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Palynological and Paleoclimatic Study of Late Miocene Epoch Sediments of Well-'W', Offshore Niger Delta, Nigeria

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Abstract— *Palynological analysis was carried out on well 'W' in Niger Delta provincial region. Sixty-one ditch cuttings were sampled at 20 m intervals. The aim was to reconstruct the paleoclimate utilizing the abundance and diversity of the analyzed miospores within the study area. The lithostratigraphic intervals composed of predominantly fine to medium grained sand with shale intercalation conformable to the paralic Agbada Formation. The samples were subjected to palynological laboratory process which involved the hydrofluoric acid maceration and the use of other acids and bases. The recovered palynomorphs were abundant and well diversified across the sampled intervals. One hundred and seventy (170) species were recovered including the key marker species, among them are: Retibrevitricolporites obodoensis, Echiperiporites estelae, Gemmamonoporites sp, Peregrinipollis nigericus, Crassoretitricolporites vanraadshooveni, Multiaerollites fomorsus, Stereisporites sp, Cyperaceoporites sp, Nympheapollis lotus, Podocarpus milanjianus, and Retistephanocolpites gracilis. Marine forms surch as Dinoflagellate cyst, Selenopimphix sp, Spiniferites sp, Polysphaeridium sp, and Lingulodinium sp. were also encountered. Using the diagnostic marker species such as Peregrinipollis nigericus and Stereisporites sp, the age of the interpreted stratigraphic intervals was assigned Late Miocene. The wet and dry trends which were based on the variations in climate and sea level changes were transcribed employing the dispersal of Zonocostites ramonea and Monoporites annulatus. The integration of terrestrial and marine forms revealed that the sediments were deposited in shallow marine environments.*

Keywords— *Lithology: Lithostratigraphy: Niger Delta: Paleoenvironment: Palynology: Stratigraphic zones.*

I. INTRODUCTION

The Niger Delta sedimentary basin where well 'W' is located (Fig.1) was initiated in the Early Tertiary times (Doust and Omatsola, 1990). It ranks amongst the most prominent and prolific petroleum producing deltas in the world and accounts for about 5% of the world's oil and gas reserves and about 2.5% of the present-day basin area on earth (Hooper *et al.,* 2002).
Geographically, the Niger Delta is located between longitude 5^0 and 8^0E and latitude 3^0 and 6^0N respectively. It occupies the Gulf of Guinea continental margin in equatorial West Africa. The Gulf of Guinea contains this basin, which has a total size of roughly 7,500 km2 and a maximum sediment thickness of 12,000 m. (Bustin, 1988; Burke, 1972). According to Reijers et al. (1997) research, the Niger Delta's sedimentary basin covers a far wider area than the present delta created by the Niger-Benue drainage system. This encompasses the delta of the Cross River and further stretches eastward onto the continental margins of the bordering sub-environments of Cameroon and Equatorial Guinea. A significant portion of the Niger Delta's sedimentary wedge is submerged and is a part of the complicated continental margin that is intruding into the Gulf of Guinea (Reijers, 1996). (Fig. 2).

I. STRATIGRAPHY OF THE NIGER DELTA REGION

During oil exploration and production, the stratigraphy of the Niger Delta's clastic wedge was documented. Most stratigraphic schemes remain restrictive to the major oil companies operating concessions in the Niger Delta Basin. Stratigraphic evolution of the Tertiary Niger Delta and underlying Cretaceous strata is described by Short and Stauble (1967). According to Evamy et al. (1978), Doust and Omatsola (1990), and Tuttle et al., (1988), the petroleum geology of the Niger Delta is outlined (1999). Based on sequence stratigraphic techniques, Stacher (1995) created a hydrocarbon habitat model for the Niger Delta. Allen, (1965) and Oomkens, (1974) described depositional environments, sedimentation and physiography of the modern Niger Delta.

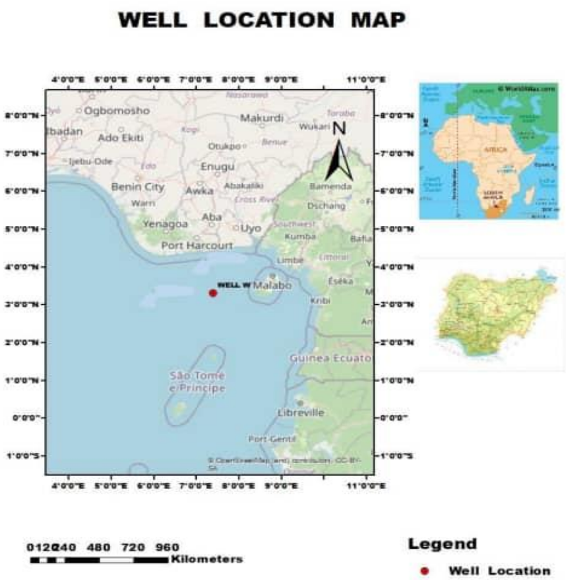

Fig. 1. Map of Niger Delta showing the studied well.

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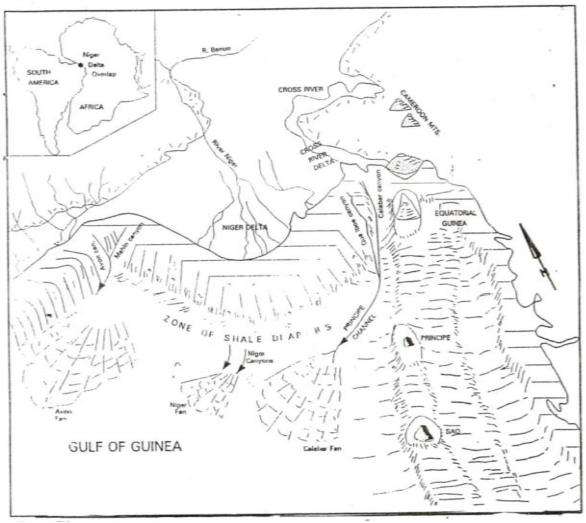

Fig. 2. Tectonic framework and the distribution of deep marine sediments in Gulf of Guinea

(After Benkhelil 1987).

The three major lithostratigraphic units defined in the subsurface of the Niger Delta are Akata, Agbada and Benin Formations (Fig 3). These lithostratigraphic units decrease in age basinward, reflecting the overall regression of depositional environments within the Niger Delta clastic wedge. Stratigraphic equivalent units to these three formations are exposed in southern Nigeria as documented by Short and Stauble, 1967. The formations reflect a gross coarsening upward progradational clastic wedge pattern (Short and Stauble, 1967), deposited in marine, deltaic and fluvial environments (Weber and Daukoru, 1975).

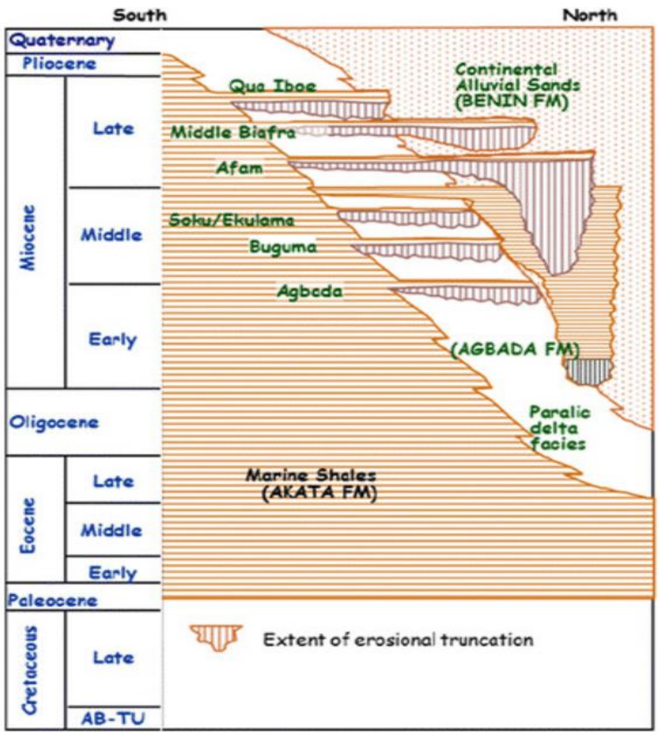

Fig. 3. Stratigraphy of the Niger Delta showing the formations (Source: Doust and Omatsola, 1990).

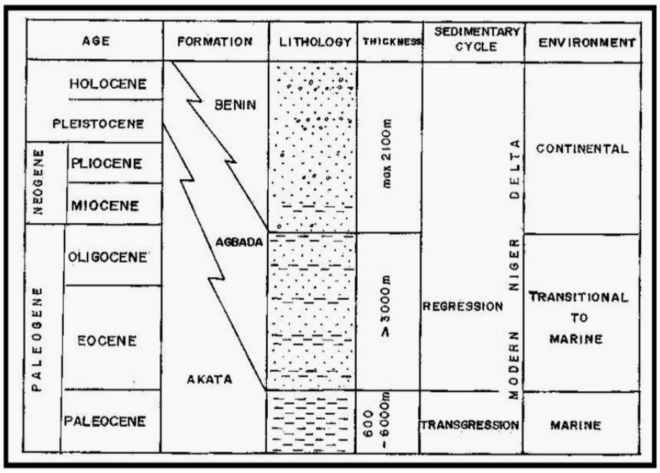

Fig. 4. Stratigraphic section of the Niger Delta adopted from Doust, 1990.

II. METHODOLOGY

Ditch cuttings samples were used for this laboratory processing. 25grams of each sample was weighed and disaggregated to increase the surface area. The samples were subjected to treatment with Hydrochloric acid (HCl) to remove the carbonates, then thoroughly washed with distilled water after decanting the HCl. Hydrofluoric acid (HF) was added to the samples to dissolve the silicates. The samples were stirred at regular intervals with a nickel rod and then left overnight in the fume cupboard then thoroughly disintegration, it was later washed with distilled water after decanting the Hydrofluoric acid (HF). The individual samples were then treated first with warm 36% HCl and then cold HCl to remove fluoride gels and then thoroughly washed with distilled water. The washed samples was treated with 0.5% HCl and were later transferred the into small 15cc. centrifuge tubes. The 0.5% HCl was decanted after centrifuging and the Zinc bromide (s.g. 2.2) was added. This step separates the dense mineral fraction from the light organic residue and concentrates the organic residue. The floating topmost part consisting of palynomorphs was then gently decanted into another test tube. A small quantity of glycerine jelly was put in the centre of clean slides and a small quantity of organic residue was added and warmed. The mixture was spread out evenly and covered with a cover slip and the slides were labelled. The slides were studied under a transmitted light microscope, and all palynomorphs assemblages encounterd were identified.

III. RESULTS AND DISCUSSIONS

Lithostratigraphy of Well -'W'

Sediments of the Well -'W' (interval 2220 – 3420m) penetrated the Agbada Formation. (Fig 5.) Agbada formation are made up of paralic development of sands and shales (with silt intercalation).

Biostratigraphy

The studied intervals of well-'W' (2220-3420 m) recovered abundance and well diversified palynomorphs. A total of one hundred and seventy (170) species were recovered.

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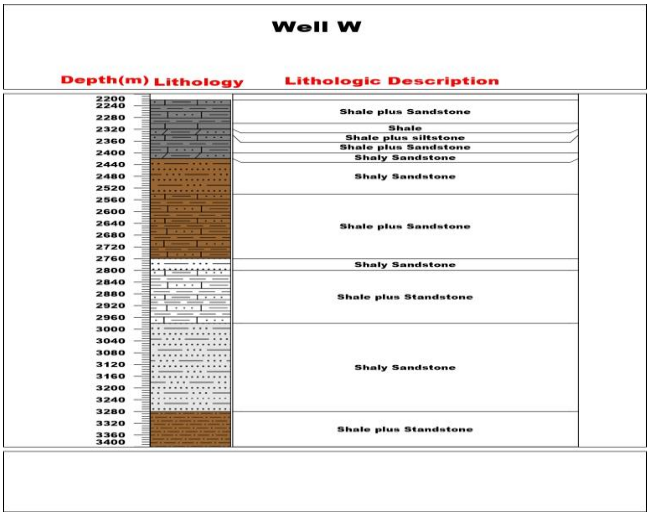

Fig. 5. Lithological Description of the well.

TABLE 1. Lithostratigraphic interpretation of the well

DEPTH (m)	LITHOLOGY	LITHOSTRATIGRAPHY
2220 – 2400	Predominantly shale/sand with intercalation of sandstone.	AGBADA FORMATION
2400 – 2720	Predominantly shale and sand intercalations.	
2720 – 2980	Predominantly shale and sand with silt intercalations.	
2980 – 3280	Predominantly shale/sand with silt intercalations.	
3280 – 3420	Predominantly sand/shale with silt intercalations.	

TABLE 2. Summary of Palynostratigraphic succession showing the zones.

Interval (m)	P zone	Age	Events
2220 – 2680	P850	Late Miocene	Quantitative top occurrence of *Peregrinipollis nigericus* at 2680 m.
2680 – 2940	P830 – P840		Quantitative base occurrence of *Stereisporites* sp. at 2940 m.
2940 – 3420	P820		The base of this subzone was not seen in this study.

These include forms such as Multiaerolites fomorsus, Cyperaceapollis spp, *Podocapites sp*, *Nympheapollis lotus*, *Monoporites annulatus*, *Zonocostites ramonae*, *Gemmamonoporites* spp, *Retibrevitricolporites obodoensis/protrudens*, *Cyperaceopollis* sp, *Echiperiporites estelae*, *Stereisporites* sp, *Retistephanocolpites gracilis*, *Striatricolpites catatumbus*, *Echiperisporites estelae*, *Pachidermites diederixi*, *Elaeise guineensis*, *Retitricolporites irregularis*, *Peregrinipollis nigericus*. *However, marine indicators such as Dinocyst indeterminate*, *Selenopemphix* spp, *Lingulodinium* sp, *Spiniferites* spp, *Polyspaeridium* spp and *Foraminiferal linings were also encountered with this interval* (Plate 1). The P850, P840-P830, and P820 subzones were dated Late Miocene age was assigned to this interval. The presence of marine environmental indicators probably indicates infiltration of marine water into the terrestrial swampy environment (Oloto, 2009).

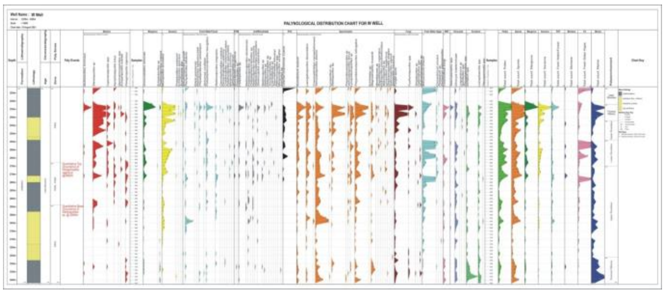
Fig. 6. Palynomorphs distribution chart of the well.

Paleoecology

Miospores abundance and diversity plot show a clear peak and trenches which seem visibly cyclic. The diversities of the miospores which occur in abundance are recorded in most of the samples. The Mangrove species dominated the section of sample no. 2 (2240 m), and there was a slight peak at sample no. 6 (2320 m). The dry period dominated by Savanna peaked is observed as being very high at sample no.7 (2340 m) with miospore diversities of 59 and continued till the section of sample no. 9 (2380) m. The trend swiftly followed by a wet period dominated by mangrove at sample no.10 (2400) m. Conversely, the dry period dominated by savanna at sample no.11 (2420 m) followed and wet period at sample no.12 (2440) while the dry period continued at sample no. 13 (2460 m) and continued till sample no.15 (2500). Wet period continued from sample no 16 (2520) to 17 (2540 m), followed by a dry period dominated by savanna from samples no. 18 (2560 m) to 23 (2660 m). Wet period again emerged and dominated by mangrove at sample no.23 (2680 m) to (2700 m) with a short period of dry climate which showed on sample no. 25 (2720 m). The mangrove elements continued dominating the intervals till (2920 m). However, Savanna species dominated a short period at 2940 m interval after which mangrove dominated sample no. 32 (2980 m) then there was a long period of dry climate dominated by savanna species from 2980 m to sample no. 40 at 3140 m. There was a long period of wet climate dominated by mangrove species from sample no. 41 at 3160 m to sample no. 55 (1540 m) T.D. The trending of increase in Mangrove and decrease Savanna was as a result of the variations between wet and dry climates within the Niger Delta region. (Morley 1995; Adojoh et al., 2017).

IV. SUMMARY/CONCLUSION

Sixty-one ditch cuttings retrieved from well-'W' were sampled at 20 m intervals from (2220-3420 m) and analysed in this study. The abundance and diversities of palynomorphs recovered were one hundred and seventy species (170) species. Based on the distribution and occurrence of marker species, two palynozones were established for this well; P850 and P830-

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P840 (*Peregrinipollis nigericus and Stereisporites sp*). The paleoenvironment of distribution of species were recorded with the highest observed diversity in the mangrove while the least was found in the montane setting. The encountered zones in this study were assigned Late Miocene age. The paleoenvironmental studies based on the abundance of miospores with respect to their depositional setting revealed that most of these species fall within the mangrove and the freshwater/algae.

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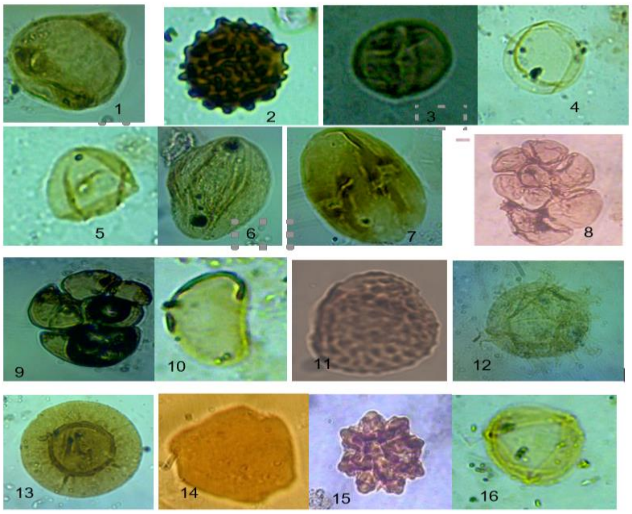

Fig. 7. PLATE 1. Photomicrograph of pollen and spores collections (X1000).

1. *Retibrevitricolporites obodoensi/protrudens* 8 &9. *Foraminiferal test lining*
2. *Aletesporites* sp 10. *Leavigatosporites* sp.
3. *Zonocostites ramonae* 11. *Verrucatosporites* sp.
4. 4 &16. *Nympheapollis clarus* 12. *Spiniferites* sp.
5. *Monoporites annulatus* 13. *Pterospermella* sp.
6. *Straitricolpites catatumbus* 14. *Psilatricolporites* sp.
7. *Sapotaceiodaepollenites* sp. 15. *Ctenolophonidites costatus*

REFERENCES

[1] O. Adojoh., M. Fabienne, R. Duller, Osterloff P., 2017. Tropical palaeovegetation dynamics, environmental and climate change impact from the low latitude Coastal Margin, Niger Delta, Gulf of Guinea during the Late Quaternary J. Paleoecol. Afr., 35 2017, pp. 107-144.

[2] J.R.L.Allen, 1965. Late Quaternary Niger Delta and adjacent areas: sedimentary environments and lithofacies. American Association of Petroleum Geologist. Bulletin, 49(5):547-600.

[3] J. Benkhelil, 1987, The Origin and evolution of Cretaceous Benue Trough, Nigeria. *Journal of African Earth Science.* 8: 251 – 282.

[4] E. Burke, 1972. Longshore drift submarine canyons and submarine fans in development of Niger Delta. American Association of Petroleum Geologists Bulletin, 56:1975-1983.

[5] R. M. Bustin, 1988. Sedimentology and characteristics of dispersed organic matter in tertiary Niger delta: origin of source rocks in a deltaic environment. Am. Assoc. Pet. Geol. Bull. 72, 277e298.

[6] H. Doust and E. Omotsola, 1990. Niger Delta. In: Edwards, J.D., Santogrossi, P.A. (Eds.), Divergent/Passive Margin Basins. American Association of Petroleum Geologists Memoir 48: 239–248.

[7] B.D. Evamy, J. Haremboure, and P. Kammeerling, 1978. Hydrocarbon Habitat of the Tertiary Niger Delta. APPG. Bull. 1 1- 39.

[8] R. J. Hooper, R. J. Fitzsimmons, N. Grant, and B. C. Vendeville, 2002, The role of deformation in controlling depositional patterns in the south-central Niger Delta, West Africa: Journal of Structural Geology. 24: 847 – 859.

[9] R.J. Morley, 1995. Tertiary stratigraphic palynology in Southeast Asia: Current statue and new directions. Geol. Soc. Malaysia, Bulletin. 1-36.

[10] R.J. Morley, and K. Richards 1993. Graminae cuticle: a key indicator of Late Cenozoic climatic change in the Niger Delta. Review of Palaeobotany and Palynology, 77:119-127.

[11] E. Oomkens, 1974. Lithofacies relations in Late Quaternary Niger Delta Complex: Sedimentology. Vol. 21, pp. 195-222.

[12] I.N. Oloto, 2009. Palynological and Sequence Stratigraphy, Case Study from Nigeria. First Ed. 2009, Pub by Legacy Integration Nig Ltd.

[13] T. J. A. Reijers, S. W. Petters, and C. S. Nwajide 1997. The Niger Delta Basin. In: Selley, R.C. (Ed.), African Basins. Elsevier, Amsterdam. p. 151–172.

[14] T.J.A Reijers., S.W. Petters and C.S. Nwajide, 1996, The Niger Delta Basin, in: T.J.A. Reijers (ed.), Selected Chapters on Geology: SPDC corporate reprographic services, Warri, Nigeria, pp. 103-114.

[15] P. Stacher, 1995, Present understanding of the Niger Delta hydrocarbon habitat. In: M. N. Oti and G. Postma (eds.), *Geology of Delta*. Balkema Publishers, Rotterdam. 257 – 267.

[16] K.C. Short, A.J. Stauble, 1967, Outline of geology of Niger Delta: American Association of Petroleum Geologist Bulletin, vol.51, no.5, pp.764-772.

[17] M. L. W. Tuttle, R. R. Charpentier, and M. E. Brownfield, 1999. The Niger Delta Petroleum System: Niger Delta Province, Nigeria, Cameroon, and Equatorial Guinea, Africa: USGS Open-file Report 99-50- H.

[18] K. J. Weber, and E.M. Daukoru, 1975. Petroleum geological aspects of the Niger Delta. Nig. Jour. Min. Geol., 12(1/2): 9-22.