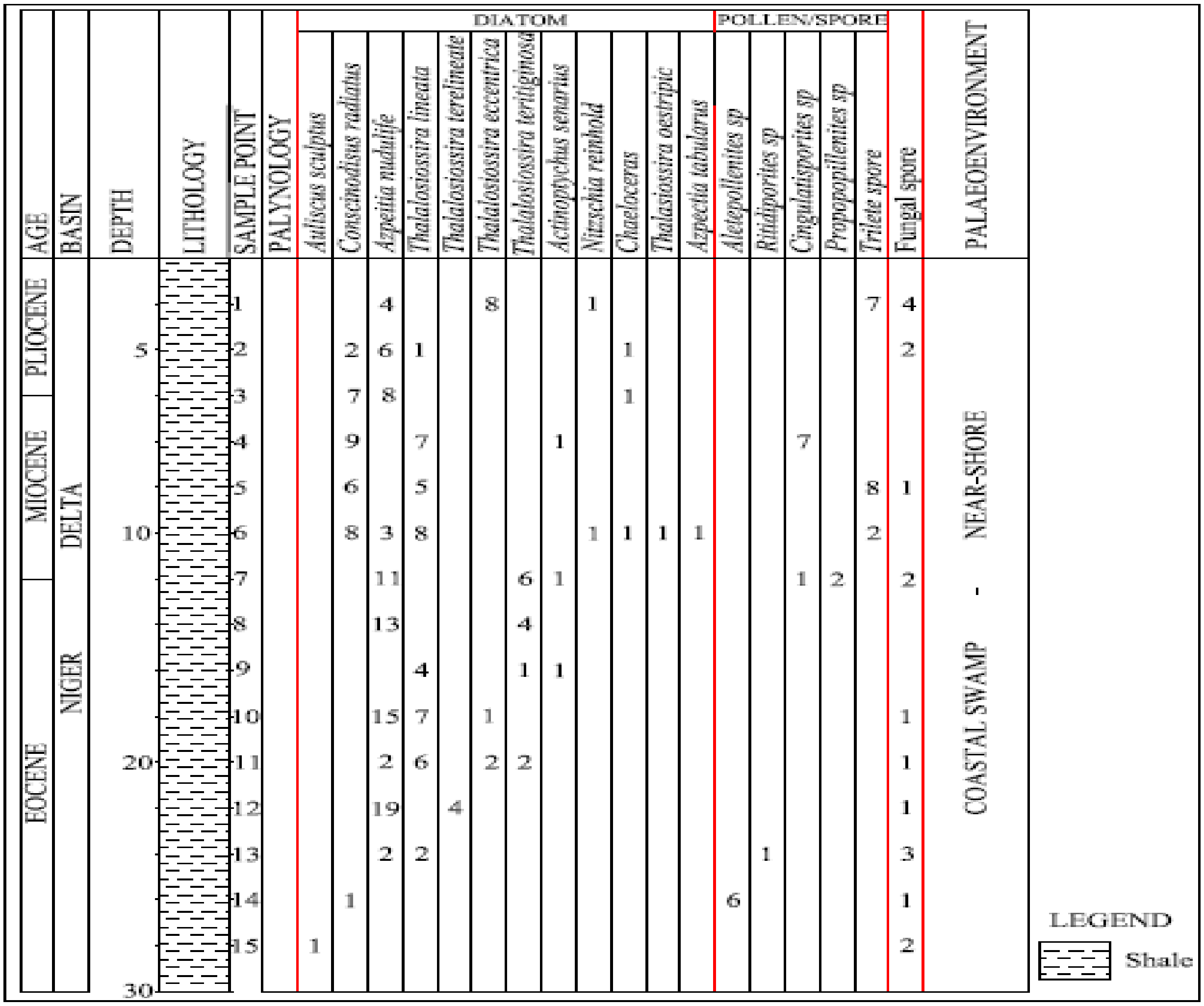

Figure 3: Percentage Distributions of Diatom, Pollen and Spore Assemblage within the Study Area.

Tides, evidenced by elevated abundance of the plank tonic species *Aspitianodulifer* in figure 3.4. Therefore, its abundance decreases (30-35%) in the dry season at the mouth of the coastal shore which flows into Bonny Beach (El - Robrini et al., 2006). Thus, only a depositional environment sufficiently calm could show conditions for the preservation of the large *Aspitianodulifer* diatom (44 to 128 µmdiameter), according to Navarro & Peribonio (1993), and with large available surface to abrasion and dissolution processes. In addition, this species showed high representation in recent sediments of bonny area (Ribeiro et al., 2008). The organic grey shale sediments occurred at sample which was present only in the core. The diatom assemblage was dominated by plank tonic species *Aspitianodulifer* and *Thalassiosira lineate*, indicating a calmer environment, with deeper water and relatively low hydrodynamic energy, which facilitated the preservation of these organisms. This indicated a local change of sedimentation environment in a probably protected area, which favored the intense sedimentation of shale material associated with higher OM contents, where plant remains (branches, roots and leaves) were associated with palynological data, indicating a probable mangrove forest associated with alluvial palm forest (Senna et al., 2007).

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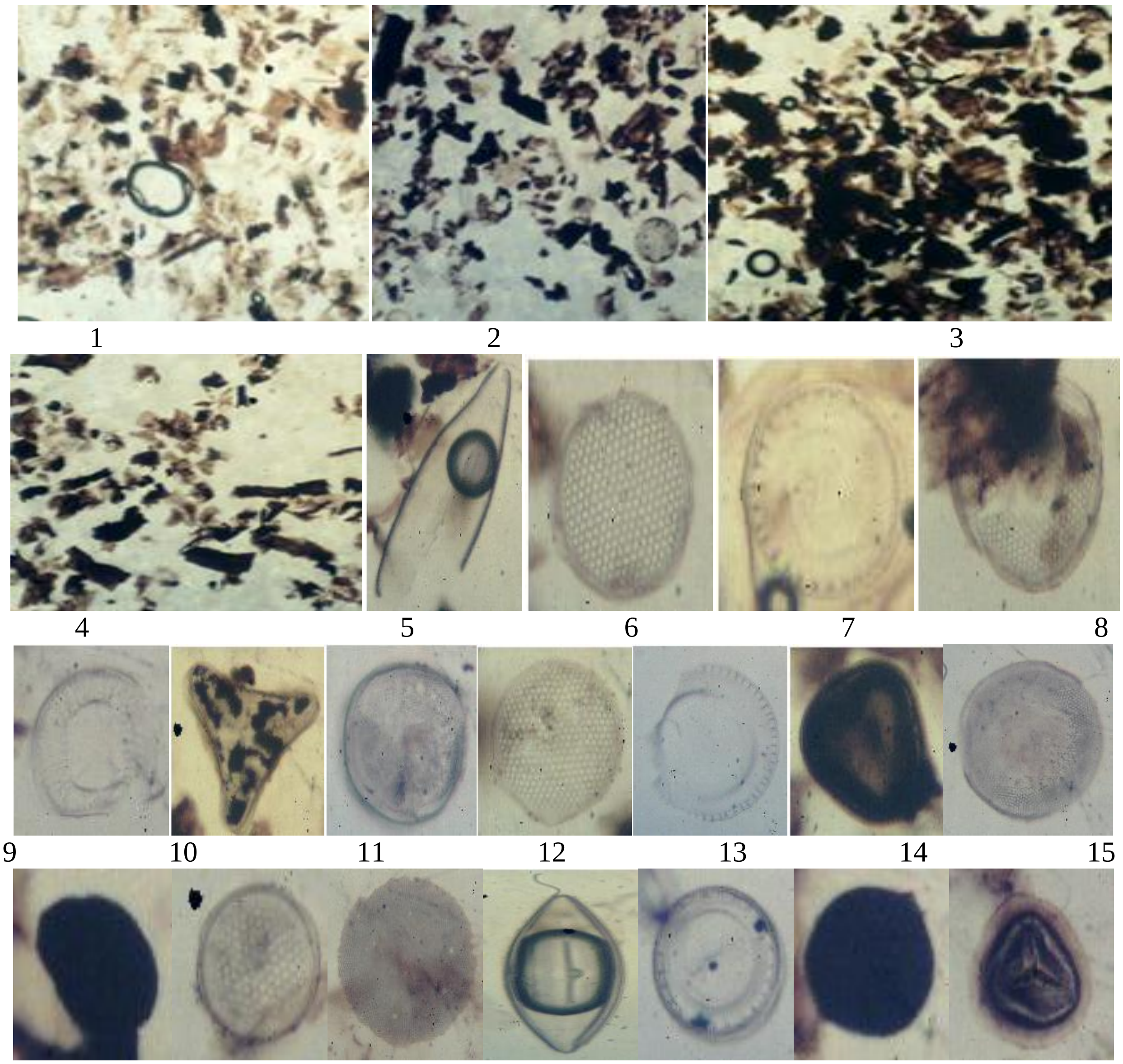
CONCLUSION

This study of palynofacies and their pale environmental record have a direct relationship with respect to vegetation and climate. The variation observed in the fifteen core sediments demonstrated changes in swamp dynamics, with strong implications on distribution and relative abundance of both plank tonic and benthic diatoms and on vertical and lateral variations of sedimentary environment. The study identified several taxonomy on which the pale environmental change in relative to climate and vegetation of the tertiary period were inferred to consist of unstable wet and dry climate regimes The age of the well can be determined with the presence of some diagnostic palynomorph which include *Aspitianodulifer*, *Thalassiosiraferelinate*, *Thalassiosiraoestriupii*, *Chactoceros*, *Nitzschiapaerenheildii* and *Actinocycu lusundulotus*, which is a diagnostic form of Miocene to Pliocene. These new environmental conditions contributed to the retention of organic shale sediments and favored the dominance of plank tonic diatom species, indicated by the good preservation of these organisms which generated different palynomorphs, such as pollen, spore and algae etc. And their paleoenvionments ranges from coastal swamp to near shore marine environments.

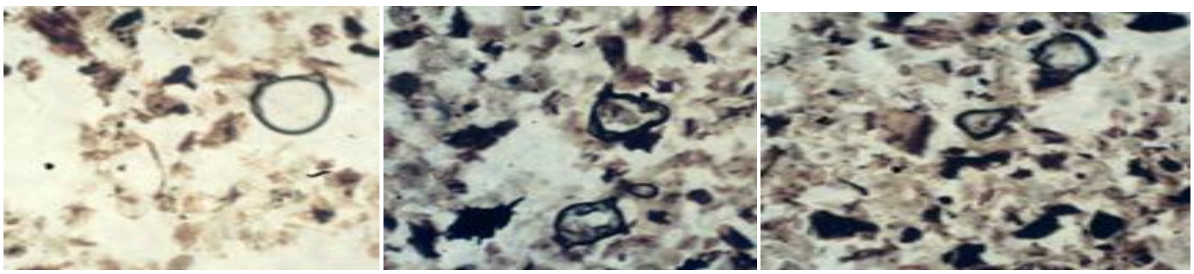
PLATE 1



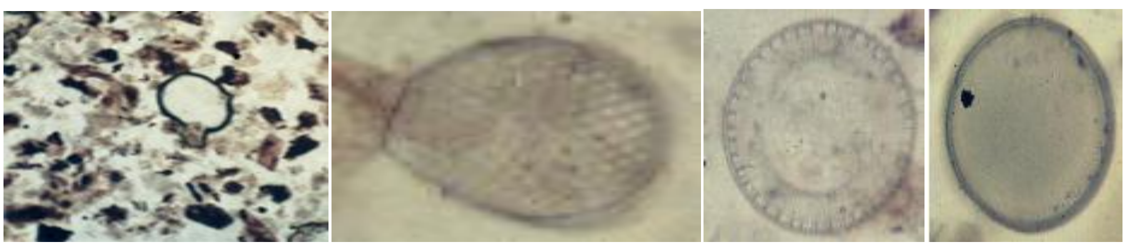
16 17 18 19 20 21 22

Fig 1-4 kerogen derived from the depth of 0-2cm from the core swamp samples in Bonny, location 2B.kerogen consists of 50% equidimensional black debris, 20% equidimensional brown debris, 5% bladed shape debris and 25% microfossils.

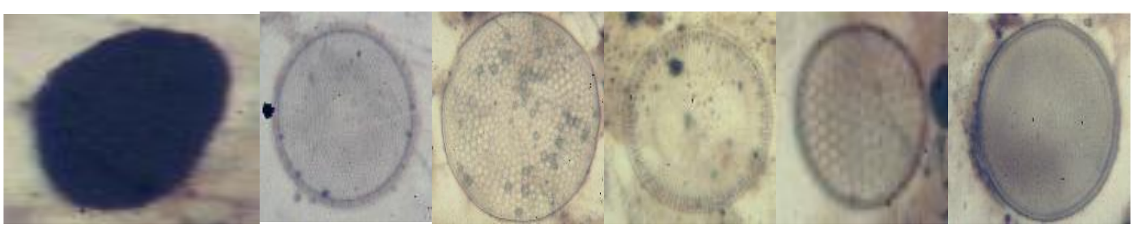
Fig 5-20 microfossils
5, Nitzschiareinholdii
6, 8, 12, 17, Thalassiosiraoccentrica
7, 9, 15, 13, 20, Azpectianodulifer
19, 16, 21, 14, Fungal spore
22, 10, Trilete spore
18 and 11, spore



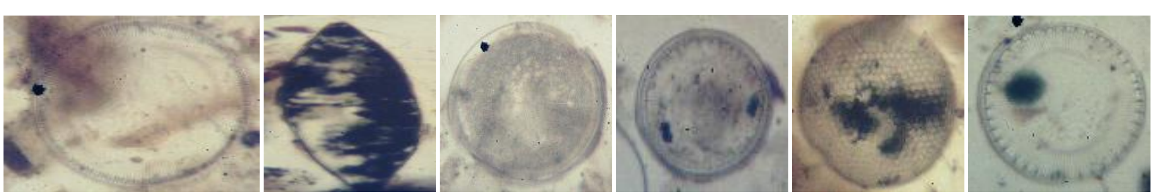
1 2 3



4 5 6 7



8 7 8 9 10 11



12 13 14 15 16 17

Fig 1-4 kerogen derived from the depth of 2-4cm from the core swamp samples in Bonny, location 2B.kerogen consists of 40% equidimensional black debris,40% equidimensional brown debris and 20% microfossils.

Fig 5-20 microfossils
5, 12, 18, 20, Coscinodiscusradiatus
7, 9, 13, 14, 16, 17, Azpectianodulifer
6, 19, 11, Chaetoceros
8, 15, Fungal spore
10, Thalassiosiralineata

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