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Microfloral Biozonation And Stratigraphic Correlation of Wells V, W And X In Mungo Field, Niger Delta Basin

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Abstract- Microfloral biozonation and stratigraphic correlation of Miocene-Pliocene sediments of wells V, W, and X were carried out. One hundred and eighty (180) ditch cuttings at 20 m depth intervals of (2740-4000m), (2220-3420m), and (460-1540m) from the Mungo Field were analysed for zoning, dating and correlating of stratigraphic intervals of the wells. The samples were subjected to standard palynological laboratory processes, which involved the maceration of samples with acids and bases to remove the drill muds. Lithologically, the samples consist predominantly fine to medium grained sand with shale intercalations which conformed to the paralic Agbada Formation. The recovery yielded low to moderate palynomorphs within the sampled intervals. A total of eight hundred (800) palynomorph species were retrieved from the wells. Four palynozones were established, which are: zones A: Nympheapollis clarus -Retistephanocolpites gracillis, zone B: Peregrinipollis nigericus - Retibrevitricolporites protrudens zone C: Stereisporites sp - Cyperaceopollis sp, and zone D: Multiareolites formosus – Monoporites annulatus. The stratigraphic intervals infiltrated Late Miocene - Early Pliocene age based on the recovered age diagnostic species such as Multiareolites formosus, Verrutricolporites rotundiporus, Crassoretitriletes vanraadshoveni and Racemonocolpites hians. The sequence stratigraphic interpretation probably points to the penetration of ?7.4/Me*Ma MFS - 2.7/Ge*1Ma MFS belonging to the Tortonian - Gelasian stages. The assessment of the wells showed that more palynomorphs were recovered from X well followed by V and W wells. The sediments of the wells deposited in a shallow marine environment within the upper to lower shoreface depositional environments.

Index Terms: Biozonation, Stratigraphy, Correlation, Niger Delta

I. INTRODUCTION

Biostratigraphy is the branch of stratigraphy which focuses on correlating and attributing relative ages to rock strata by using the fossil assemblages found within them. The basic purpose of biostratigraphy is correlation, establishing that a certain horizon in one geological section reflects the same period of time as another horizon at a different section (Fig 2). Fossils within these strata are valuable because sediments of the same age may look radically different, as a result of differences in the sedimentary environment. Basic notion of biostratigraphic principles were introduced several centuries earlier, as in the early 1800s. A Danish scholar and bishop by name Nicolas Steno was one of the first geologists to notice that rock strata is related to the Law of Superposition. Biostratigraphy includes three branches namely: Paleontology, Nannopaleontology and Palynology respectively. This study is focused on palynology, which is the science of palynomorph. Palynomorphs are defined as organic walled microfossils between 5 and 500mm in size, they are extracted from sedimentary rocks and sediments cores of samples by ultrasonic treatment, wet sieving, and chemically by chemical digestion to liberate the non-organic fraction, general term for all entities found in palynological preparation (eg, pollen, spores, and dinoflagellate cysts, etc). Dinoflagellates have a convoluted life cycle in which the planktonic, motile cell can transform into a cyst (encystment) that lies dormant on the ocean floor during times of adversity, such the winter (Evitt, 1985). During incubation, dinoflagellates can stay dormant in this cyst for decades (Ribeiro et al., 2011). As environmental circumstances improve, the dinoflagellate cell is able to break out of the cyst via an opening (the archaeopyle) and resume swimming (excystment). After the cyst has been emptied, it sinks to the ocean floor. Only around 10–20% of current dinoflagellate species are known to encyst after sexual

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reproduction, despite the fact that practically all fossil dinoflagellates are preserved as cysts (Evitt, 1985). Over 4,400 different types of dinocyst fossils have been discovered so far (Williams et al., 2017). Dinoflagellates are one of the main areas of research for palynologists, and for good reason: they are incredibly abundant and diverse in the more recent fossil record (Evitt, 1985), making them ideal for elucidating the ebb and flow of the oceans over the Mesozoic and Cenozoic (Fensome et al., 1996).

Due to their sensitivity to changes in water temperature, salinity, and depth, dinoflagellate cysts are also useful as paleoenvironmental markers (Stover et al., 1996 and Okereke et al,.2022). One common indicator of productivity and/or nutrient availability in surface waters is the abundance ratio of two main dinoflagellates taxa, Gonyaulacaceae and Peridiniaceae (Sluijs et al., 2005).

The aim of this work is to carry out the biozonation and correlation of the ditch cuttings from V,W, and X wells in order to correlate and establish the palynological zonation and paleoenvironment of deposition of the strata infilterated by the well within the Intervals of (2740-4000m), (2220-3420m), and (460-1540m).

Location of Study Area

The study wells V, W, and X are located in the Mungu Field Niger Delta Basin Nigeria (Fig. 1). It lies between longitude 8^0 0' 0'' N, 1^0 0' 0'' S and Latitudes 4^0 0' 0'' E. The successive phases of developments exhibited by the Cenozoic Niger Delta Basin have been referred to as depositional belts or depobelts (Doust and Omatsola, 1990; Reijers et al., 1996).

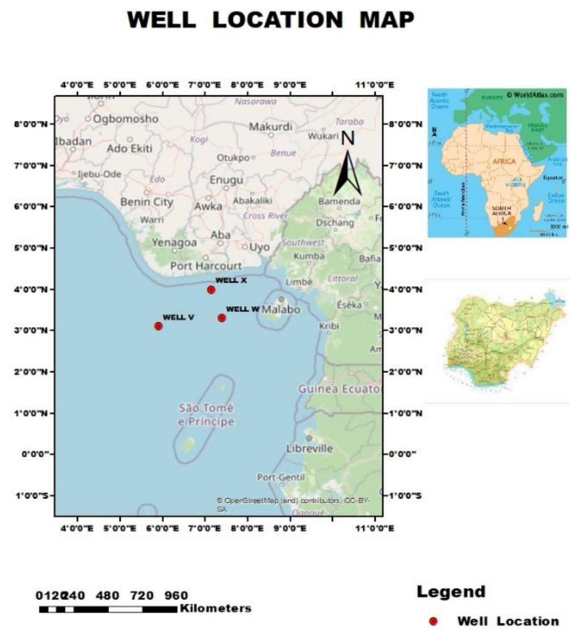

Fig 1: Location map of the study area.

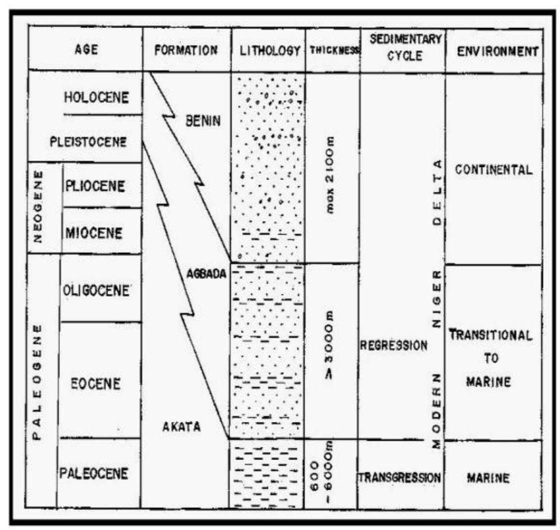

Fig. 2: Correlation of subsurface and surface formations of the Niger Delta (Source:Doust and Omatsola,1990).

II. LITHOSTRATIGRAPHY OF NIGER DELTA

Deposits in the Tertiary Niger Delta occurred in three distinct sequences, as evidenced by well sections drilled vertically within these settings. It has been stated that the lithostratigraphic units in the Niger Delta are very diachronous (Fig.3) (Stacher, 1995). Many employees and international corporations that have done work in this region have documented the primary lithostratigraphic sequences or units found within the Niger Delta formation, and they include the Benin Formation, the Agbada Formation, and the Akata Formation (Fig. 4). The sand, shale, silt, and/or sandstone facies equivalents that were intercalated within these formations are typical of delta plain, delta front, and prodelta settings.

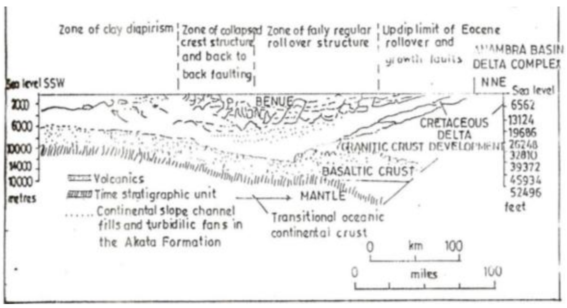

Fig. 3: Lithostratigraphic unit and Tectonic Elements in the Niger Delta (Weber and Daukoru 1975).

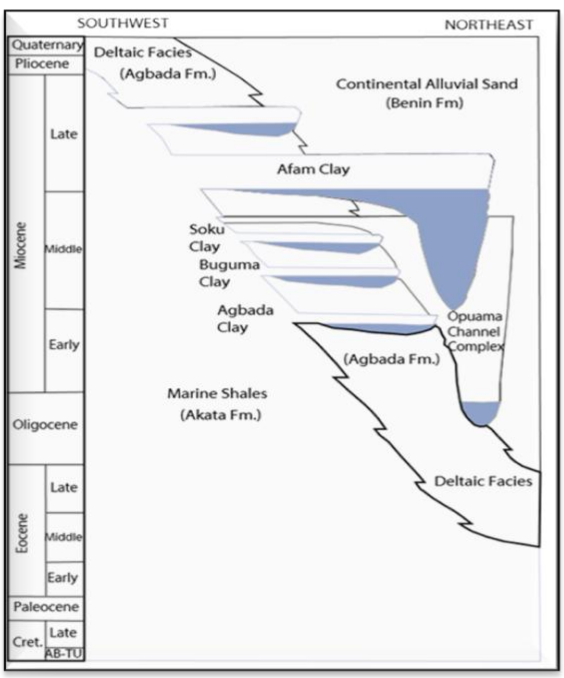

Fig. 4: Stratigraphic column showing the three Formations of the Niger Delta (Doust and Omatsola, 1990).

III. MATERIALS AND METHODS

Ditch cuttings was used following the standard acid palynological preparation method.

The standard acid palynological preparation method of Armstrong and Brasier (2005) was adopted. One hundred and eighty ditch cuttings were analyzed, 25 grams of each sample was treated with 10% HCl under a fume cupboard for the complete removal of carbonates present in the samples.

Each sample was prepared by weighing 25 grams on a scale and soaked, Hydrochloric acid (HCl) was added to dissolve carbonates from the samples, and then the HCl was decanted and the samples were thoroughly washed in distilled water. Hydrofluoric acid (HF) is then added to the samples to dissolve the silicates, the following step in the process. After decanting the HF, the samples are carefully cleaned with distilled water and then permitted to rest in the fume closet for an entire day while being agitated at regular intervals with a nickel rod. Following a thorough washing in distilled water, the samples are treated with warm 36% HCl to dissolve the fluoride gels, followed by cold HCl to precipitate them out. The samples were then transferred to 15 cc centrifuge tubes after being rinsed with 0.5% HCl. After centrifuging the 0.5% HCl, the Zinc bromide (s. g. 2.2) was added and well mixed with a glass rod before being reintroduced to the mixture. Once centrifuged, the organic material that floats to the top is carefully decanted into a new tube and given a thorough washing in distilled water. The organic waste was then poured into porcelain basins and very slowly and carefully treated with strong nitric acid (HNO3). After warming for a few minutes, it was swirled well with a glass rod. The Nitric acid was decanted, and the centrifuged residue was washed in distilled water.

After centrifuging and removing the KOH, warm Potassium hydroxide (KOH) was added to the residues and let to sit for about 5 minutes. In order to remove any remaining KOH, the residue was rinsed with distilled water a few times. A last two alcohol washes removed all traces of the scum.

Preparation of Microscopic Slides:

Small amounts of glycerine jelly and organic waste are combined and warmed in the center of clean microscope slides. After spreading the liquid

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uniformly and covering it with a cover slip, the slide was correctly labeled with the well's name and depth.

IV. RESULTS AND DISCUSSION

The results of the analysis of ditch cuttings obtained from wells V,W, and X. samples were analyzed at 20 m intervals. A total of sixty four (64) samples were analyzed for well V sixty one (61) for well W and fifty five (55) for well X respectively.

Lithostratigraphy of the Wells

The sediments of wells V and W infilterated the Agbada Formation while well X infiltrated both Benin and Agbada Formation as observed from the lithology (Fig. 4.1, 4.2 and 4.3). Agbada Formation is made up of paralic development of sands and shales with silt intercalations, while Benin Formation is Predominantly sand and shale with intercalation of sandstone. From the observation and inference drawn, the sediments revealed that the deposits are characterized by fine to coarse grained sands, shales and silt/siltstones intercalations.

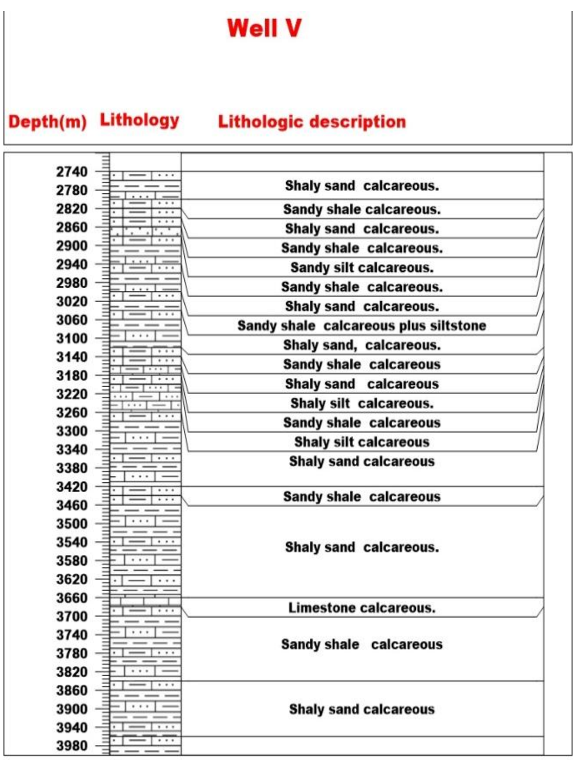

Fig. 4.1: Lithologic decription of well V

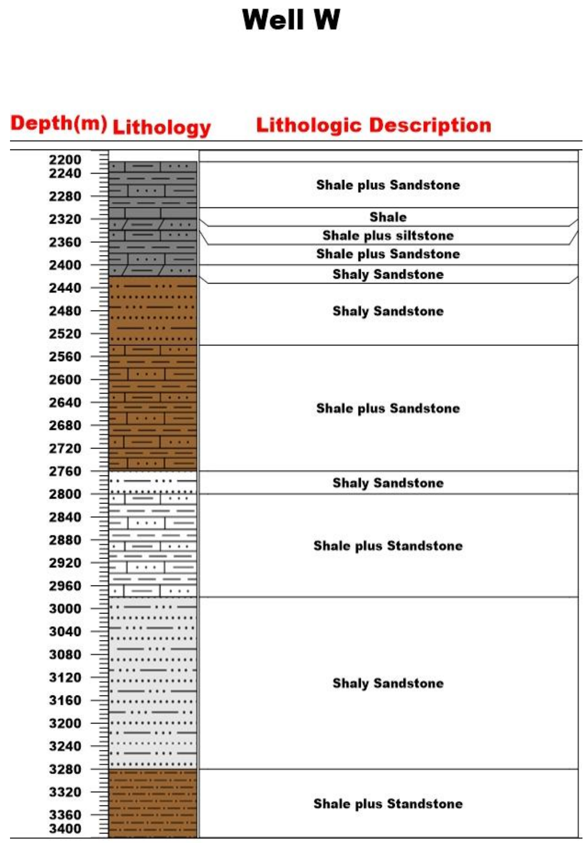

Fig. 4.2 Lithological Description of well W

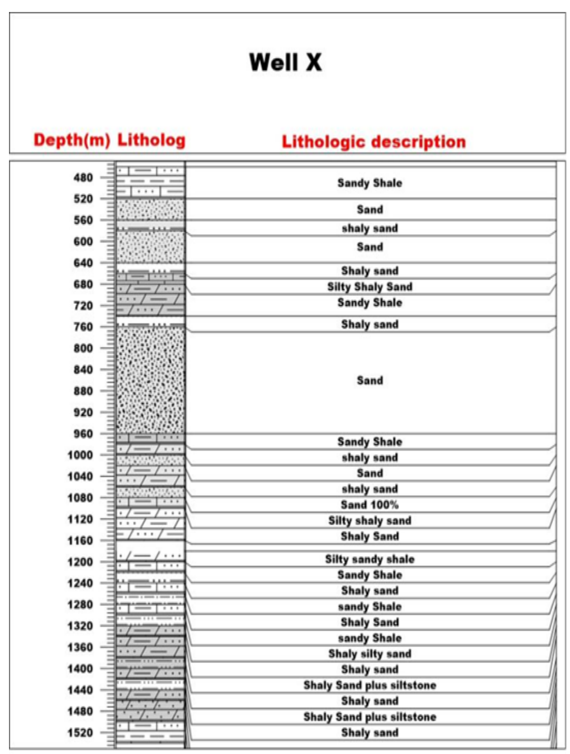

Fig. 4.3 Lithological Description of well X

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Biozonation of Wells V, W, and X

Zonation scheme of Germaraad et al, (1968) and Evamy et al, (1978) was adopted for this study. A total of four palynological subzones (Nympheapollis clarus -Retistephanocolpites gracillis, Peregrinipollis nigericus - Retibrevitricolporites protrudens, Stereisporites sp - Cyperaceopollis sp)

were defined using diagnostic maker species and they are equivalent to P860, P850, P830-P840 and P820 subzones of Evamy et al., (1978).

Assemblage Zones: A zone is an officially recognized division of the geological record defined by the presence of a certain group of indicator fossils. The presence of a single species defines certain areas, whereas the presence of many species serves to differentiate others. Species that are typical of a region are often used as the basis for the zone's name. One or more of these fossils is the inspiration for the name. These elements are the foundation for identifying assembly zones:

First Appearance Datum (FDO) and Last Appearance Datum (LDO) assemblage zones may represent ecological facies, age, or both based on variations in fossil taxa, number of specimens, or both. The zones established were Nympheapollis clarus– and Stereisporites sp– Peregrinipollis nigericus

Zone A

Nympheapollis clarus -Retistephanocolpites gracillis

Stratigraphic interval: 740 -3200 m

Definition: The top of the zone is defined by the first downhole occurrence (FDO) of Nympheapollis clarus at 740 m while the base is marked by the last downhole

Quantitative baseline occurrence of Nymphaeapollis lotus at 3200 m. Since Retistephanocolpites gracillis was not seen, the top of this subzone was not define during our investigation. 740 m was picked as the base since that's where the greatest number of Nympheapollis clarus was found.

Characteristics: The assemblages of palynomorphs taxa that characterize this zone include Absence of Retistephanocolpites gracillis, high percentage of Stereisporites sp and Nymphaeapollis clarus, fairly rich occurrences of Monoporites annulatus and Aletesporite sp, and low occurrences of Elaeis guineensis and Multiaerollites formosus all lend credence to the existence of the zone within this well interval.

Age: The zone is dated Early Pliocene because of the presence of Nympheapollis clarus.

Remark: The zone is equivalent to P860 subzone of Evamy et al. (1978) This is because the age diagnostic species such as Nympheapollis clarus used in erecting the

zone are contained in the zone of the afore mentioned authors.

Zone B

Peregrinipollis nigericus - Retibrevitricolporites protrudens

Stratigraphic Interval: 3200 m – 3400 m

Definition: The base of the zone is defined by the First Downhole Occurrence (FDO) of Peregrinipollis nigericus at 3200 m, while the top is marked by the Last Downhole Occurrence (LDO) of Retibrevitricolporites protrudens at 3400 m.

Characteristics: The assemblages of diagnostic marker species that characterized this zone include: Elaeis guineensis, Acrostichum aureum, Zonocostites ramonae, Laevigatosporites sp., Peregrinipollis nigericus, Verrucatosprites sp, Retibrevitricolporites protrudens and Praedapollis flexibillis. More species occurring within the zone are Botryococcus braunii, and Psilatricolporites sp.

Age: The age of this zone is Late Miocene (Tortonian – Messinian) based on the influence of the following diagnostic species: Peregrinipollis nigericus, Retibrevitricolporites protrudens, Echitricolporites spinosus, and Verrucatosprites sp.

Remark: This zone is equivalent to P850 subzone of Evamy et al. (1978).

Zone C:

Stereisporites sp - Cyperaceopollis sp

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Stratigraphic Interval 3400-4000 m

The top of the zone is defined by the first downhole occurrence (FDO) of Stereisporites sp at 3400 m while the base is marked by the last downhole (LDO)

Quantitative base occurrence of Steiresporites sp at 4000 m

Definition: Quantitatively highest incidence of Steiresporites sp at 3400m defines interval. Stereisporites sp. occurs continuously at a base altitude of 4000 m. However, the presence of Cyperaceopollis sp on a quantitative base that would have allowed the subzone border delineation was not seen during this time frame. This is the time period where the two subzones were made composite. The highest quantitative occurrence of Stereisporites sp at 3400 m and the bottom continuous occurrence of Stereisporites sp at 4000 m define the upper and lower limits of the composite subzones, respectively. Characteristics are the presence of Crassoretitriletes vanraadshooveni, a rich occurrence of Monoporites annulatus, a high occurrence of Pereginipollis nigericus, and the presence of Adenantherites simplex, corresponding with the P830 and P840 subzones of Evamy et al., (1978).

Zone D

Multiareolites formosus – Monoporites annulatus Zone

Stratigraphic Interval 460 - 1540m

Definition: The top of the zone is defined by the first downhole occurrence (FDO) of Stereisporites sp while the base was not encountered

Characteristics: The assemblages of diagnostic marker species that characterized this zone include: Due to lack of documented quantifiable base occurrences of Multiaerolites formosus and Echiperiporites estelae inside the well's interval, the base was not encountered in this study. The existence of the P820 subzone inside this interval of the well is further supported by the presence of Alchornea cordifolia, Polyadopollenites vancampori, and the extremely infrequent occurrence of Crototricolporites crotonoisculptus. The zone is equivalent to P820 subzone of Evamy et al., 1978.

Age: The zone is dated late Miocene.

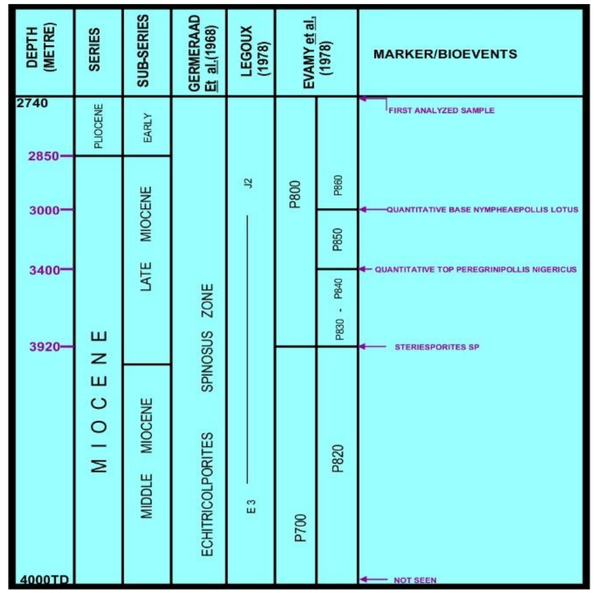

Fig. 4.4: Palynozones recognized in Well (Source: This study)

Correlation of wells

Stratigraphic unit equivalence may be demonstrated from one region to another by means of a well-correlation study. It also demonstrates how fossils and faunal succession may be used to establish that sedimentary rocks from different regions can be chronologically compared. Similar fossil assemblages in different sedimentary layers are used to infer an age of the layers. According to the stratigraphic units, the layers of sediment in well X do not correspond to those in wells V and W fig.(4.5)

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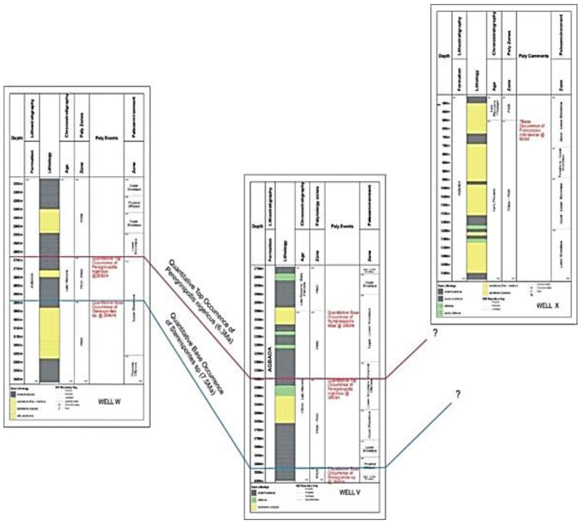

Fig. 4.4: Wells V W and X Correlation

Environments of deposition

Dinoflagellates combination with pollen and spores from land were useful in identifying the various ecosystems that had been reached at various depths by the various wells. Coastal deltaic (nearshore) and deep marine depositional habitats were also represented. Pollen and spores predominated in shallow habitats. For the Middle to Late Miocene sections of the V,W and X wells in the swamp region inferred environments which agree with (Oboh and Salami, 1989, Oboh et al., 1992) who suggested a mixture of coastal plain and swamp and coastal deltaic (nearshore) depositional environments based on pollen and spores associations. But the neritic dinoflagellate cysts Selenopimphix sp. and Dinocyst indeterminatus were documented in the most notable marine intervals. Oboh et al., (2001) and (Head (1998).

CONCLUSION

One hundred and eighty ditch cuttings retrieved from three wells V, W, and X fromY-field deep offshore Niger Delta, from 2740-4000 m, 2220-3420 m and 460-1540 m at 20 m intervals were analysed for this study. The recovery yielded low to moderate and high preservation within the sampled intervals. The total number of palynomorphs recovered for well V was two hundred and sixty (260) species, for well W, one hundred and seventy (170) species and for well X was three hundred and seventy (370) species, making it a total of eight hundred species for the three wells. Based on the distribution and occurrences of maker species four (4) palynozones were established they include:

Zone A: Nympheapollis clarus -Retistephanocolpites gracillis

Zone B: Peregrinipollis nigericus - Retibrevitricolporites protrudens

Zone C: Stereisporites sp - Cyperaceopollis sp

Zone D: Multiareolites formosus – Monoporites annulatus

Remark: The top of zone A and the base of D were not encountered in the study.

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