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Foraminiferal Biostratigraphy of Well Z, OPL 310, Offshore Dahomey Basin, South-Western Nigeria

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Abstract
The sedimentary succession penetrated by the Well Z, OPL 310 Dahomey basin, South western Nigeria has been investigated for their microfaunal content. A total of fifty ditch cutting samples from the well were processed and analysed for foraminifera following the standard procedures. The result of the analysis revealed moderately rich and diverse macrofauna totalling a hundred and seven (107) species out of which sixty-five (65) are benthonic and forty-two (42) are planktonic foraminifera species**.** The sedimentological analysis of the samples revealed two (2) sedimentary sequences: a basal sandstone unit characteristically milky white, coarse to pebbly, sub-angular and poorly sorted with alternation of marine shale overlain by a dark grey, non-fissile shale wih glauconite pellets and mica flakes alternating with sandstone which shows that sediments belong to Oshosun and Afowo Formation respectively. Based on First Downhole Occurrences (FDO) and Last Downhole Occurrences (LDO) of the foraminiferal index forms, four planktonic foraminiferal zones and One benthonic zone corresponding to the P14, P18-P21, N9-N14, N16 and N17 of Blow (1969, 1979) were proposed for the well. The planktonic zones are *Globorotalia opima opima* Interval zone, *Orbulina universa* - *Globorotalia mayeri* Concurrent-range Zone, *Globorotalia acostaensis* Interval range Zone, *Globorotalia plesiotumida* Taxon range Zone and the benthonic foraminiferal zone proposed is *Uvigerina hourqi* Taxon range zone. These zones were used to delineate the sedimentary succession from Middle Eocene to Late Miocene age.

Keywords: foraminifera, biostratigraphy, age, zonation, Dahomey Basin Miocene

Introduction
Foraminifera has become extremely useful in biostratigraphic studies, different forms have shown evolutionary bursts at different periods in the geologic record. Planktic foraminifera has become increasingly important biostratigraphic tool, especially as petroleum exploration of hydrocarbon has extended to deep offshore environments. The studied well is located in OPL 310 offshore Dahomey basin, south western Nigeria (figure 1). The aim of this work was to undertake a biostratigraphic study of the well in order to reconstruct the age of the sedimentary succession penetrated by the well thereby contributing to the existing geological data of the Dahomey basin while the objectives were to establish the lithostratigraphic units penetrated by the well section, identify and provide detailed documentation of the foraminiferal assemblage and establish the biostratigraphic zonation of the rock succession for the purpose of age determination.

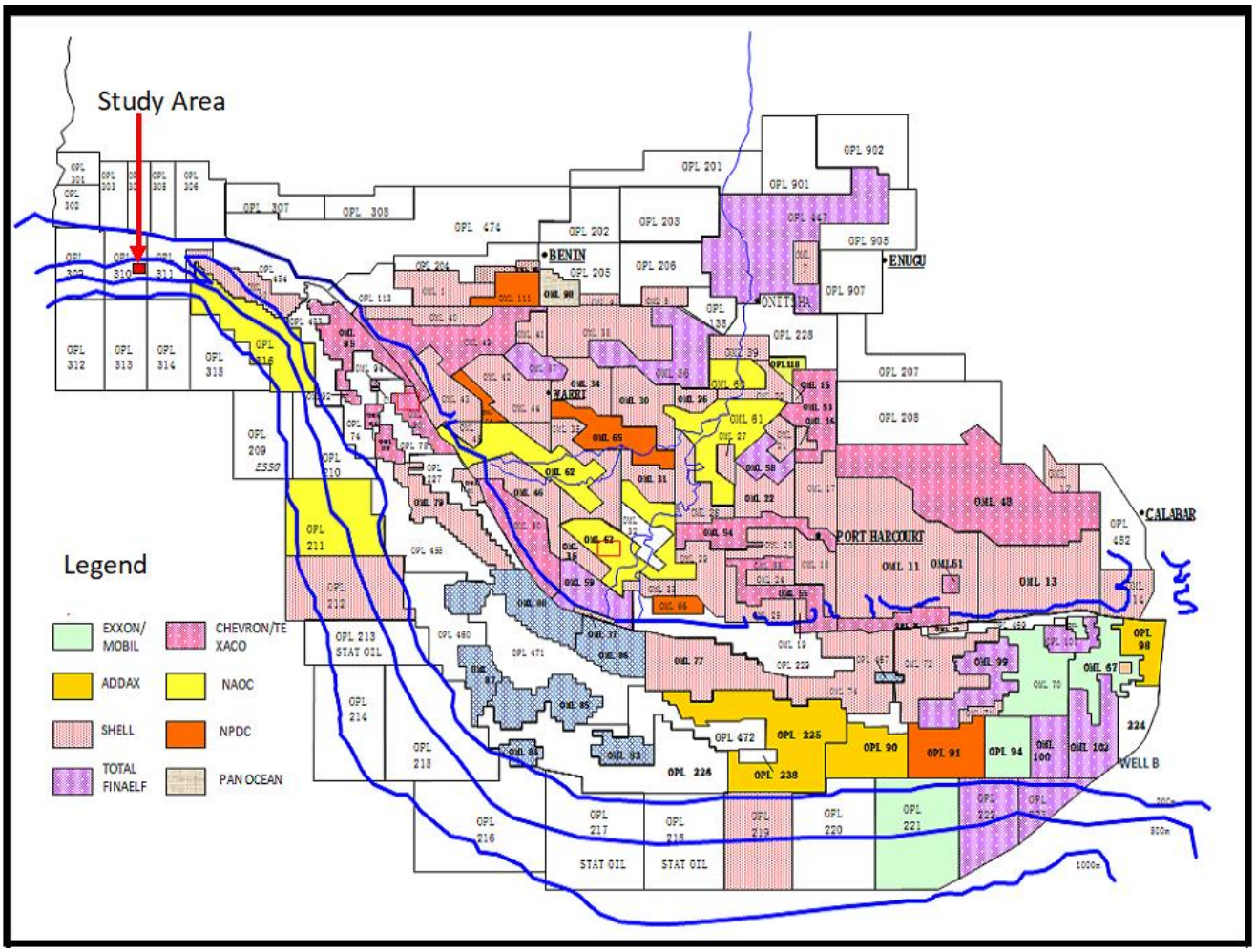


Figure 1: Niger delta oil mining lease (OML) map showing location of the study area.

Previous biostratigraphic studies: Foraminiferal biostratigraphy of the basin has been fairly documented. Reyment, 1965, studied the biostratigraphy and tectonic setting of the Cretaceous and Cenozoic sediments in Nigeria. He gave detailed paleontological account of both mega and microfossils such as foraminifera, ostracods, gastropods, pelecepods, pollen and spores in age characterization and environment of deposition. Fayose (1970) studied the foraminifera biostratigraphy of Afowo-1 well in the Dahomey Basin and proposed ten biostratigraphic units. Adegoke *et al* (1971) studied thirty six (36) offshore bottom samples from the gulf of Guinea for planktonic foaminiferal content and recovered twenty two (22) planktonic species dominated by *Globigerinoides ruber, Globigerinoides trilobus, Globoquadrina dutertrei and Globorotalia menardii.* They also delineated four paleoecologic zones (Shoreline – 25m, 25 – 200m, 200 – 1000m and over 1000m) on the basis of the distribution and abundance of planktonic species. Ogbe (1972) reported that the Ewekoro formation contains plaleocene planktonic foraminifera, such as Globorotalia Pseudobulloides, G. acuta, Globigerina triloculinoides and

Globorotalia velascoensis which is diagnostic of the G. velascoensis zone. He also interpreted the Akinbo formation to be between latest Thanetian and earliest Ypresian on the basis of presence of such foraminifera as Globorotalia convexa, G aequa, and G. Velascoensis (Early to late Paleocene) and some typical Eocene forms such as Globorotalia aragonensis and G. Simulatilis. On the basis of foraminifera and ostracods. Petters (1979) recognized three biostratigraphic zones in Parabe-1: *Globorotalia opima nana* and *Globorotalia opima opima and Globorotali foshi peripheroacuta* and used it to delineate late Oligocene through early Miocene and Pliocene age respectively. Petters (1982, 1983) investigated the benthonic and planktonic foraminiferal biostratigraphy of the Central West Africa and Gulf of Guinea respectively and defined nine planktonic and five benthonic foraminiferal zones. Okosun (1990), considered the age of the Oshosun formation to be early to middle Eocene. He also reported that the occurrence of the foraminifera: Eponides Pseudoelevatus, Globorotalia velascoensis and Globigerina triloculinoides in the upper part of Araromi Formation indicates a late Paleocene age. Okosun and Alkali (2012) suggested that the Paleocene benthic foraminiferal recovered from the Eastern Dahomey basin shows strong affinity to the Midway Formation of Gulf coastal plain of North America. Some species of the assemblage are common to the Paleocene of Tunisia and Libya, that the Paleocene benthic foraminifera shows similarity to the Sokoto Basin. They also opined that the two coeval assemblages belong to different biogeographic. Akinsile et al (2016) examined twenty (20) ditch cutting samples of the SILE-Well, offshore Dahomey basin for foraminifera. Seventy-eight (78) species were recorded of which, sixty-four (64) species are calcareous while fourteen (14) species are arenaceous. Forty-five (45) species of the calcareous forms are benthics while the remaining nineteen (19) species are planktics. They recognized three (3) major foraminiferal zones, *Haplophragmoides excavate/Morozovella Subbotinae zone* (early Eocene), *Eponides pseudelevatus/Morozovella vellascoensis zone* (latest Paleocene-early Eocene) and an Undiagnostic zone suggesting Maastrichtian- Paleocene.

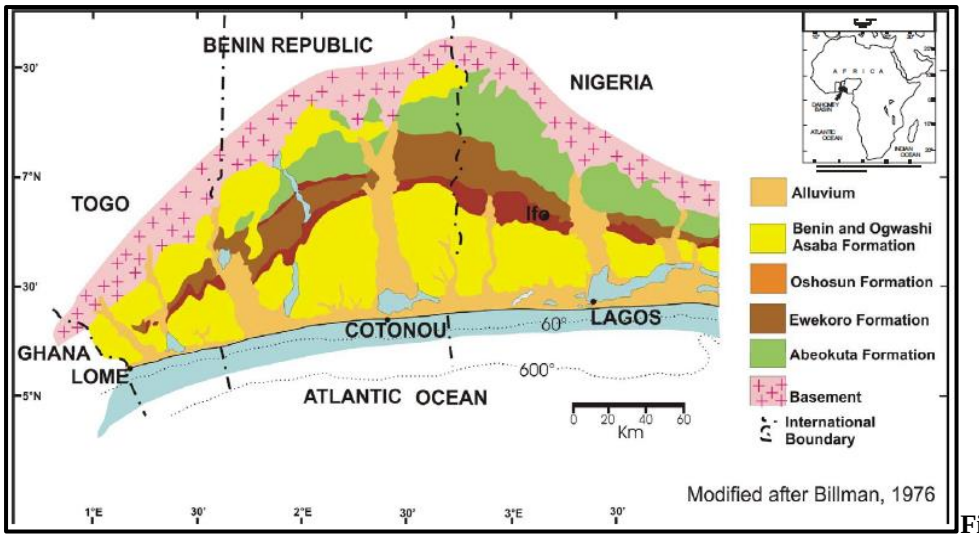


Figure 2: Geological Map of the Dahomey Basin with an inset map of Africa showing the location the Dahomey Basin (modified after Billman, 1976)

Basin Geology:

The Dahomey (Benin embayment) Basin is an extensive basin located in West Africa; it covers much of the continental margin of the Gulf of Guinea, extending from Volta-delta in Ghana through Togo and Republic of Benin to south-western Nigeria (figure 2), where it is separated from and cut off by stratigraphically younger Niger Delta. Dahomey Basin is a marginal pull apart basin or marginal sag basin which was developed as the African and South American lithospheric plates separated in the Mesozoic and continental margin was formed. The Eastern Dahomey basin of the Nigeria sector contains extensive wedge of cretaceous to recent sediments; up to 3000m which thickens towards the offshore. It is separated from the Niger Delta by a subsurface basement high referred to as the Okitipupa Ridge. Its offshore extent is poorly defined. Sediment deposition follows an east-west trend. In the Republic of Benin, the geology is fairly well known (Billman, 1976). In the onshore, Cretaceous strata are about 200 m thick (Okosun, 1990). A non-fossiliferous basal sequence rests on the Precambrian basement. This is succeeded by coal cycles, clays and marls which contain fossiliferous horizons. Offshore, a 1,000 m thick sequence consisting of sandstones followed by black fossiliferous shales towards the top has been reported. This was dated by Billman (1976) as being pre-Albian to Maastrichtian. The Cretaceous is divisible into two geographic zones, north and south. The sequence in the northern zone consists of a basal sand that progressively grades into clay beds with intercalations of lignite and shales. The uppermost beds of the Maastrichtian are almost entirely argillaceous. The southern zone has a more complicated stratigraphy with limestone and marl beds constituting the major facies.

There has been a nomenclature problem in the stratigraphy of the Dahomey Basin. Researches on the stratigraphy of the basin include the works of Jones & Hockey (1964) in which they assigned the Abeokuta Formation to the mainly

arenaceous strata with mudstone, silt, clay and shale interbeds that outcrop onshore in the Nigerian sector of the basin. Billman (1976), from the study of some offshore Cretaceous sequences in the Republic of Benin, erected two informal lithostratigraphic units in Dahomey basin ; the older Folded Sediments and the Albian Sand while the remaining portion of the Cretaceous sequence was referred to as the Abeokuta Formation, Awgu shale and Nkporo shale. Omatsola and Adegoke (1981) assigned Abeokuta Group to the Cretaceous sediments and subdivided it into three formations: Ise Formation, Afowo Formation and Araromi Formation. The first two correspond to the unnamed Older Folded Sediments and the unnamed Albian Sands respectively, while the Araromi Formation was considered lateral equivalent to the Nkporo shale of Billman, 1976. Billman (1992) divided the stratigraphy of the entire Dahomey basin into three chronostratigraphic units: the pre-lower Cretaceous folded sediments, Cretaceous sediments and Tertiary sediments and observed that the Tertiary strata which lies conformably on the Araromi Formation in the basin characterised by lens shaped, sandy, glauconitic and phosphatic limestone of the Ewekoro Formation dated Upper Paleocene (Adegoke, 1977). The predominantly shaly Imo Formation lies unconformably on the Ewekoro Formation. The formation consists of fine-textured dark micro-micaceous shale, locally silty with glauconitic marl and conglomerate at the base. The greenish-grey variety of the shale encountered in the subsurface of most inland areas of Western Nigeria and which in the Ewekoro quarry disconformably overlies the Ewekoro Formation was named Akinbo Formation by Ogbe (1972). The formation has been dated Lower-Middle Eocene. The Oshosun Formation overlies the Akinbo Formation across a gradational boundary and is composed of green to greenish grey clays and glauconitic shales interbedded with loose sand. The formation has been assigned a Late Paleocene to Early Eocene age (Bankole *et al.* 2005). The formation is conformably overlain by the Ilaro Formation which is characterized by coarse to fine-grained sands, clays and shales with occasional thin bands of phosphate beds. This was overlain by the Coastal Plain Sands (Benin Sand Formation). The formation consists of very poorly, clayey, pebbly sands, sandy clay and rare thin lignite (Reyment, 1965). The Benin Formation was dated Upper Miocene to Recent (figure 3).

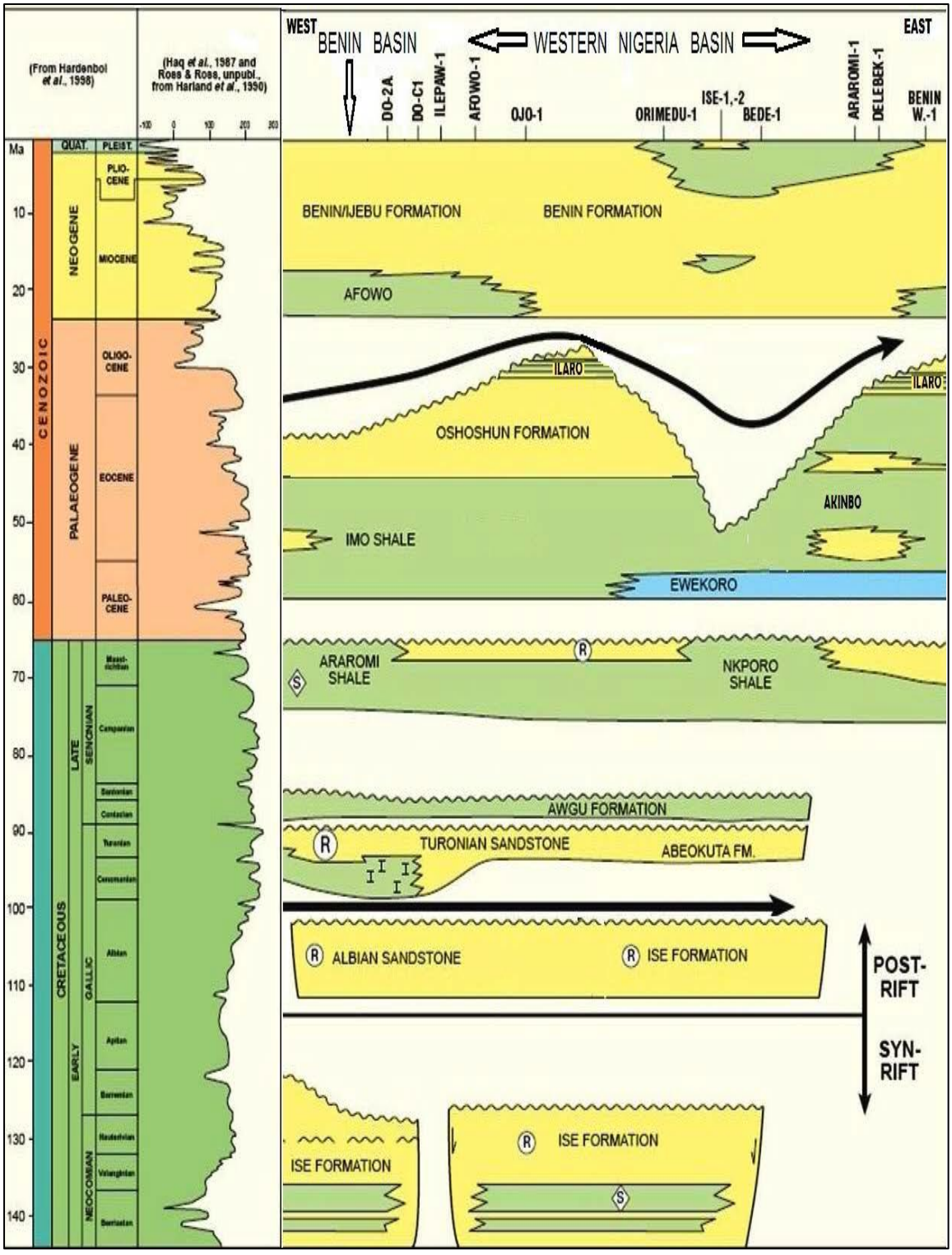


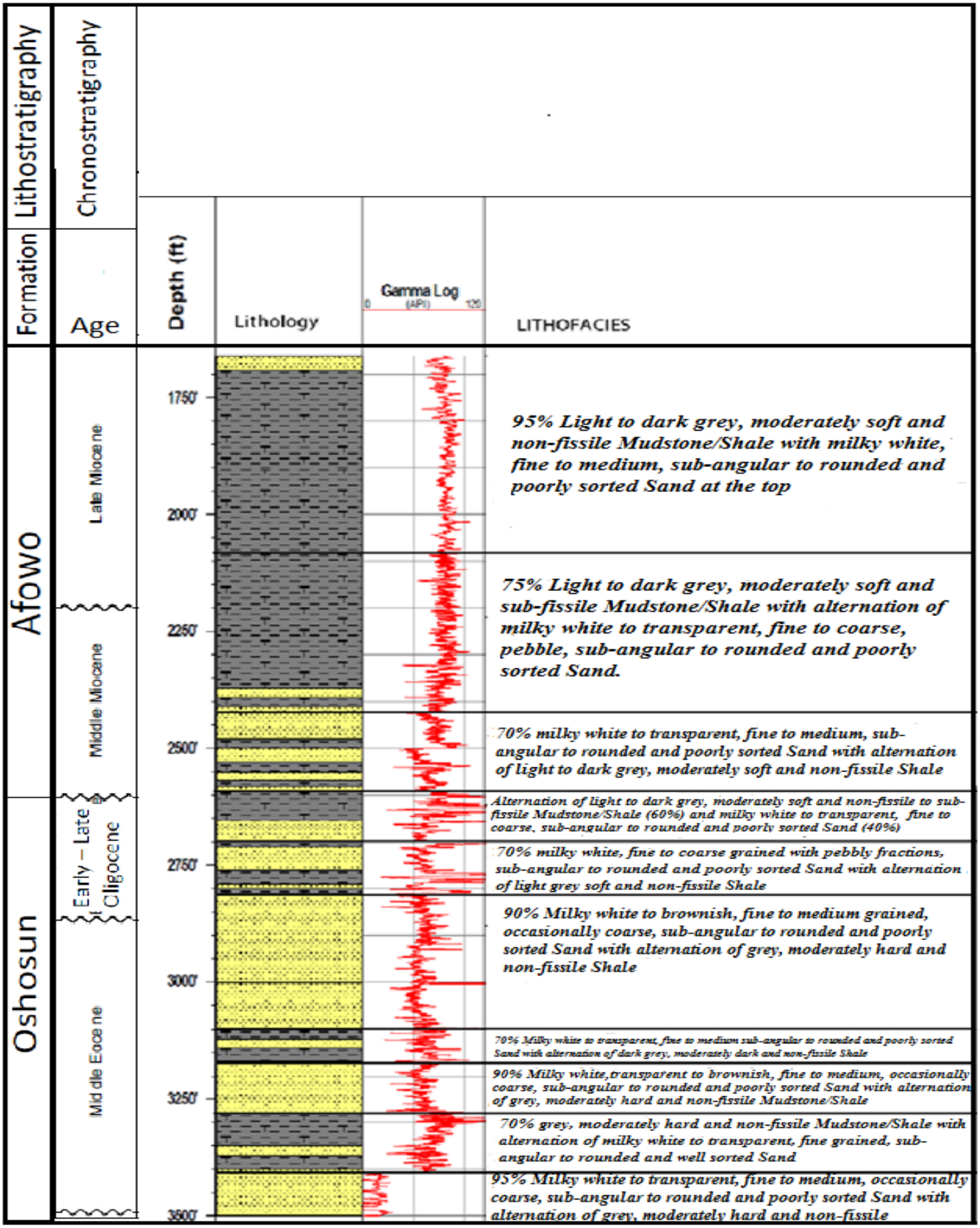
Figure 3: Schematic cross section showing lithostratigraphic units of Dahomey and Western Nigeria offshore basins.

Methodology of Study

A total of fifty (50) ditch cutting samples from interval 1620 to 3500ft of well Z, were used for this study. The samples were subjected to standard detailed processes and activities, which include; lithological and micropaleontological analysis. The lithological analysis was done with the aid of Gamma ray log (GR). Twenty grammes (20gm) of each sample were weighed (using a Mettler PC 440 digital balance) and correctly transferred into clean aluminium sample bowls. 30 ml of kerosene was poured into the weighed sample while still hot and soaked for two hours. The kerosene was drained out and the samples were soaked in water. Each sample was then washed over a 63 microns sieve with water from a hand directed water jet. The residue collected from the sieve was replaced in the sample bowl and dried on the hot plate. The residue was then sieved over 20- and 80-microns mesh sieves for the medium and coarse fractions while the finest residue in the receiver was treated as fine fraction. The coarse, medium and fine fractions were then stored in properly labelled sample phials for onward transfer for picking and analysing. In carrying out the detailed procedure outlined above, care was taken to avoid contamination with other samples. All size fractions were examined individually on a picking tray, foraminifera was picked with the aid of a sable brush under a binocular microscope. The various foraminifera taxa encountered in each sample during the picking exercise were grouped and mounted with gum on a micropaleontological slide cavity and covered with a cover slip. These slides were properly labelled with well name and sample depth and arranged serially for identification. The identification of the various foraminifera was done largely by comparison with forms that have been previously described by (Sellier de Crivrieux, 1976), Petters (1982), (Loeblich, Jr, & Tappan , 1987), (Bolli & Saunders, 1985) and other relevant literature dealing with the identification of micro fauna in general.

Results and Discussion

Lithostratigraphy: The lithological analysis revealed a generally fining upward sequence of basal sandstone characteristically milky white to transparent and brownish, Fine to coarse, pebbly, sub-angular to rounded and poorly sorted to well sorted and light to dark grey, moderately soft to moderately hard and non-fissile to fissile shale/mudstone sequence at the top. Accessory mineral assemblage present includes: Mica flakes, glauconite pellet, carbonaceous detritus and ferruginous materials. the basal sandstone unit belong to the Oshosun Formation while the upper shaly unit is typical of Afowo Formation (figure 3).


Lithostratigraphy
Chronostratigraphy
Formation
Age
Depth (ft)
Lithology
Gamma Log
(API)
LITHOFACIES
Afowo
Oshosun
Late Miocene
Middle Miocene
Early – Late Oligocene
Middle Eocene
1750'
2000'
2250'
2500'
2750'
3000'
3250'
3500'
95% Light to dark grey, moderately soft and non-fissile Mudstone/Shale with milky white, fine to medium, sub-angular to rounded and poorly sorted Sand at the top
75% Light to dark grey, moderately soft and sub-fissile Mudstone/Shale with alternation of milky white to transparent, fine to coarse, pebble, sub-angular to rounded and poorly sorted Sand.
70% milky white to transparent, fine to medium, sub-angular to rounded and poorly sorted Sand with alternation of light to dark grey, moderately soft and non-fissile Shale
Alternation of light to dark grey, moderately soft and non-fissile to sub-fissile Mudstone/Shale (60%) and milky white to transparent, fine to coarse, sub-angular to rounded and poorly sorted Sand (40%)
70% milky white, fine to coarse grained with pebbly fractions, sub-angular to rounded and poorly sorted Sand with alternation of light grey soft and non-fissile Shale
90% Milky white to brownish, fine to medium grained, occasionally coarse, sub-angular to rounded and poorly sorted Sand with alternation of grey, moderately hard and non-fissile Shale
70% Milky white to transparent, fine to medium sub-angular to rounded and poorly sorted Sand with alternation of dark grey, moderately dark and non-fissile Shale
90% Milky white,transparent to brownish, fine to medium, occasionally coarse, sub-angular to rounded and poorly sorted Sand with alternation of grey, moderately hard and non-fissile Mudstone/Shale
70% grey, moderately hard and non-fissile Mudstone/Shale with alternation of milky white to transparent, fine grained, sub-angular to rounded and well sorted Sand
95% Milky white to transparent, fine to medium, occasionally coarse, sub-angular to rounded and poorly sorted Sand with alternation of grey, moderately hard and non-fissile

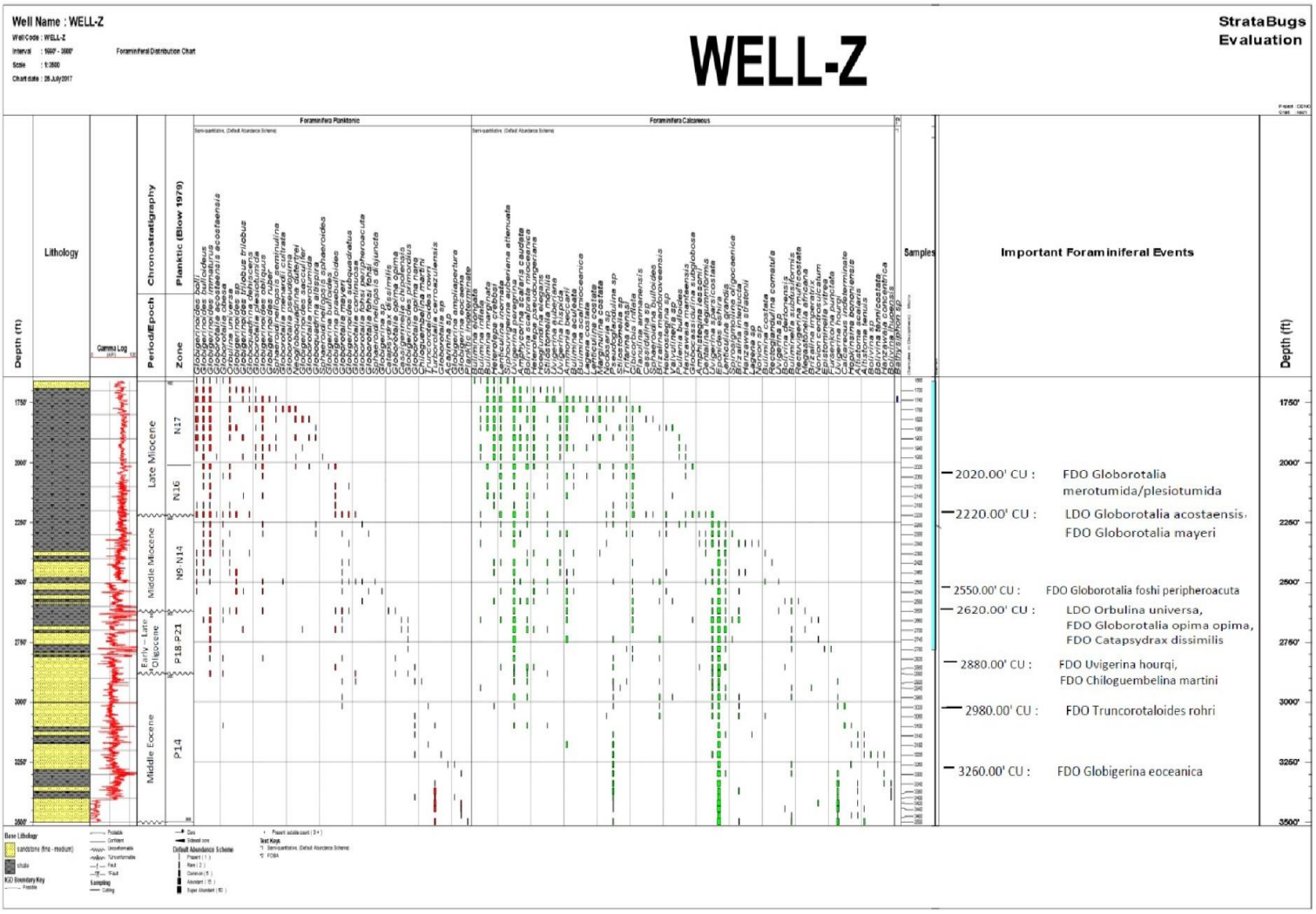


Figure 4: Lithostratigraphic section of well-Z

The foraminiferal recovered was generally good, characterized by forty-two (42) planktic and sixty-five (65) benthonic and arenaceous benthic foraminifera species. The distribution chart is presented in figure 5 and illustrated in plates 1-3.
Figure 5: Stratigraphic distribution of foraminifera in well Z

Foraminiferal biozonation and age characterization of well Z:

Zone 1 (*Uvigerina hourqi* Taxon range zone)

Stratigraphic Interval: 2,880 –3,520ft.
Age: Middle Eocene
Definition: The upper limit of this zone was marked by the FDO of *Uvigerina hourqi* at 2,880ft, the lower limit placed at depth 3,500ft which is the terminal depth of the analysed interval is indeterminate because of the absence of marker species.

Occurrences: Interval is characterized by the co-occurrences of *Chiloguembelina martini* ,*Globigerina eoceanica*, *Globigerina ampliaperta*, *Truncorotaloides rohri* and *Globigerina cerroazulensis*, These occurrences indicate a middle Eocene age. The benthic assemblage is characterized by the association of *Brizalina ihuoensis*, *Uvigerina hourqi*, *Brizalina interjuncta*, *Brizalina tenuicostata*, *Eponides eshira*, *Uvigerinella sparsicostata* and *Lenticulina grandis* supporting the middle Eocene age.

Remark: This *Uvigerina hourqi* interval has been correlated to the Lower part of the P14 planktic foraminiferal zone of Blow (1969,1979) & Berggren et al (1988).

Zone 2: (*Globorotalia opima opima* Interval zone)

Stratigraphic Interval: 2,620 – 2,880ft.

Age: Early to Late Oligocene

Definition: The lower limit of this zone is marked at 2,880ft by the FDO of benthic foraminifera *Uvigerina hourqi* and FDO of *Globorotalia opima opima* at 2,620ft which is the upper limit of this zone.
Occurrences: Planktic assemblage over this interval include *Globorotalia opima opima, Globigerinoides primordius, Catapsydrax dissimilis, Globorotalia mayeri, Cassigerinella chipollensis,* and *Globigerina praebulloides*. The above planktic association indicates early to late Oligocene age. Also, the co-occurrences of the following benthic assemblage including *Brizalina mandoroveensis, Brizalina interjuncata, Eponides eshira, Lenticulina grandis, Buliminella aff. subfusiformis, Uvigerinella sparsicostata, Brizalina imperatrix, Nonion centrosulcatum* and *Fursenkoins punctata* supports the early to late Oligocene age.

Remark: *Globorotalia opima opima* zone as identified in this study correlates with zone P18 - P21 of Blow (1969,1979) & Berggren et al (1988). This depth consists of admixture of early Oligocene P18 to P21 and middle Eocene P14 foraminiferal species suggesting a fault/unconformity at this depth. This could be responsible for the non-recognition of P17 to P15 zones.

Zone 3: (*Orbulina universa - Globorotalia mayeri* Concurrent-range Zone)

Stratigraphic Interval: 2,220 – 2,620ft.

Age: Middle Miocene

Definition: The lower limit of this zone was marked at 2,620ft based on the LDO of *Orbulina universa* and the upper limit was marked at 2,220ft based on the FDO of *Globorotalia mayeri.*
Occurrences: This interval is characterized by the following planktic foraminiferal assemblage: *Globorotalia foshi, Globorotalia peripheroacuta, Globorotalia obesa, Globorotalia mayeri, Globorotalia continuosa, Cassigerinella chipollensis, Globigerinoides subquadratus, Sphaeroidinellopsis disjuncta, S. sphaeroides* and *Orbulina universa*. The association of these foraminiferal species suggest a middle Miocene age. Associated benthic foraminiferal species includes *Marginulina costata, Amphistegina lessonii, Bulimina aculeata, Amphycorina scalaris caudata, Cibicorbis inflata, Heterolepa pseudoungeriana, Hanzawaia stratonii, Trifarina reussi, Bolivina scalprata miocenica* and *Ammonia beccarii.*

Remark: *Orbulina universa - Globorotalia mayeri* zone correlates with zone N9 – N14 of Blow (1969,1979) & Berggren et al (1988). This depth consists of admixture of middle Miocene N14-N9 zone and early to late Oligocene P18-P21 zone, suggesting a fault/unconformity. This

could be responsible for the non-recognition of N4 to N8 and P22 zones.

Zone 4: (*Globorotalia acostaensis* Interval range Zone)

Stratigraphic Interval: 2,020 – 2,220ft.

Age: Late Miocene

Definition: The lower limit of this zone in the studied well interval was based on the LDO of *Globorotalia acostaensis* at 2,220ft and also the LDO of *Globorotalia plesiotumida* & *Globorotalia merotumida* at 2,020ft.
Occurrences: This interval is characterized by the presence of other typical Late Miocene planktic foraminiferal species including: *Globoquadrina dehiscens*, *Globigerinoides immaturus*, and *Globigerinoides menardii*. This foraminiferal assemblage suggests a late Miocene age. Associated benthic foraminiferal species includes*; Amphistegina lessonii*, *Bulimina aculeata*, *Cibicorbis inflata*, *Trifarina renssi* and *Ammonia beccarii.*

Remark: *Globorotalia acostaensis* Interval zone correlates with zone N16 of Blow (1969,1979) & Berggren et al (1988). This depth also consists of admixture of late Miocene N16 and middle Miocene N14 to N9 zone suggesting a fault/unconformity. This could be responsible for non-recognition of N15 zones.

Zone 5: (*Globorotalia plesiotumida* Taxon range Zone)

Stratigraphic Interval: 1620 - 2,020ft.

Age: Late Miocene

Definition: The lower limit of this zone in the studied well interval was based on the LDO of *Globorotalia plesiotumida/merotumida* at 2,020ft. The upper limit of the Late Miocene is tentatively placed at 1,620ft
Occurrences: This interval is characterized by the following planktic foraminifera: *Neogloboquadrina dutertrei, Globorotalia menardii cultrata, Sphaeroidinellopsis seminulina, Globoquadrina dehiscens, Globorotalia acostaensis, Globorotalia merotumida* and *Globorotalia menardii.* This foraminiferal assemblage suggests a late Miocene age. This foraminiferal assemblage suggests a late Miocene age. Associated benthic foraminiferal species includes *Marginulina costata, Bulimina aculeata, Amphycorina scalaris caudata, Cibicorbis inflata, Heterolepa pseudoungeriana, Trifarina renssi, Bolivina scalprata miocenica* and *Ammonia beccarii.*

Remark: *Globorotalia plesiotumida* zone correlates with zone N17 of Blow (1969,1979) & Berggren et al (1988) the summary of the zones in correlation with other zones is presented in figure 6.

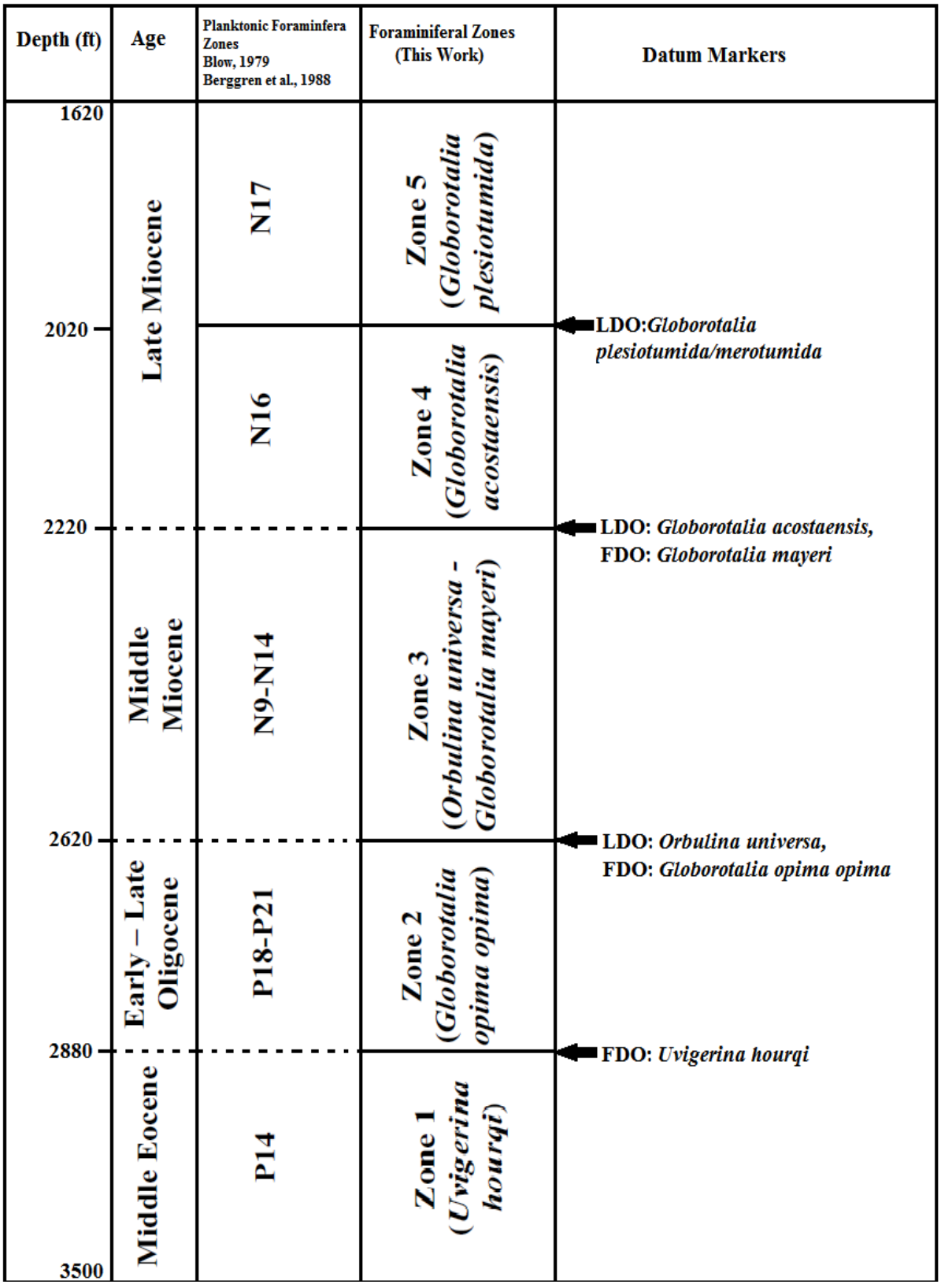


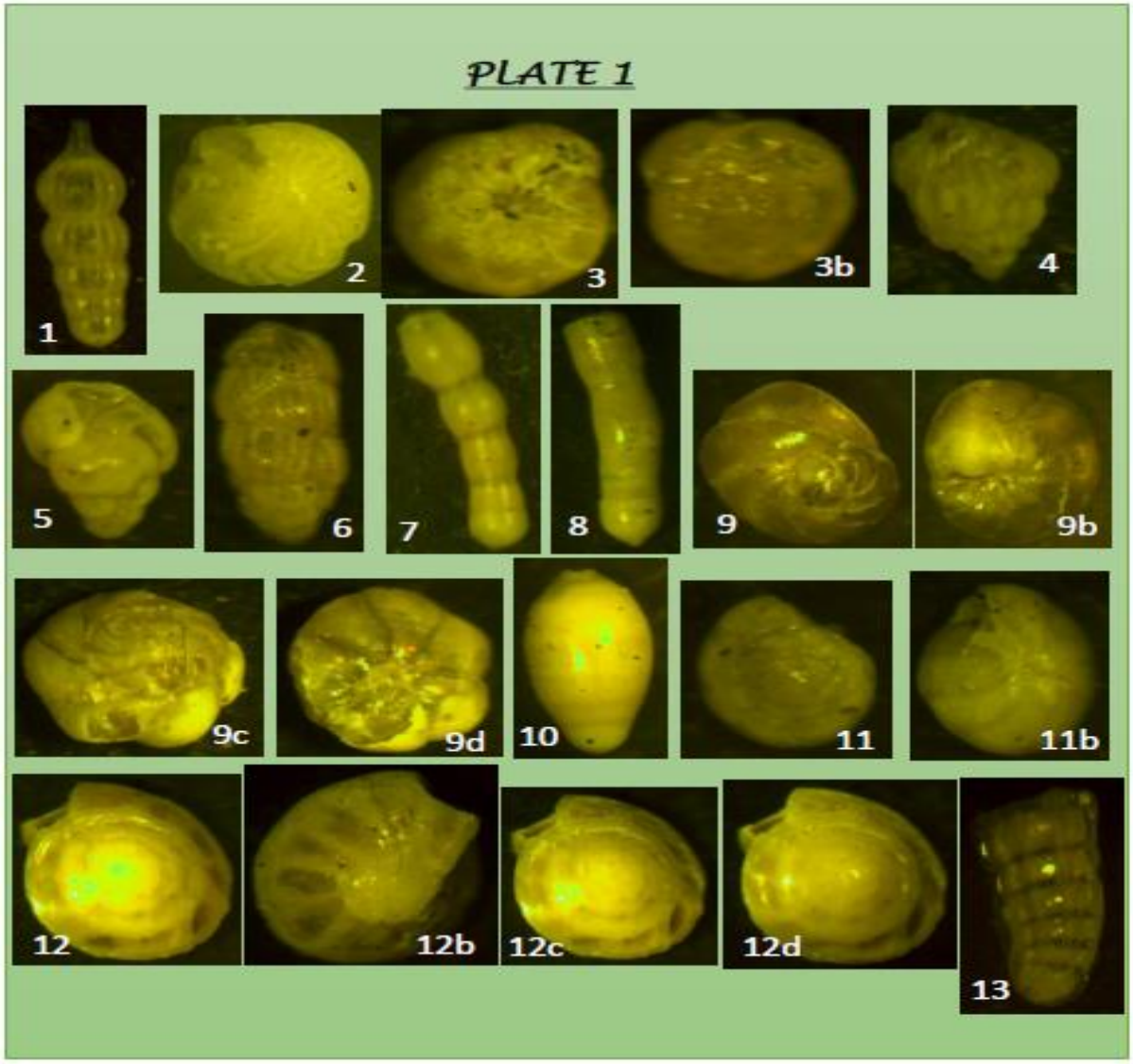
Figure 6: Comparison of the Zones identified in this study with other standard zonation schemes .

Conclusion

This study was carried out on ditch cutting samples of Well-Z. The studied depth interval ranges from 1620 - 3500ft. The Lithology show the alternation of sandstone and shale, the shale is light to dark grey in colour (occasionally black to brown,), non-fissile to fissile, moderately soft to hard. The sandstone is milky white to transparent and brownish, fine to coarse, pebbly, sub-angular to rounded and poorly sorted to well sorted and predominantly unconsolidated. The lower layer which is made of alternation of shale and sand is believed to be Oshosun formation while the upper layer composed basically of thick shale belongs to the Afowo formation.

The biostratigraphic data acquired over the analyzed interval facilitated the stratigraphic resolution of the well section and were used in the dating of the interval. Foraminiferal recoveries were generally good, characterized by high abundance and diversity of both planktic and benthic foraminiferal species. A total of 107 foraminiferal species were identified out of which 42 species are planktonics and represent 39% of the total foraminiferal assemblage. The remaining 65 species are benthonics out of which 64 are calcareous and 1 is arenaceous representing 61% of the total foraminiferal assemblages respectively. Four planktonic and one benthonic foraminiferal zones were established namely; *Globorotalia opima opima* Interval zone, *Orbulina universa* - *Globorotalia mayeri* Concurrent-range Zone, *Globorotalia acostaensis* Interval range Zone, *Globorotalia plesiotumida* Taxon range Zone which correspond to P18-P21, N9-N14, N16 and N17 of Blow (1969, 1979). The benthic foraminiferal zone established is the *Uvigerina hourqi* Zone which is a taxon range zone and it is equivalent to P14 of (Blow 1969, 1979). These zones were used to characterize the age from middle Eocene to late Miocene in the well. Based on the lithologic & foraminiferal analysis of Well-Z, it is inferred that the intervals penetrated by the well correspond to Afowo and Oshosun formations of Dahomey (Benin) basin and the entire deposition took place during Middle Eocene to Late Miocene.

This study contributes to the understanding of the biostratigraphy of Dahomey basin which is currently the focus of intensive hydrocarbon exploration activities in Nigeria.



1. *Amphycorina scalaris caudata* *2. Amphistegina lessonii* *3. Ammonia beccarii*

3b. Ammonia beccarii2 *4. Bulimina inflata* *5. Bulimina marginata*

6. Uvigerina peregrina *7. Dentalina legumiformis* *8. Dentalina sp*

9. Eponides eshira *9b. Eponides eshira2* *9c. Eponides eshira 3*

9d. Eponides eshira4 *10. Globoglandulina sp* *11. Heterostegina crebbsi*

11b. Heterolepa crebbsi2 *12. Heterolepa pseudoungeriana* *12b. Heterolepa pseudoungeriana2*

12c. Heterolepa pseudoungeriana3 *12d. Heterolepa pseudoungeriana4* *13. Marginulina costata*

1. Lenticulina inornata *2. Lenticulina grandis* *3. Orbulina universa*

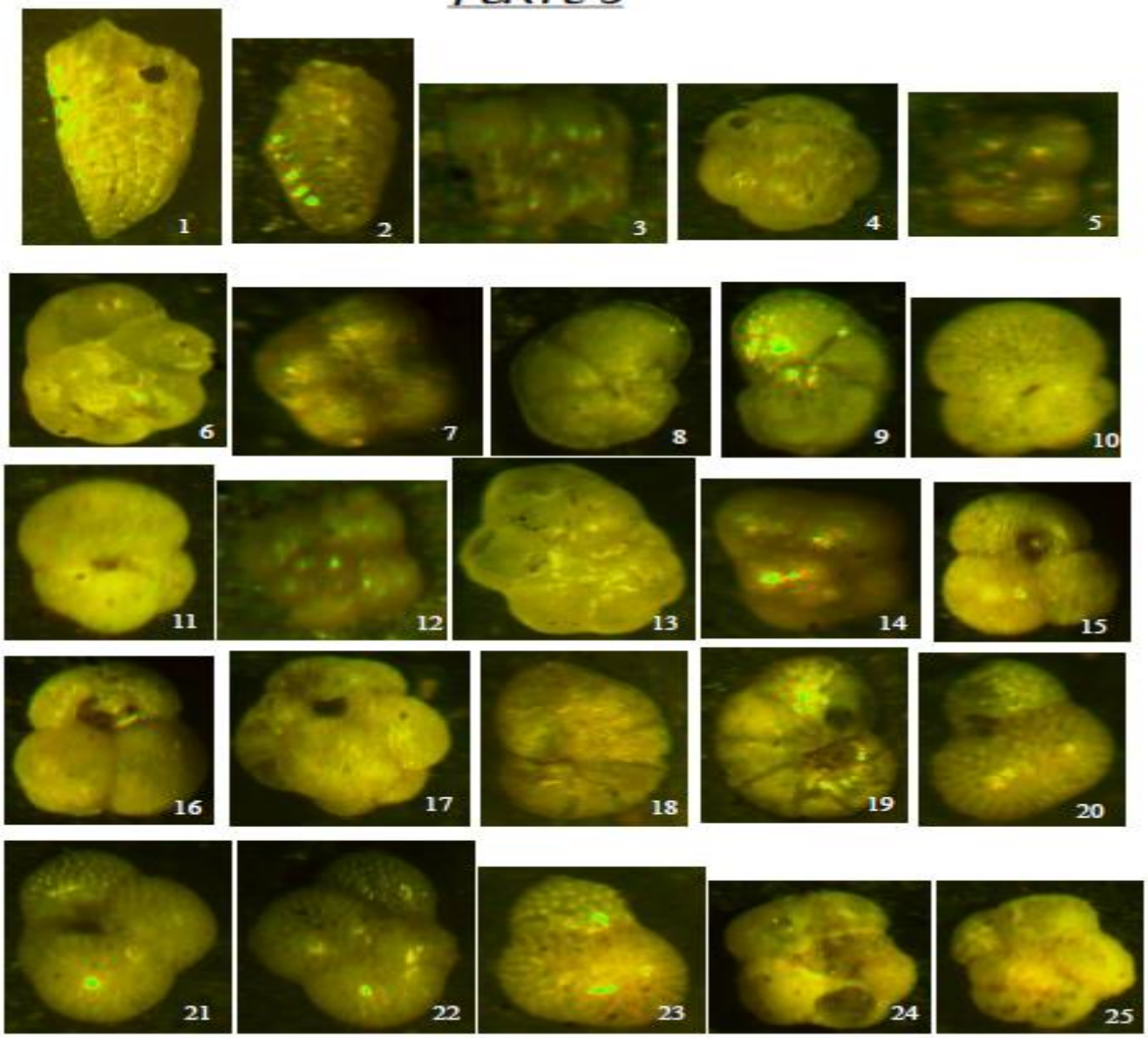
4. Pseudoglandulina *5. Pullenia bulloides* *6. Stilostomella monilis*

7. Trifarina reussi *8. Uvigerina hispida* *8b. Uvigerina hispida2*

9. Uvigerina sparsicostata *10. Uvigerina peregrina* *11. Uvigerina hourqi*

12. Uvigerina hourqi2 *13. Uvigerina sparsicostata*

PLATE 3



1.Brizalina imperatrix *2. Bolivina scalprata miocenica* *3. Globorotalia continuosa*
4.Globoquadrina altispira *5. Globorotalia continuosa* *6. Globorotalia fohsi fohsi*
7. Globorotalia opima opima *8. Globorotalia. Pleisotumida* *9.Globorotalia pleisotumida*
10. Globigerinoides primordius *11. Globigerinoides primordius* *12 Globorotalia continuosa*
13. Globorotalia fohsi fohsi *14. Globorotalia opima opima* *15. Globigerinoides subquadratus*
16. Globigerinoides subquadratus *17. Globoquadrina altispira* *18. Nonion centrosulcatum*
19. Nonion centrosulcatum *20. Sphaeroidinellopsis seminulina* *21. Sphaeroidinellopsis disjuncta*
22.Sphaeroidinellopsis disjuncta *23. Sphaeroidinellopsis seminulina* *24. Turborotalia cerrazuellensis*
25. Turborotalia cerrazuellensis

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