FORAMINIFERAL BIOSTRATIGRAPHY AND PALEOENVIRONMENT OF WELL BL-1X, DEEP OFFSHORE, NIGER DELTA BASIN, NIGERIA

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Abstract

Foraminiferal boistratigraphic analysis was carried out using one hundred and sixty (160) ditch cutting samples from BL-1X well, deep off-shore Niger Delta basin, Nigeria. The interval studied is 7710–13020 ft belonging to the Agbada Formation. Lithologically, the section varies from shaly-sand to sandy-shale to shale. Biozonation included four planktonic zones, the proposed planktonic zones are: *Globigerinoides extremus-G. humerosa zone – interval zone Globorotalia acostaensis acostaensis zone – taxon range zone Globorotalia fohsi peripherronda - Globigerinatella insueta zone – interval zone Catapsydrax stainforthi zone – taxon range zone* which are correlatable with the zones of previous workers. Samples from the section was dated early to late Miocene based on paleontological evidences. Sediments of well of BL-1X were deposited in the lower – upper bathyal environment based on environmentally restricted benthic species.

Keywords: Biostratigraphy, Foraminifera, Biozonation, Miocene, Agbada, Niger Delta

Introduction

The Tertiary Niger Delta Basin is situated along part of the Gulf of Guinea on the west coast of Africa. It lies within latitudes 04° 00' 00" and 07° 00' 00" N and longitudes 03°00' 00" and 09° 00' 00" E (Figure 1). It is a large arcuate delta of destructive wave-dominated type (Weber and Daukoru, 1975; Evamy *et al.,* 1978). Niger Delta Basin is one of the sedimentary basins formed by the rift faulting of the Nigerian Precambrian rock (Evamy *et al.*, 1978). Niger delta is important because of its hydrocarbon resources, the delta started to evolve in Eocene period, due to the interplay between sediment supply and subsidence. Presently, deposition is still going on offshore. Previous work have been done on the Niger Delta Basin which include those on sedimentology (Short and Stauble 1967; Weber, 1971; Weber and Daukoru, 1975; Stacher 1994), palynology of Tertiary sediments from tropical areas(Gemeraad *et al.,* 1968), the palynomorphs in the paleoenvironments of some eastern Niger delta sediments (Mebradu, 2000), planktonic foraminifera in the Gulf of Guinea sediments (Adegoke *et al.,* 1971) and Adegoke *et al.* (1976) on benthic foraminifera biofacies of the Niger Delta. Petters (1982) studied the benthic foraminiferal biostratigraphy of the central West African

Cretaceous sediments. Avbovbo (1978) studied the lithostratigraphy of the Niger Delta, while Ojo and Salami (1992) worked on the Biostratigraphy of the Niger Delta; Ojo and Adebayo (2001) studied the miospore biostratigraphy of Agbada Formation, eastern Niger Delta basin. A detailed description of the stratigraphy and lithology of this formation, including its type section (interval in thisstudy belongs to the Agbada Formation), has been presented by Short and Stauble (1967) and Avbovbo (1978). Others works also on Foraminifera retrieved from well and outcrop studies, in the Niger Delta oil province include Ozumba, 1997; Fadiya, 1998; Okosun and Liebau, 1999.

This present study will complement the existing data and will provide additional information for the existing dataset on the stratigraphic column of the Niger Delta oil province, which will help in refining the age and zones especially in the deep offshore Niger Delta basin.

The well under investigation is located in the deep offshore depobelt of the Niger Delta, and situated within latitude 3° 31′ 42″ and longitude 6° 56′ 25″ E.

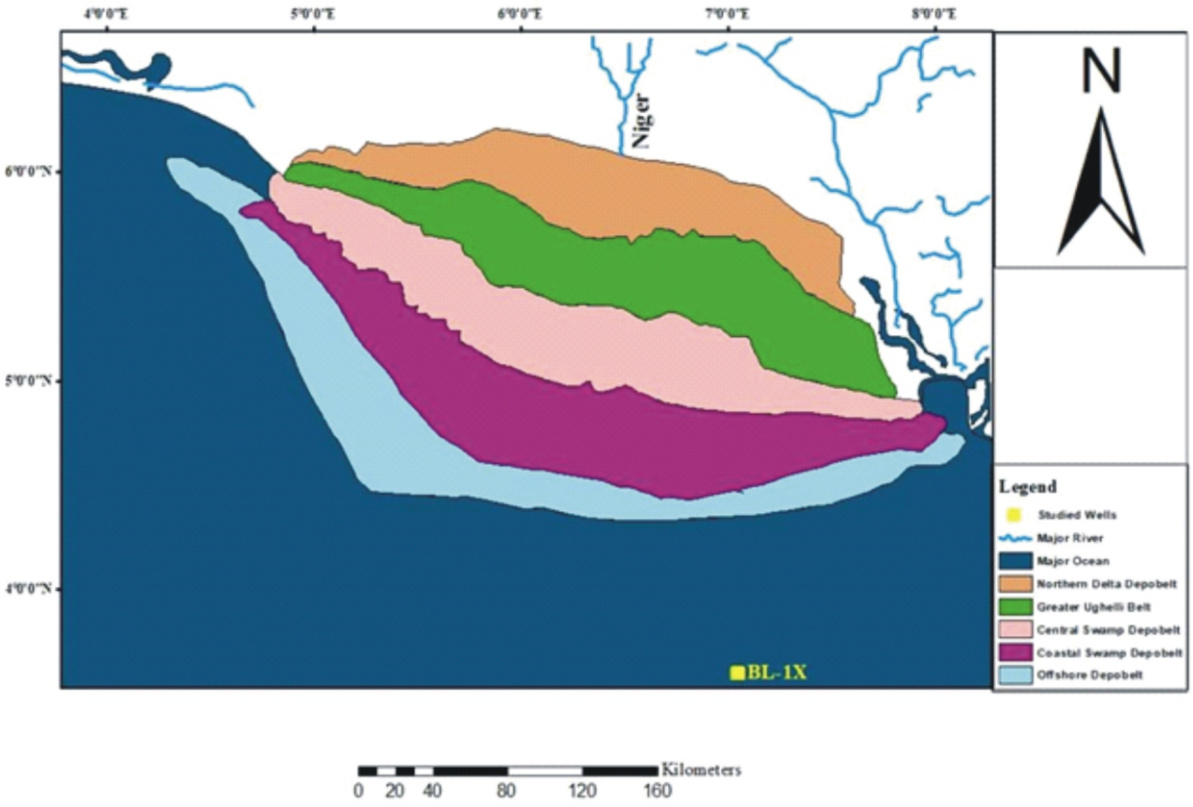


Figure 1: Location of the studied well in the deep offshore Niger Delta (Redrawn from Chukwuma-Orji *et al.,* 2021)

Materials and Methods

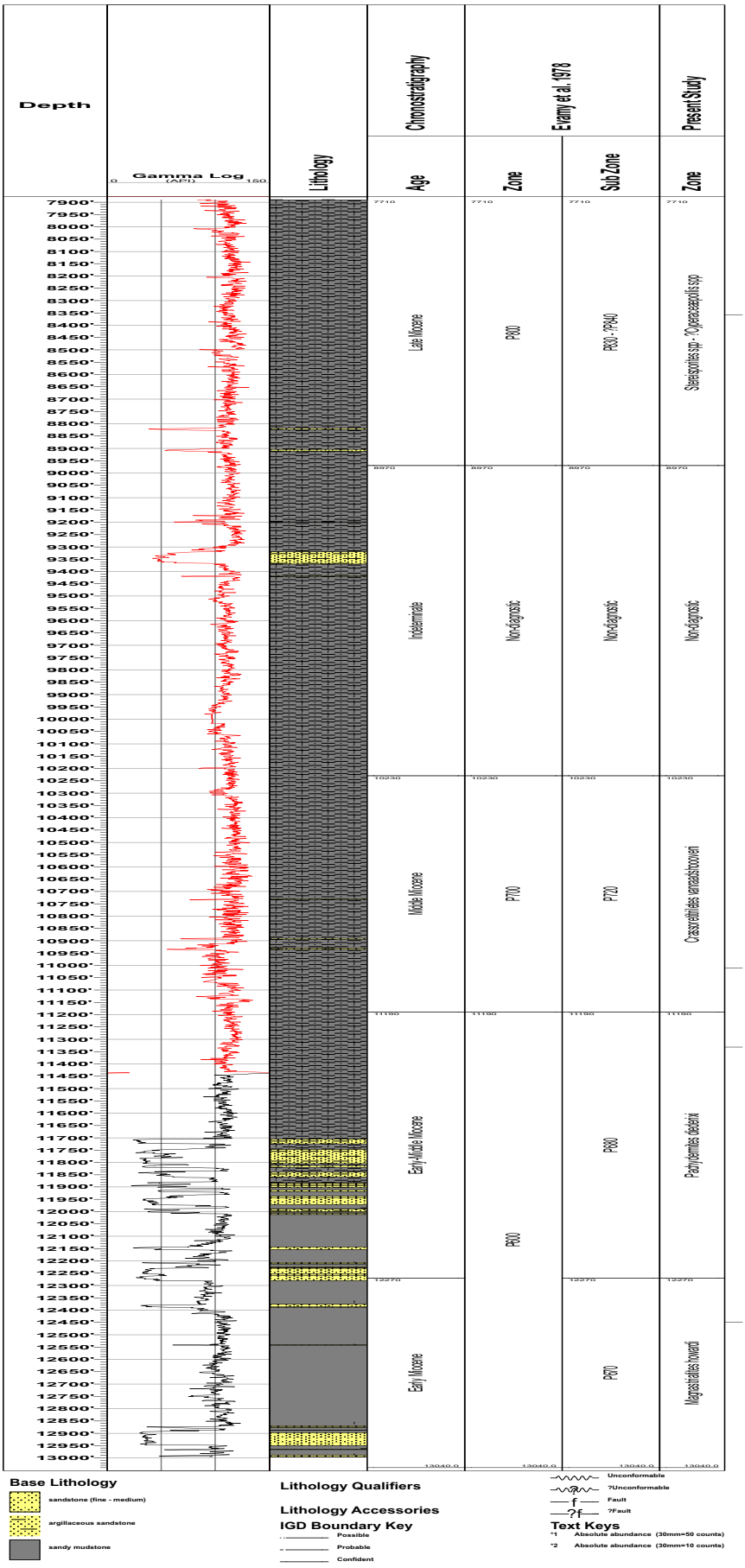
One hundred and sixty (160) ditch cutting samples from the well BL-1X within the interval 7710–13020ft was used for foraminifera study. Most of the samples were at 30ft intervals while few of the samples came at various intervals.

25g of samples was soaked in labelled beakers for a period of 4-6 hours in a solution of 10% hydrogen peroxide to allow proper disaggregation of the samples. Disaggregated sample were washed under a gentle current of tap water through a 63 μm mesh screen to liberate the microfossils, the residue was oven dried and stored in labelled vials before picking. Because of the relative paucity of foraminifera in all the samples analyzed, all available foraminifera specimens from each sample were picked into reference slides and later identified and counted using the Wild Heerbrugg M 18 binocular microscope. Identification was made following the classification of Loeblich and Tappan (1988). Other literatures include Bolli *et al*. (1985), Zacharinsse (1990) and Jones (1994).

Results and Discussion

Lithology

Analysis from the well logs shows that the lithology ranged from shaly-sand to sandy-shale to and shale (Figure 2). However, there are significant differences in the sandy units and the shaly units; this is not unusual in this type of depositional environment (Braide, 1983). Accessory minerals include mica flakes, carbonaceous materials at the upper part of the well while the lower part of the well accessory minerals include pyrite and some traces of glauconite.



Description
Alternation of sand and shale of almost equal proportion, sand is well sorted, fine grain with mica flakes and some broken pieces of shell while shale is dark grey and platy with few carbonaceous materials
Alternation of sand and thick shale, sand is well sorted, fine grain and glauconitic at some intervals while shale is dark grey and fissile.

Figure 2: Lithologic column of the Well BL-1X

Biostratigraphy

Foraminifera recovered were generally low to moderate both in abundance and diversity. However, abundant foraminifera were recovered within intervals 8310- 8490ft, 9600-9630ft, 9990-10080ft, 10440-10620ft, 11280-11310ft, 11520-11760ft and 12600-12870ft. One hundred and twenty-seven (127) foraminifera species were recovered. Twenty-nine (23%) of these were planktonics, fifty-seven (45%) were calcareous benthonics while the remaining forty-one (32%) were arenaceous benthonics. Associated microfauna present were shell fragments, pelecypod and gastropods.

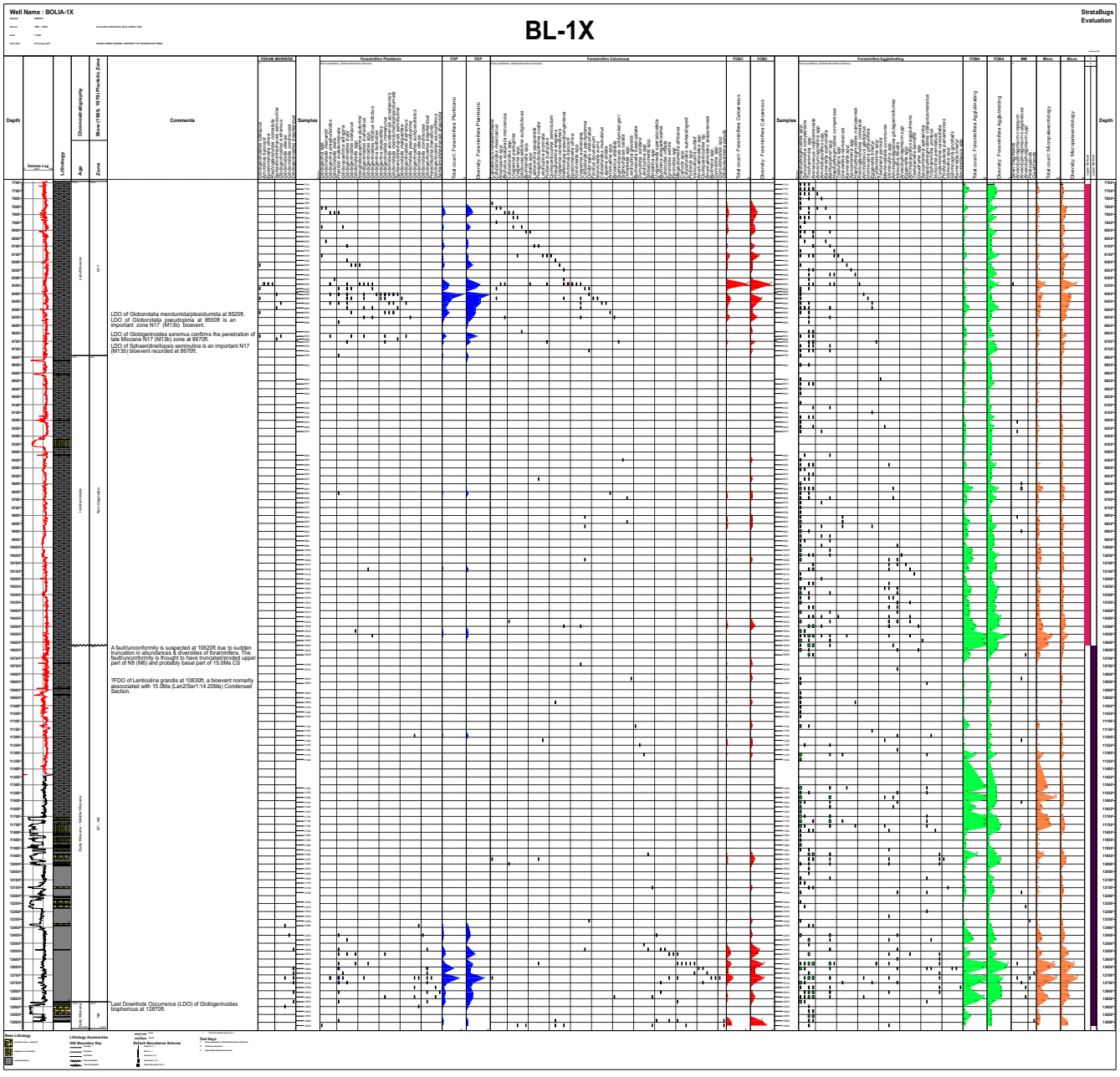


Figure 3: Foraminiferal distribution chart of BL-1X

Biozonation

The following bioevents are significant in the zonal delineations of the studied well intervals:

I. First and Last Downhole Occurrences (FDO and LDO) of chronostratigraphically important planktic and benthic foraminiferal species.

ii. Foraminiferal abundance and diversity peaks when datable with foraminiferal marker species whose stratigraphic ranges are well established in the Niger Delta and worldwide.

The planktic foraminiferal zones recognized in this study are based on the revised Cenozoic geochronologic and Chronostratigraphic Schemes of Berggren *et al*. (1995) and Blow (1969, 1979). Planktic foraminiferal zones recognized in this study are summarized in Figure 4 and briefly described below.

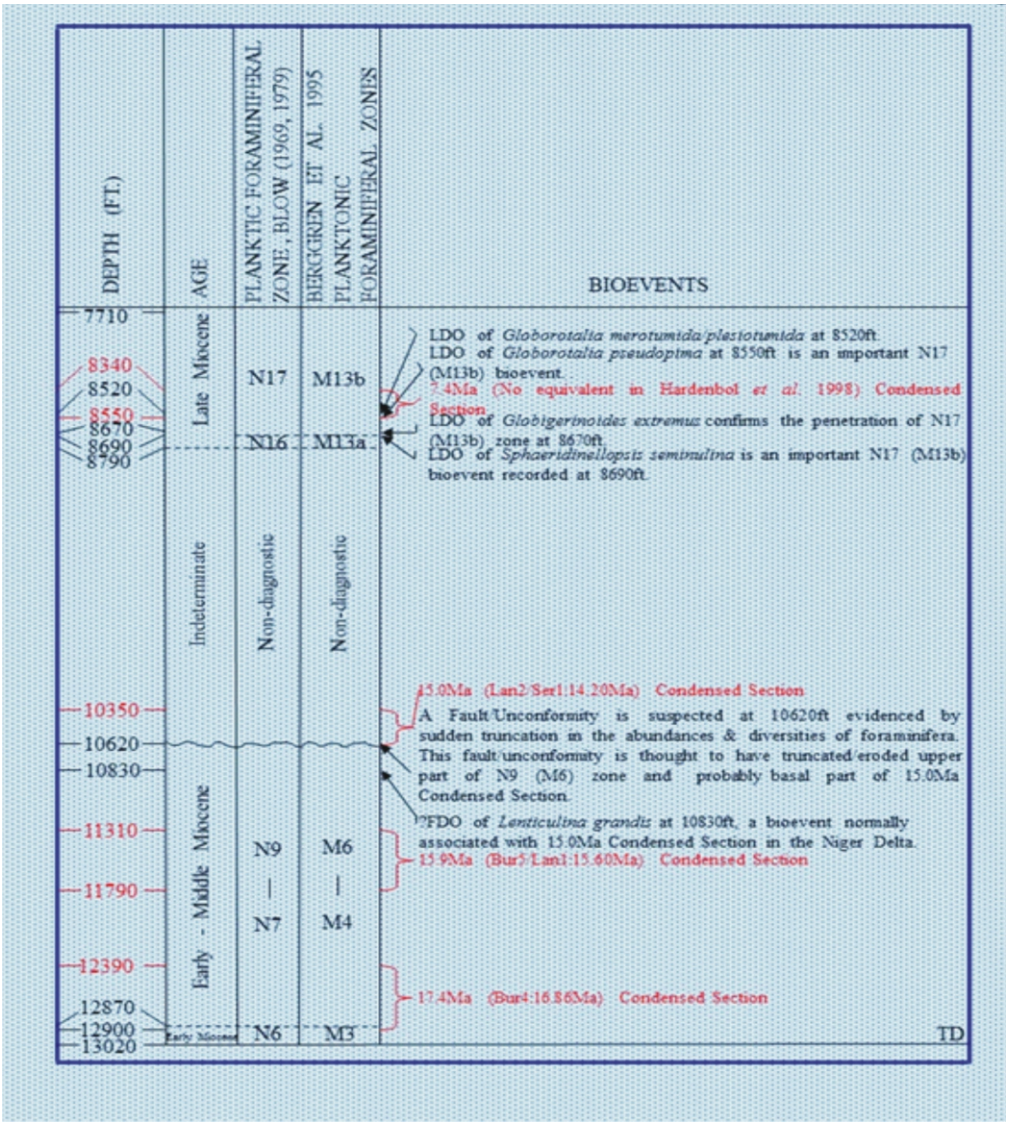


Figure 4: Foraminiferal biozonation of well BL-1X

Globigerinoides extremus-G. humerosa zone N17 (M13b) – interval zone

Stratigraphic Interval: 7710-8690ft

Age: Late Miocene

Diagnosis: Top of the zone is tentatively placed at 7710ft, top of the analyzed section whilethe base is defined by the Last Downhole Occurrence (LDO) of *Spheroidinellopsis seminulina at 8690ft*. The interval is characterized by low to moderate abundance but low diverse planktics. Planktics recorded include *Neogloboquadrina dutertrei*, *Globorotalia pseudopima*, *Globorotalia acostaensis acostaensis*, *Globigerinoides bolli* and *Globigerina nepenthes*. Last Downhole Occurrences (LDOs) of *Globorotalia merotumida*/*plesiotumida* (8520ft), *Globorotalia pseudopima* (8550ft) and *Globigerinoides extremus* (8670ft) are important Late Miocene *Globigerinoides extremus-G. humerosa zone* (N17) (M13b) bioevents recorded. These confirmed both the zonal and age assignments to the interval.

Remarks: Last Downhole Occurrence (LDO) of *Globigerinoides extremus* is normally used to delineate *Globigerinoides extremus-G. humerosa zone* (N17) (M13b)/ *Globorotalia acostaensis acostaensis* (N16)(M13a) zonal boundary, but LDO of *Spheroidinellopsis seminulina* which is in N17 (M13b) was delineated at 8690ft slightly below it, showing that the interval is still within N17 (M13b) zone at depth 8690ft.

Globorotalia acostaensis acostaensis zone N16 (M13a) – taxon range zone

Stratigraphic Interval: 8690-8790ft

Age: Late Miocene

Diagnosis: Top of the interval is defined by the Last Downhole Occurrence (LDO) of *Spheroidinellopsis seminulina at 8690ft while the base is tentatively placed at 8790ft, the top of the non-diagnostic zone*. The interval is characterized by low abundance and low diverse planktics. Planktics indeterminate species was the only planktic recovered.

Remarks: Age and zonal assignments to the interval is based on superposition as it lies below a positively identified and well dated *Globigerinoides extremus*/*G. humerosa* (N17) (M13b) zone.

Stratigraphic Interval: 8790-10620ft

Planktic foraminifera Zone: Non-diagnostic

Age: Indeterminate

Diagnosis: Top of the non-diagnostic zone is placed at *the base of N16 (M13a) zone while the base is approximated at the depth of the suspected fault/uncoonformity at 10620ft. The interval is characterized by long-ranging and non-age diagnostic planktics which made both zonal and*

age assignment to the interval difficult. *Globigerinoides trilobus trilobus*, planktic indeterminate species, species of *Globorotalia* and *Globigerinoides* were the only planktics recovered. There is a sudden drop in the abundances and diversities of foraminifera at 10620ft. This is thought to have been caused by either a fault or unconformity. This fault/unconformity is thought to have cut off or eroded the upper parts of N9 (M6) zone.

Globorotalia fohsi peripherronda - Globigerinatella insueta zone -N9-N7 (M6-M4) – interval zone

Stratigraphic Interval: 10620-12870ft

Age: Middle - Early Miocene

Diagnosis: Top of the combined *Globorotalia fohsi peripherronda - Globigerinatella insueta zone (*N9-N7) (M6-M4) zones is approximated at 10620ft, the unconformity/fault surface while the base is placed at the Last Downhole Occurrence (LDO) of *Globigerinoides bisphericus* at 12870ft.

The upper part of the interval (10620-12450ft) is characterized by dearth of planktics with *Globigerinoides subquadratus* being the only planktonics recovered within the interval. However, the lower part of the interval (12450-12870ft) is characterized by low to moderately abundant but low diverse planktics. Planktics recovered include *Globoquadrina altispira*, *Globigerinoides bollii*, *Globigerinoides bulloides*, *Globorotalia obesa*, *Globorotalia continuosa*, *Praeorbulina transitoria* and *Globigerinoides sacculiferus*.

Remarks: *Globorotalia fohsi peripherronda - Globigerinatella insueta zone (*N9-N7) (M6-M4) are combined due to non-recoveries of *Orbulina suturalis* and *Praeorbulina sicana*, the *Globorotalia fohsi peripherronda - Praeorbulina glomerosa zone* (N9-N8) (M6-M5) and *Praeorbulina glomerosa -Globigerinatella insueta* (N8-N7) (M5-M4) boundary marker species.

Catapsydrax stainforthi zone N6 (M3) – taxon range zone

Stratigraphic Interval: 12870-13020ft

Age: Early Miocene

Diagnosis: Top of the zone is approximated at 12870ft, the Last Downhole Occurrence (LDO) of *Globigerinoides bisphericus* while the base is placed at 13020ft, depth of last sample studied. Low abundance and low diverse planktics characterize this interval. *Globorotalia obesa*, planktonic indeterminate species and *Globigerina* spp were the only planktics recovered.

Paleoenvironment

The lower part of interval 13020-12540ft is characterized by moderate to abundant foraminiferal species while the upper part (12540-10620ft) is characterized by low to abundant foraminiferal species. This microfauna is dominated by arenaceous benthics. Deep water arenaceous benthics recorded include *Saccammina coplanata*, *Ammodiscus glabratus*, *Eggerella bradyi*, *Gravellina narivaensis*, *Haplophragmoides obliquicameratus*, *Cyclammina cancellata*, *Glomoospira gordialis*, *Karreriella bradyi*, species of *Bathysiphon* and *Trochammina*. Associated deep water calcareous benthics present include *Anomalinoides alazanensis*, *Oridosalis umbonatus*, *Praeglobobulimina ovata* and *Globocassidulina subglobosa.* Accessory microfauna were rare within the interval. Pelecypods and gastropods were the only ones recovered. The sediments of the interval were deposited in lower bathyal environment.

An unconformity/fault is suspected at 10620ft as evidenced by abrupt increase in abundances and diversities of microfauna. However, the span could not be ascertained. Above the unconformity/fault surface at 10620ft, arenaceous benthics continued to dominate the microfauna assemblage up to 8700ft. The dominance of arenaceous benthics may be as a result of environmental conditions favorable for the proliferation/thriving of arenaceous benthics like slow rate of deposition, cooler bottom water conditions, high oceanic influx and anerobic bottom water conditions. Above 8700ft to the top of the well, there were changes in environmental conditions favorable for the proliferation of calcareous benthonic foraminifera like warmer environments lower oceanic influx, slower rate of sedimentation and oxygenated bottom water conditions. These led to the resurfacing of calcareous foraminifera. Deep water arenaceous benthics recorded include *Saccammina coplanata*, *Karreriella siphoonella*, *Haplophragmoides compressa*, *Gravellina narivaensis*, *Haplophragmoides narivaensis*, *Ammodiscus glabratus*, species of *Bathysiphon* and *Karreriella*. *Uvigerina peregrina*, *Globocassidulina subglobosa*, *Laticarinina pauperata*, *Pullenia bulloides* and *Hoeglundina elegans* are among the associated deep water calcareous benthics present. Shell fragments were the only accessory microfauna recovered. The sediments of interval 8620-7710ft were deposited in upper bathyal environment.

Summary and Conclusion

This study reports on foraminifera assemblages from sediments penetrated by BL-1X well in the deep offshore Niger delta basin. The well is rich in diverse planktonic and benthic foraminiferal assemblages. Planktonic zones: *Globigerinoides extremus- G. humerosa zone – interval zone, Globorotalia acostaensis acostaensis zone – taxon range zone, Globorotalia fohsi peripherronda - Globigerinatella insueta zone – interval zone and Catapsydrax stainforthi zone – taxon range zone was established in the studied well and are* correlatable with Blow (1969, 1979) and Berggren (1995). An early to late Miocene age has been assigned to the studied interval in BL-1X.

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