

Biostratigraphy and Paleoecology of FT-1 Well, Offshore Niger Delta, Nigeria: Implications for Paleoenvironment of Deposition

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Abstract

Although biostratigraphy and paleoecological studies are central to reconstructing paleodepositional environments and constraining source and reservoir rock distribution during petroleum exploration, detailed applications in offshore Niger Delta wells remain limited. This study analyzes the lithostratigraphy and foraminiferal assemblages of the FT-1 Well, offshore Niger Delta, over the 2,300–2,550 m interval to reconstruct the stratigraphic framework and paleoenvironmental history. Lithostratigraphic analysis reveals predominantly shaly facies, whereas foraminiferal biostratigraphy shows the dominance of benthic species (68.4%) over planktonic species (31.6%), a relationship that is diagnostic of outer–upper bathyal marine settings. The studied interval is assigned to the N18–N19 planktonic foraminiferal zones and to the NNDF 04–NNDF 06 benthic foraminiferal zones of the Neogene Niger Delta. The section is richly fossiliferous, containing abundant and diverse foraminiferal assemblages. The top of the N18–N19 interval is tentatively placed at 2,300 m based on the First Downhole Occurrence (FDO) of *Globigerina nepenthes*, while the base is constrained by the Last Downhole Occurrences (LDOs) of *Neogloboquadrina dutertrei* and *Globorotalia tumida* at 2,490 and 2,540 m, respectively. The NNDF 04 Zone extends from 2,300 to 2,430 m and is marked at its base by the occurrence of *Cyclammina cf. minima*; NNDF 05

spans 2,430–2,460 m, defined by the FDOs of *C. cf. minima* and *Haplobragmoides narivaensis*; NNDF 06 extends from 2,460 m to 2,550 m, the deepest analyzed sample, and is characterized by the continued occurrence of *H. narivaensis*. Paleoecological interpretation of the foraminiferal assemblages indicates mostly tropical–subtropical conditions with normal marine salinity, but includes cooler-water indicators such as *Cyclamina cf. minima*, *Globocassidulina subglobosa*, *Uvigerina hispida*, and *Uvigerina auberiana*, which are typical deep-water species. On the basis of the N18–N19 planktonic zonation, the sediments are interpreted to have been deposited during the Late Miocene–Early Pliocene. Collectively, these findings refine the stratigraphic framework and enhance understanding of the paleoenvironmental evolution of the Niger Delta’s offshore deposits, with implications for more accurate prediction of petroleum system elements.

Keywords: Biostratigraphy; Foraminiferal Zonation; Paleoenvironmental Reconstruction; Niger Delta; Late Miocene–Early Pliocene

INTRODUCTION

The intersection of the Benue Trough and the South Atlantic Ocean where a triple junction developed during the separation of the continents of South America and Africa in the late Jurassic as stated by Amos-Uhegbu *et al* (2024) is where the Cenozoic Niger Delta is situated at. It is the youngest of the three large sediment bodies that filled the aulacogen formed after the separation of the African and South American plates (Adegoke *et al.*, 2017).

Province contains only one identified petroleum system (Anomneze *et al*, 2025). It is one of the world’s largest deltas and shows an overall upward transition from the basal Paleocene to Recent pro-delta marine shales (Akata Formation) through the Eocene to Recent sand-shale paralic facies (Agbada Formation) to the Oligocene to Recent fluvial continental sands of the Benin Formation (Obaje, 1999).

Exploration activities in the Niger Delta which dates back to the 1950s recalls the accessibility to subsurface formations that characterize the basin. Wells have been drilled in thousands across the delta penetrating the sediments in which petroleum generation, migration and accumulation have occurred. The large amount of data obtained from each well drilled have been to the considerable understanding of the regional geology and

stratigraphy of the basin. These data are usually acquired via wireline logs and 3D reflection seismology techniques (Obaje, 1999).

Many techniques have and are still been undertaken to understand the petroleum system in the Niger Delta for more discoveries of hydrocarbon pool. Selected authors have used foraminifera to study biostratigraphy, paleoenvironment and Sequence stratigraphy Jayaraju *et al* 2010; Okosun & Chukwumaorji 2016; Abubakar *et al* 2017; Nwaejije *et al* 2017; Ukpong and Anaynwu 2018 a&b; Umoh & Fasina 2020; Adeola *et al* 2021; Abubakar *et al* 2021; Sedimentology, Paleobathmetry and paleosalinity Itiowe *et al* 2020; Asadu & Ajogu 2023; Kiamuke & Adebayo 2020; and paleoecological Oluwajana *et al* 2021; Oretade *et al* 2022; Adeoye *et al* 2022; Integrating foraminifera, calcareous nannofossil and palynormorphs to study biostratigraphy, paleoenvironment and paleosalinity studies Boboye & Adeleye 2009; Fajemela 2012; Obaje & Okosun 2013; Fadiya *et al* 2014; Adeigbe & Adeleye 2016; Joshua *et al* 2020. All of these studies and discoveries plays important roles in revealing information on source and reservoir rocks leading to identification of a petroleum system.

This study seeks to determine the age, biozonation, paleoenvironmental, and paleoecology of foraminifera in the study well as a contribution to existing database of the Niger Delta and to aid exploration activities.

Location of the Study Area

The study area falls within the western offshore of the Niger Delta basin (in Figure 1) which occupies the Gulf of Guinea continental margin in equatorial West Africa (Nwajide, 2013). The Niger Delta is in the southern part of Nigeria, between longitudes 3-9° E and latitudes 4°31'-5°20'N and lies in the humid tropics (Uwadiae Oyegun, et al., 2023).

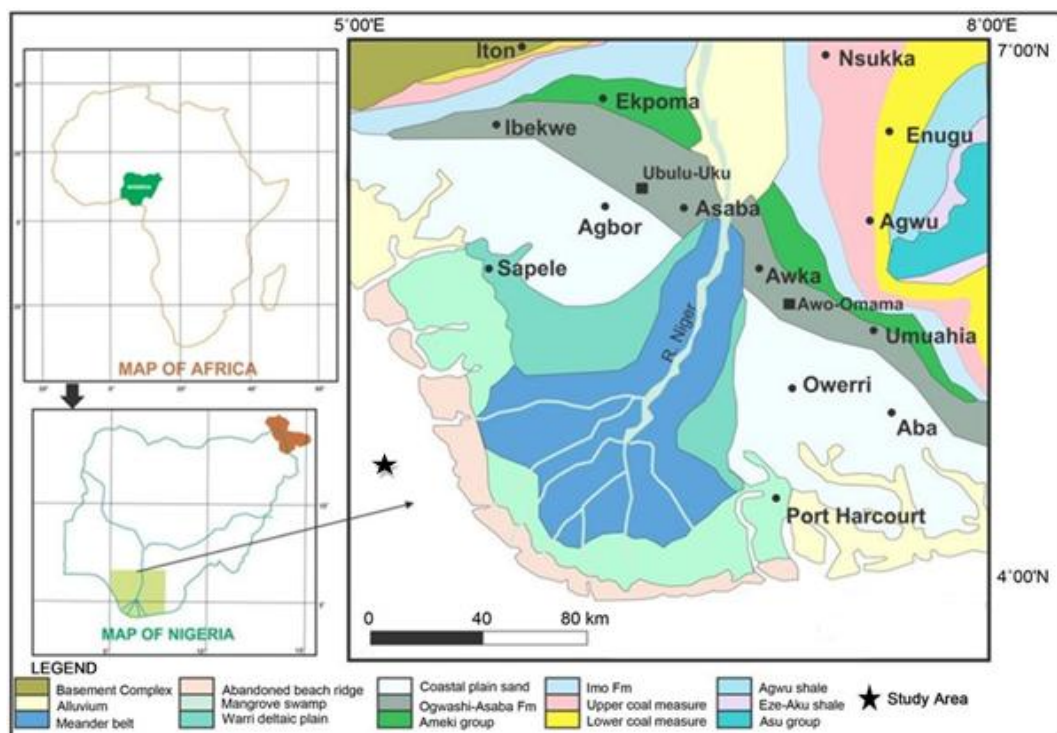


Figure 1: Map of the Niger Delta highlighting the Study Area (modified after Nwajide, 2013)

METHODOLOGY

A total of twenty-five (25) ditch cutting samples from FT-1 Well, Western offshore Niger Delta with a depth interval ranging from 2300 m-2550 m were used in this study.

The ditch cutting samples were subjected to analysis under a petrographic microscope per depth interval of 10m, to describe and determine the lithological character such as colour, texture and mineral content from the observations made under the microscope. Data was computed using the StrataBugs software. About 25g of each ditch cutting samples were weighed and soaked in hydrogen peroxide and left overnight to disaggregate after which they were decanted. The samples were washed with distilled water through 63-micron sieve and dried, after which they were packaged in labelled plastic bags and Packaged samples were ready for picking and analysis.

The packaged samples were taken under the microscope for identification of foraminifera species, with the guidance of appropriate Foraminifera literatures including Blow (1969, 1979) and Berggren *et al* (1995). A checklist was made of all foraminifera recovered and a distribution chart was produced. Representative photographs of some of the species recovered are presented in plate 1.

RESULTS AND DISCUSSION

Lithology

From the analysis carried out with the use of a petrographic microscope, it was deduced that Well-FT is dominated by shale (Table 1). However, from depth 2460 m to 2530 m, sandy-shale was observed, with the quartz content is observed to range from 30% to 50%. The lithological analysis showed that the shales and sandy shales are grey in Colour. The samples were fine to medium grained. The size of the grains ranged from sub-angular to rounded, and were poorly sorted. Minerals observed include muscovite, felsic and mafic clay minerals (where the mafic minerals were quite predominant) and biotite. Based on the sandy-shale occurrence from depth 2460 m to 2530 m, the well is suggested to be a section of the Agbada Formation of Niger Delta.


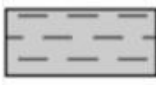




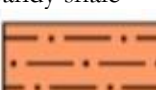


Biostratigraphy








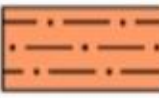
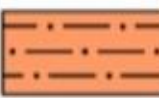
Preservation of foraminifera in the ditch cutting samples was fair. Fairly abundant diverse planktonic species (31.6%), characteristic deep-water benthic species and agglutinated forms (68.4%) were recovered from the section. Accessory microfauna such as ostracod and scaphopod were also recorded. Some species recovered include *Globigerina nepenthes*, *Globigerinoides obliquus obliquus*, *Cyclammmina cf. minima*, *Globigerina praebulloides*, *Globoquadrina dutertrei*, *Globigerinoides bolli*, *Globigerinoides trilobus immaturus*, *Globorotalia spp*, *Globocassidulina subglobosa*, *Heterolepa pseudoungeriana*, *Uvigerina hispida*, *Uvigerina auberiana*, *Valvulina flexillis*, *Glomospora charoides*, *Ammobaculites strathaenensis* (Appendix 1).

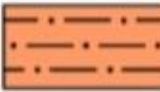
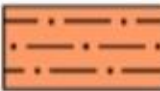





The studied section is assigned to the N18-N19 planktonic foraminiferal zones based on the planktonic foraminiferal zonation scheme of Bolli and Saunders, (1989) and NNDF 04 Zone – NNDF 06 Zone of Neogene Niger Delta Benthonic Foraminifera Zonation. Stratigraphic Interval; 2300-2550m, Planktonic foraminiferal Zones; N18-N19, Benthonic Foraminifera Zone - NNDF 04 Zone – NNDF 06, Age ; Early Pliocene–Late Miocene

Table 1: Lithological description

| S/ N | Sample Depth | Lithology | Descriptions | Minerals |
|---------|-----------------|-----------|--------------|----------|
|---------|-----------------|-----------|--------------|----------|

| S/N | Sample Depth | Lithology | Descriptions | Minerals |
|-----|--------------|--|--|---|
| 1 | 2300 - 2310 | Shale  | Fine to medium grained (70% medium grained), sub-angular, poorly sorted, greyish shale | Quartz (about 5%), mafic and felsic clay minerals (where mafic > felsic content), muscovite |
| 2 | 2310 - 2320 | Shale  | Fine to medium grained (70% medium grained), moderately rounded, poorly sorted, greyish shale | Quartz (about 5%), mafic and felsic clay minerals (where mafic > felsic content), muscovite |
| 3 | 2320 - 2330 | Shale  | Fine to medium grained (70% medium grained), sub-angular, poorly sorted, greyish shale | Quartz (< 5%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 4 | 2330 - 2340 | Shale  | Fine to medium grained (70% medium grained) moderately rounded, poorly sorted, greyish shale | Mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 5 | 2340 - 2350 | Shale  | Fine to medium grained (90% medium grained), moderately rounded, poorly sorted, greyish shale | Mafic and felsic clay minerals (where mafic > felsic content), muscovite |
| 6 | 2350 - 2360 | Shale  | Fine to medium grained (70% medium grained), moderately rounded, poorly sorted, greyish shale | Mafic and felsic clay minerals (where mafic > felsic content), muscovite |
| 7 | 2360 - 2370 | Sandy shale  | Fine to medium grained (70% medium grained), rounded, poorly sorted, greyish sandy shale, with obvious fissility | Quartz (about 30%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 8 | 2370 - 2380 | Shale  | Fine to medium grained (70% medium grained), rounded, poorly sorted, greyish shale, with obvious fissility | Quartz (< 10%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 9 | 2380 - 2390 | Shale  | Fine to medium grained (60% medium grained), rounded, poorly sorted, greyish shale, with fair fissility | Quartz (< 5%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |

| S/N | Sample Depth | Lithology | Descriptions | Minerals |
|-----|--------------|--|---|---|
| 10 | 2390 - 2400 | Shale  | Fine to medium grained (90% medium grained), rounded, poorly sorted, greyish shale, with fair fissility. | Quartz (< 5%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 11 | 2400 - 2410 | Shale  | Fine to medium grained (70% medium grained), rounded, poorly sorted, greyish shale, with fair fissility | Quartz (< 5%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 12 | 2410 - 2420 | Shale  | Fine to medium grained (60% medium grained), rounded, poorly sorted, greyish shale, with fair fissility | Quartz (< 5%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 13 | 2420 - 2430 | Shale  | Fine to medium grained (90% medium grained), sub-angular to moderately rounded, poorly sorted, greyish shale, with fair fissility | Quartz (< 10%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 14 | 2430 - 2440 | Shale  | Fine to medium grained (80% medium grained), sub-angular, poorly sorted, greyish shale | Quartz (<5%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 15 | 2440 - 2450 | Shale  | Fine to medium grained (80% medium grained), sub-angular, poorly sorted, greyish shale, with fair fissility | Quartz and feldspar (< 5%), mafic clay minerals, muscovite, biotite |
| 16 | 2450 - 2460 | Shale  | Fine to medium grained (70% medium grained), sub-angular to rounded, poorly sorted, greyish shale, with fair fissility | Quartz (< 10%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 17 | 2460 - 2470 | Sandy shale  | Fine to medium grained (80% medium grained), sub-angular to rounded, poorly sorted, greyish sandy shale, with fair fissility | Quartz (about 50%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |
| 18 | 2470 - 2480 | Sandy shale  | Fine to medium grained (70% medium grained), sub-angular to moderately rounded, poorly sorted, greyish sandy shale, with fair fissility | Quartz (about 50%), mafic and felsic clay minerals (where mafic > felsic content), muscovite, biotite |

| S/N | Sample Depth | Lithology | Descriptions | Minerals |
|-----|--------------|--|--|--|
| 19 | 2480 - 2490 | Sandy shale  | Fine to medium grained (60% medium grained), sub-angular, poorly sorted, greyish sandy shale, with fair fissility | Quartz (about 50%), mafic clay minerals, muscovite, biotite |
| 20 | 2490 - 2500 | Sandy shale  | Fine to medium grained (80% medium grained), sub-angular, poorly sorted, greyish sandy shale, with obvious fissility | Quartz (about 40%), mafic clay minerals, muscovite, biotite, traces of silt. |
| 21 | 2500 - 2510 | Sand shale  | Fine to medium grained (80% medium grained), sub-angular, poorly sorted, greyish sandy shale, with fair fissility | Quartz (about 40%), mafic clay minerals, muscovite, biotite, traces of silt |
| 22 | 2510 - 2520 | Sandy shale  | Fine to medium grained (70% medium grained), sub-angular, poorly sorted, greyish sandy shale, with fair fissility | Quartz (about 40%), mafic clay minerals, muscovite, biotite, traces of silt |
| 23 | 2520 - 2530 | Sandy shale  | Fine to medium grained (50% medium grained), well rounded, poorly sorted, greyish sandy shale, with fair fissility | Quartz (about 30%), mafic clay minerals, muscovite, biotite, traces of silt |
| 24 | 2530 - 2540 | Shale  | Fine to medium grained (70-80% medium grained), well rounded, poorly sorted, greyish shale, with fair fissility | Quartz (5-10%), mafic clay minerals, muscovite, biotite, traces of silt |
| 25 | 2540 - 2550 | Shale  | Fine to medium grained (70% medium grained), rounded, poorly sorted, greyish shale, with fair fissility | Quartz (< 5%), mafic clay minerals, muscovite, biotite |

Biozonation

Planktonic Foraminifera Zonation

Stratigraphic Depth Interval: 2300 – 2550 m

Zone: N18–N19 of Bolli and Saunders, (1989)

Epoch: Early Pliocene – Late Miocene

Age: Zanclean- Messinian

Characteristics: The top of this interval was tentatively placed at the shallowest depth, 2300 m. The interval is characterized by the First Downhole Occurrences (FDOs) of *Globigerina nepenthes*, and at 2330m and the Last Downhole Occurrences (LDOs) of *Neogloboquadrina dutertrei* at 2490m and *Globorotalia tumida* at 2540m. The interval is richly fossiliferous containing abundant and diverse assemblage of foraminifera. Base of the interval is placed at 2550 m, which is the deepest sample analyzed for the section (Fig. 2).

Benthonic Foraminifera Zonation

Stratigraphic Depth Interval: 2300 – 2430m

Zone: *Marginulina costata* (NNDF 04)

Epoch: Early Pliocene – Late Miocene

Age and Correlation: 5.47Ma (Zanclean-1/Messinian-2) and younger, according to Gradstein et al., (2012).

Characteristics: The top of this interval was tentatively placed at the shallowest depth, 2300 m where the first sample was analyzed and the base of the zone is placed at 2430m characterized by FDO of *Cyclammina cf. minima* dated 5.47Ma (Fig. 2). Important bioevent recorded within the Zone include the FDO's of *V. flexilis*. The zonal assemblage is commonly dominated by *A. crassum*, *Bulimina inflata*, *H. pseudoungeriana*, *Gyroidina spp*, and *C. cancellata* (Appendix 1). This zone is equivalent of the upper N18-N19 planktonic foraminifera zones of the Berggren *et al.*, (1998a, and b). This zone is the oldest benthonic foraminifera Zone of the Pliocene recognized in the Niger Delta region.

Stratigraphic Depth Interval: 2430 – 2460m

Zone: *Cyclammina minima* (NNDF 05)

Epoch: *Late Miocene*

Age and Correlation: 5.47Ma (Zanclean-1/Messinian-2) – 5.99Ma (Messinian 1/Tortonian 3) according to Gradstein *et al.*, (2012)

Characteristics: This zone is known as the youngest benthonic foraminiferal zone in the Late Miocene of the Niger Delta. The top of the zone at 2430m is characterized by FDO of *C. minima* and lone occurrence of *Ammobaculites stratbearnensis*, which are indicative

of deep water setting and had been correlated to 5.47Ma and the base is set at 2460m characterized by FDO of *Haplophragmoides narivaensis* which is dated 5.99Ma (Fig. 2).

Foraminifera Zonation of FT-1 WELL -(2300 – 2550m)

| DEPTH (m) | SYSTEM/ PERIOD | SERIES/ EPOCH | STAGE /AGE | Gradstein et al., (2012) | Neogene Niger Delta Planktonic Foram zone | Planktonic Foram Zone of Berggren (1998 a,b) | This Study | Key bio-events |
|-----------|-----------------|--------------------------------------|-----------------|--------------------------|---|--|--------------------------|--|
| 2300 | TERTIARY | LATE MIOCENE – EARLY PLIOCENE | ZANCLEAN | ZANCLEAN1 | NNDF 04 | “upper” N18 – N19 | “upper” N18 – N19 | First sample analyzed |
| 2350 | | | | | | | | FDO of <i>Globigerina nepenthes</i> at 2330m |
| 2400 | | | | | | | | |
| 2450 | | | | | | | | FDO of <i>Cyclonina minima</i> (5.47Ma) at 2430m |
| 2500 | | | | | | | | FDO of <i>Haplophragmoides narivaensis</i> (5.99Ma) at 2460m |
| 2550 | | | | | | | | Lone occurrence of <i>Globocassidulina duterrei</i> at 2490m |
| | | | | | | | | LDO of <i>Globorotalia nana</i> at 2540m |
| | | | | | | | | Last sample analyzed |

Figure 2: Foraminifera zones in FT-1 Well

One remarkable feature of this zone is the major influx of agglutinated foraminifera with a significant drop in both the abundance and diversity of calcareous and almost absolute absence of planktonic forms. This sudden change has been attributed to the effect of the terminal “Messinian Salinity Crisis event” (Adegoke et al., 2017). This Zone is further characterized by the top regular occurrence of *Haplophragmoides sp*, *Bathysiphon spp*, *Glomospira charoides*, and *Trochamina spp.*, all co-occurring with rare calcareous forms, such as *Globocassidulina subglobosa*, *Sigmollopsis schlumbergeri*, *Uvigerina auberiana*, *Hanzawala spp*, *H. elegans*, and *Nodasaria spp*. The zone has been confirmed to be equivalent of the upper N17- Lower N18 planktonic foraminiferal zones of Berggren *et al* (1998a,b).

Stratigraphic Depth Interval: 2460 – 2550 m

Zone: *Haplophragmoides narivaensis* (NNDF 06)

Epoch: Late Miocene

Age and Correlation: 5.99 Ma (Tortonian 3/Messinian 1) and older according to Gradstein *et al.*, (2012).

Characteristics: The top of the zone is described by the FDO of *H. narivaensis* at 2460m correlated to be 5.99Ma (Gradstein *et al.*, 2012) while the zonal base is defined by last and deepest sample analyzed for the section. The Zone is also further marked by co-occurrence of calcareous foraminiferal and agglutinated forms like *Erggerella scabra*, *Erggerella brady*, *Trochammina spp.*, *C. minima*, *C. cancellata*, *Sigmollopsis schlumbergeri*, and *Uvigerina Auberiana*. According to Gradstein *et al.*, (2012) the zone is dated Late Miocene (7.72–5.99 Ma), and corresponds with the “middle” N17 Zone of Berggren *et al.* (1998a,b). However, diagnostic marker for the base of the zone was not encountered so the interval can best be described to be older than 5.99Ma and not as late as 7.72Ma.

Paleoenvironment

The fairly abundant and diverse planktonic species and characteristic deep-water benthic species recovered from the section suggest **outer neritic/upper bathyal** bathymetric setting for the well section. The benthic species include *Pyrgo bulloides* (at depth 2550 m), *Globocassidulina subglobosa* (at depths 2310 m, 2330 m, 2350 m, 2380–2390 m, 2430–2440 m, 2490–2520 m, 2540 m), *Bulimina inflata* (at depths 2310 m, 2470 m, 2490 m, 2510 m, 2540–2550m), *Hanwaia mantaensis* (at depths 2310–2350 m, 2370 m, 2410 m, 2470 m, 2490–2510 m, 2530–2550 m). *Uvigerina hispida* (at depths 2310 m, 2350 m, 2430 m, 2460 m, 2490 m, 2540–2550 m, *Uvigerina auberiana* (at depths 2330–2340 m, 2380 m, 2460 m, 2500 m, 2540–2550 m), *Pullenia quinqueloba* (at depths 2500–2510 m, 2530 m, 2550 m), *Gyroidinoides neosoldani* (at depths 2510 m, and 2550 m), *Epistominella vitrea* (at depth 2540 m), *Sphaeroidina bulloides* (at depth 2540 m), *Oridosalis umbonatus* (at depths (2530–2550 m) and *Hoeglundina elegans* (at depth 2470 m), *Cyclammina cf. minima* (2430 m and 2540 m), *Cribrostomoides spp.* (at depths 2340 m, 2390–2420 m, 2450– 2460 m, 2550 m), *Saccammina complanata* (at depths 2390 m, 2430 m, 2450 m, 2480 m, 2500 m, 2530 m, 2540 m), *Sigmoilopsis schlumbergeri* (at depths 2350 m, 2450 m, 2520 m, 2550 m), *Glomospira gordiales* (at depths 2480 m and 2530 m), *Glomospira charoides* (at depths

2430– 2450 m), *Cyclammina cancellate* (at depths 2380 m, 2440 m, 2530 m), and *Alveolophragmium crassum* (at depth 2400 m).

Paleoecology (Paleodepth, Paleosalinity and Paleotemperature of Index Fossils)

Index fossils observed are *Globigerina nepenthes*, *Globigerinoides obliquus obliquus*, *Cyclammina cf. minima* and *Globoquadrina dutertrei*. Most of the forms are found in neritic to bathyal part of the ocean, salinity of the forms identified are normal while the indicates that most forms are found in warm to temperate regions but with some specific forms like *Cyclammina cf. minima*, *Globocassidulina*, *Uvigerina hispida*, *Uvigerina auberiana* found in the cold areas Table 2.

Table 2: Paleodepth, Paleosalinity and Paleotemperature of Index Fossils

| S/ N | Index/Zone Fossil | Paleodepth | Paleosalinity | Paleotemperature |
|------|--|--|--|---|
| 1. | <i>Globigerina nepenthes</i> | This species is generally associated with upper neritic to epipelagic zones, found in shallow marine environments down to about 200 meters. | As a planktonic foraminifer, it thrived in normal marine salinities, which are generally around 35 PSU (Practical Salinity Units). | Prefers warmer waters, typically in the range of tropical to subtropical sea surface temperatures, approximately 20-28°C. |
| 2. | <i>Globigerinoides obliquus obliquus</i> | This species is typically found in open ocean settings, at depths ranging from the surface to the upper part of the thermocline (up to 200 meters). | Lives in normal marine salinity conditions (around 35 PSU). | Found in tropical to subtropical waters, with preferred temperatures ranging from 20-28°C. |
| 3. | <i>Cyclammina cf. minima</i> | Associated with deeper marine settings, ranging from the upper bathyal zone to the lower neritic zone, typically found at depths between 200 to 1000 meters. | Prefers normal marine salinity (around 35 PSU). | Often found in cooler, deeper water temperatures, generally between 10-15°C. |
| 4. | <i>Globoquadrina dutertrei</i> | This species is also planktonic. Inhabits intermediate depths in the ocean, typically found in the | Thrives in normal marine salinity conditions (around 35 | Lives in subtropical to temperate waters, with temperatures ranging from 15-25°C. |

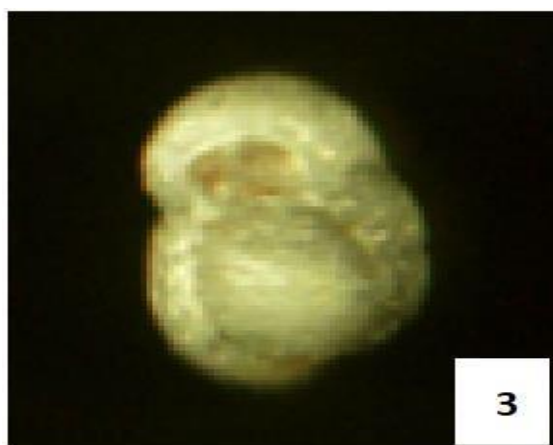
| S/N | Index/Zone Fossil | Paleodepth | Paleosalinity | Paleotemperature |
|-----|---|--|----------------------------------|--|
| | | thermocline layer, ranging from 100 to 500 meters depth. | PSU). | |
| 5. | <i>Globigerinoides bolli</i> | Shallow to intermediate waters (upper photic zone, 0-200 meters). | Normal marine salinity (35 PSU). | Warm waters (tropical to subtropical, 20-30 °C). |
| 6. | <i>Globigerina praebulloides</i> | Intermediate waters (epipelagic to upper mesopelagic, 0-500 meters). | Normal marine salinity (35 PSU). | Warm to temperate waters (15-25 °C). |
| 7. | <i>Globigerinoides trilobus immaturus</i> | Shallow to intermediate waters (upper photic zone, 0-200 meters). | Normal marine salinity (35 PSU). | Warm waters (tropical to subtropical, 20-30 °C). |
| 8. | <i>Globorotalia spp.</i> | Intermediate to deep waters (upper mesopelagic, 200-1000 meters). | Normal marine salinity (35 PSU). | Warm to temperate waters (10-25 °C). |
| 9. | <i>Globocassidulina subglobosa</i> | Deep waters (bathyal to abyssal, 500-4000 meters). | Normal marine salinity (35 PSU). | Cold waters (0-10 °C). |
| 10 | <i>Heterolepa pseudoungeriana</i> | Shallow to intermediate waters (neritic to upper bathyal, 0-500 meters). | Normal marine salinity (35 PSU). | Warm to temperate waters (10-25 °C). |
| 11 | <i>Unigerina hispida</i> | Deep waters (bathyal to abyssal, 500-4000 meters). | Normal marine salinity (35 PSU). | Cold waters (0-10 °C). |
| 12 | <i>Unigerina auberiana</i> | Deep waters (bathyal to abyssal, 500-4000 meters). | Normal marine salinity (35 PSU). | Cold waters (0-10 °C). |
| 13 | <i>Valvulina flexillis</i> | Shallow to intermediate waters (neritic to upper bathyal, 0-500 meters). | Normal marine salinity (35 PSU). | Warm to temperate waters (10-25 °C). |
| 14 | <i>Glomospora charoides</i> | Shallow waters (neritic, 0-200 meters). | Normal marine salinity (35 PSU). | Warm to temperate waters (10-25 °C). |
| 15 | <i>Ammobaculites strathbaenensis</i> | Shallow meters (neritic, 0-200 meters). | Normal marine salinity (35 PSU). | Warm to temperate waters (10-25 °C). |



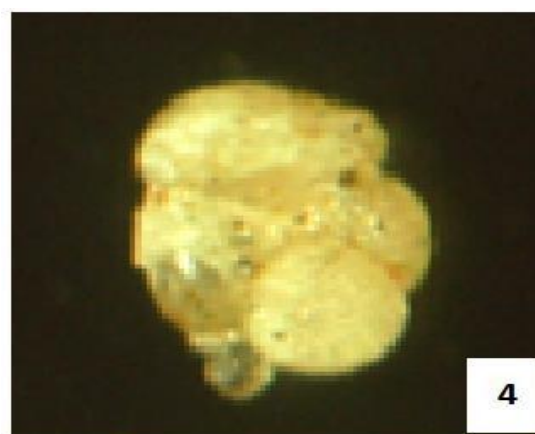
Globigerina nepenthes



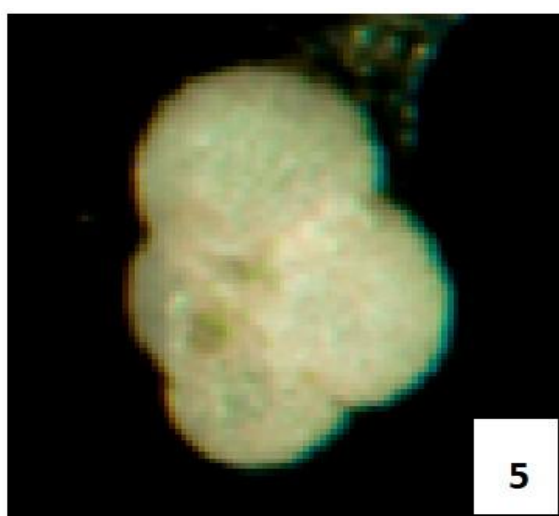
Cyclammina cf. minima



Globigerinoides obliquus obliquus



Globoquadrina dutertrei



Globigerina praebulloides

Plate 1: Photographs of some aof the species recovered from the studied interval

CONCLUSION

Foraminiferal biostratigraphic study has been carried out on FT-1 Well, within a depth of 2300 m – 2550 m located offshore Niger Delta. From the lithological characterization, the well was suggested to be found in the Agbada formation of the Niger delta Basin. Several assemblages of foraminifera and accessory microfauna were recovered from this study. Eighty – two (82) foraminiferal species were recovered from the studied samples. About 32% of these are planktonic species, while 68% are benthic species. Ostracod and scaphopod Accessory were recorded as microfauna.

The studied section was assigned to the N18 – N19 planktonic foraminiferal zones based on the planktonic foraminiferal zonation scheme of Bolli and Saunders, (1989) while the benthic foraminiferal zones was assigned to Neogene Niger Delta zones, NND04, NND05, NND06 based on Gradstein et al., (2012) with the age Late Miocene – Early Pliocene.

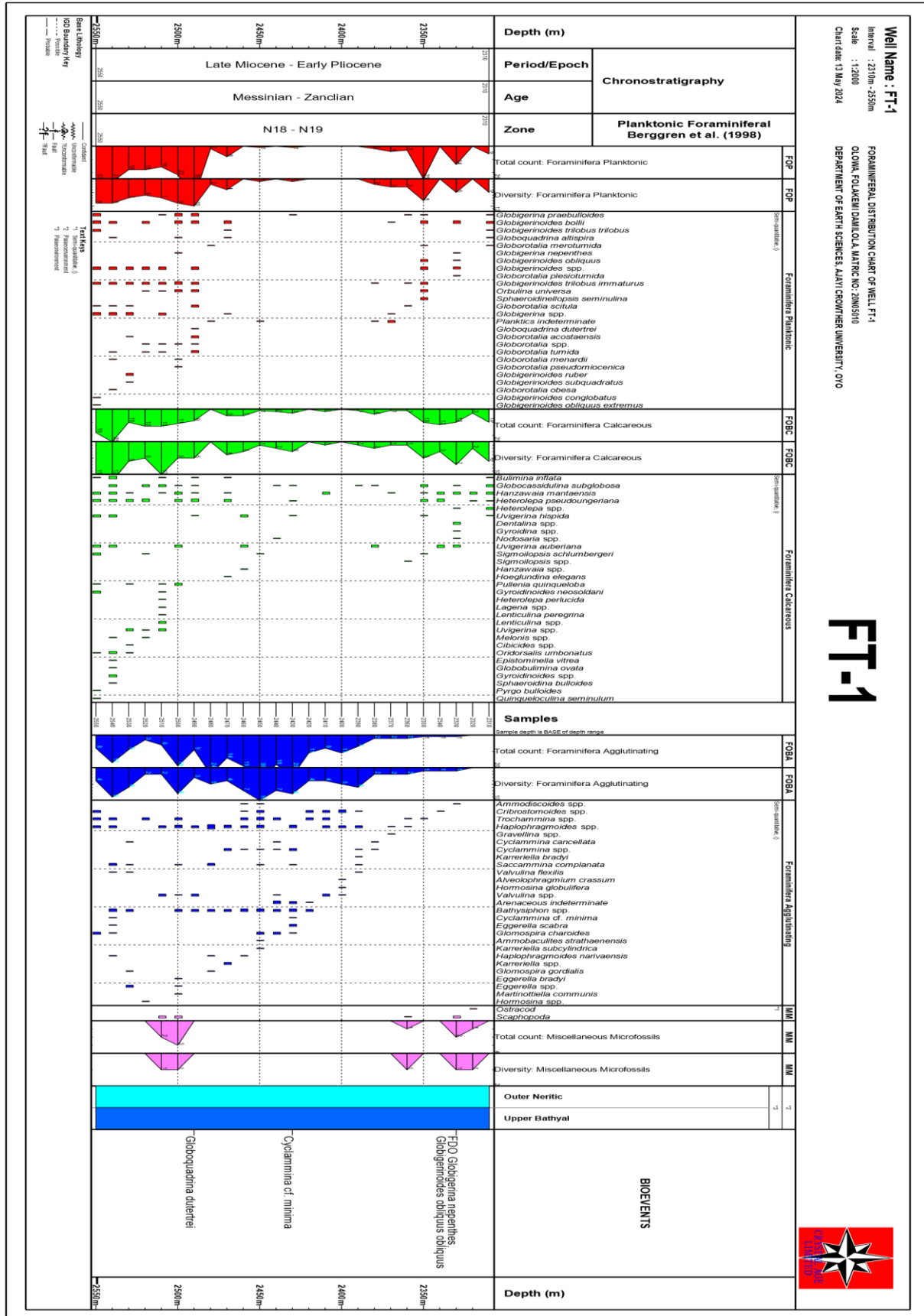
The fairly abundant and diverse planktonic species and characteristic deep-water benthic species recovered from the section suggest outer neritic – upper bathyal bathymetric setting for the well section with a normal salinity level and warm to temperate temperature though NND05 is believed to be a period of “Messinian Salinity Crisis event” as a result of rare to absence of Calcareous Benthic foraminiferal forms in this zone.

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Appendix: Distribution chart of foraminifera recovered from FT-1 well of this study.