NEOGENE PLANKTIC FORAMINIFERAL BIOSTRATIGRAPHY OF SECTION OF KAM- 1 WELL, WESTERN NIGER DELTA, NIGERIA

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Abstract

Neogene planktic foraminiferal Biostratigraphy of 6,960 ft (2121.4 m) – 10,140 ft (3090.7 m) intervals of Kam -1 well, Western Niger Delta, Nigeria was studied to delineate the intervals into planktic zones. 10g each of 53 ditch cuttings samples were processed for foraminiferal extraction using hydrogen peroxide (H_2O_2) and all treated samples were wet sieved with 63 microns mesh screen. Recovered foraminifera were examined with the aid of Olympus binocular microscope. Specific occurrences at intervals and first and last appearances were employed in the delineation of boundaries. Recovery ranges from poor to rich. Recovered planktic foraminifera were identified, evaluated and appraised for their biostratigraphic relevance. N8-N9 planktic zone was established based on last downhole occurrence of *Orbulina universa* which was placed at 9360 ft (2852.9 m), the interval was also characterised by the abundance of *Orbulina universa, Globigerinoides sacculifera* and *Biorbulina bilobata* at 7980 ft (2432.3 m). Below 9360 ft (2852.9 m) was assigned early Miocene even though diagnostic species was not recorded. The entire section was assigned early Miocene / middle Miocene in age. The established N8 –N9 planktic zone could allow regional correlation which underpins most drilling of marine sequences and is key Hydrocarbon exploration.

Keywords: Biostratigraphy, Central Niger delta, Correlation, Diagnostic specie, Miocene, Planktic foraminifera,

Introduction

The Foraminifera are a diverse group of marine protists that are widely distributed throughout the world's marine habitats. They are unicellular eukaryote organisms that likely evolved from an amoeba-like ancestor, and comprise of a single cell, usually encased in a protective shell or 'test' that may be organic, agglutinated or calcareous in nature. (Lee., 1990).

The number of living foraminiferal species has been estimated at approximately 10,000 (Vickerman, 1992). The bulk of these are benthic taxa, species that inhabit marine sediments. The planktonic foraminifera have adopted a pelagic mode of life, free-floating in the water column. In contrast to the benthic taxa, the planktonic foraminifera, are represented by far fewer species, estimated at around 40 – 50. Planktonic species are younger in comparison to their benthic relatives, first appearing in the fossil record during the Jurassic period Caron & Homewood, 1983). The planktonic foraminifera show immense diversity and adaptability, both in their morphology and biology and have expanded to fill a wide variety of niches within the global ocean. They are classified taxonomically based on the characteristics of their calcareous shell. Identification is based on general morphology as well as the ultrastructural and microstructural features of the shell (Hemleben *et al*., 1989) obtained by transmission electron microscope (TEM) Takayanagi *et al*., 1968) and scanning electron microscope (SEM) Cifelli,1982) investigations. The major morphological split is between the spinose planktonic foraminifera (those with spines) and the non-spinose planktonic foraminifera (those without spines) (first recognized by Parker, 1962). The non-spinose taxa can be further divided into the macro perforate, micro perforate, and non-spiral groups (summarised by Hemleben *et al*., 1989). Molecular phylogenetic studies have led to an extensive increase in our understanding of the evolutionary relationships of the planktonic foraminifera, refining our views of their taxonomic relationships.

At various levels, foraminiferal biofacies in the Niger delta basin have been discussed Petters, 1995, studied the biostratigraphy of Afowo-1 well from which he proposed ten biostratigraphic units, most of which are Cretaceous to Palaeogene in age. It is the last three units that contain Neogene forms, *Globigerina officinalis, Globigerina ciperoensis, angustiumbilicata, Opima opima, Globigerina woodi, Globigerinoides trilobus trilobus* and *Globigennoides insueta*, and all these do not occur beyond early Miocene. Petters (1979) described three stratigraphic zones in Parabe-1 well using, *Globorotalia opima nana* and *Globorotalia fohsi peripheronda* to describe early middle Miocene and *Globorotalia tumida* to delineate the Pliocene. Several other workers have utilized foraminifera and other microfossils to study the biostratigraphy of the Niger Delta region. The Niger Delta Neogene (N) 8-N9 planktic zone of the early to middle Miocene age was described based on the presence *of Praeorbulina glomerosa, Globorotalia obesa, Globigerinoides immaturus, Orbulina universa and a suite of benthic foraminiferal assemblages; Bolivina miocenica, Bolivina beyrichi, Saccamina complanata and Cyclamina minima* (Jacinta *et al*.,2012: Oloto,2014). Also, the Neogene boundaries was resolved based on the occurrence of planktonic foraminiferal such as *Globorotalia margaritae Zone* (N18), *Globigerinoides obliquus extrenules-sphaeroidinellopsis seminulina Zone* (N17), *Globorotalia acostaensis acostaensis* Zone (N16) and used in dating corresponding maximum flooding surfaces and sequence boundaries (Ajayi *et al*.,2014; Kasa *et al*.,2021).

Globorotalia fohsi fohsi- Grt. fohsi robusta zone (N10-11) and Grt. *merotumida Plesiotunmida - tumida* zone as representative of the late Miocene to Pliocene of the delta. This present study utilises the recovered planktic

foraminifers to establish planktic foraminiferal zonation's to determine the age of the studied interval, thereby permitting regional correlation which form the basis of most drilling of marine sedimentary sequences and is key to hydrocarbon exploration.

Geologic Setting

The Tertiary Niger delta basin is situated on the Gulf of Guinea on the West coast of Africa. It is located onshore of the delta, the central depobelt Niger delta, Nigeria (Figure 1).

During the Tertiary, it built out into the Atlantic Ocean at the Niger Benue, river system, an area of catchment that encompasses more than a million square kilometres of predominantly savannah covered lowlands. The regressive clastic sequence which it comprises is thought to reach a maximum thickness of about 12000 m the central part and 6000 to 9000 m along the flanks (Doust and Omatsola,1990)

The convex shaped nature of the basin is directly related to the structural configuration of the underlying basement (Evamy *et al*., 1978). The basin contains thick wedge deltaic sediments, which have been grouped into three diachronous Formation (Short and Stauble, 1967). The oldest Akata formation is characterize by black shale that are interpreted as marine, with occasional sand and silt interbeds which are considered as turbidites and continental slope channel fills. This is overlain by Agbada Formation, which is characterized by alternating sand and shale sequences believed to have been deposited under paralic conditions. The youngest is the Benin formation and contain predominantly coarse sand that have been described as continental in origin although in the eastern part of the delta, the formation contains some deep water clay fills that have been described as submarine canyon deposits (Burke, 1972). The Niger delta has been variously described as balanced or were dominated (Weber, 1987) its outgrowth started in the Eocene, a regressive phase that followed the Palaeocene eustatism subsequently, there has been migration of sediments downdip forwards the Atlantic along the bight of Biafra. Sedimentation within the basin has been dependent on the balance between the rate of deposition and the state of subsidence (Weber, 1971) the Niger Delta is further subdivided into six depobelt (Doust & Omatsola, 1990). These appear to have been influenced by the structural configuration of the basement and shale tectonics.

Methodology

The ditch cuttings used were provided by Geological Survey Agency of Nigeria (NGSA), Kaduna. A total of 53 samples taking at a regular interval of 60 ft (18.3 m) and an average of 10 grams each of the samples was utilized for the analysis.

The conventional approach employed in preparing the sample for micropaleontological studies include treatment with hydrogen peroxide (H_2O_2) (30 % concentration) all treated samples were wet sieved with 63 µm mesh screen.

All fractions of the washed and dried residue were sorted for foraminifers' counts. Foraminifera were examined with the aid of an Olympus microscope Examination of the samples and the preparation of slides for all fossiliferous samples which are of foraminifera and their modes of abundance were considered for biozonation. Taxonomic analysis and identification of the foraminifera forms were based on the documents and illustrations depicted on the work of Blow,1979, Bolli and Saunders 1985, Loeblich and Tappan 1987, Hardenbol *et al.,* 1998 Wade *et al*., (2011).

Results and Discussion

Age diagnostic planktic foraminifera retrieved from the Kam-1 well were used for zonation and dating of the sedimentary rocks in the studied interval of the well. Figures 2 and 3 were based on a specific occurrence at certain interval and first downhole occurrences (FDO) and or last downhole occurrences (LDO) of recovered foraminifera for delineation of boundaries.

Orbulina horizon is an acceptable datum, diagnostic of middle Miocene boundary as discussed by Bolli and Saunders (1985) among several authors. *Orbulina suturalis* Bronninann has been the datum marker for the N9 zone which also represent lower / middle Miocene boundary in the low latitudes, the first occurrence of *O.suturalis* was put at the lower / middle Miocene boundary (Bolli; & Saunders 1985) and the upper boundary of the Langhian stratotype defined by the appearance of *O. suturalis*.

Due to problem of caving, the first appearance of *O.universa* which took place in *Globigerinoides sacculifera* acme interval at 6960 ft (2121.4 m) (Fig. 3) was not used; instead the base of its peak occurrence was defined as the Orbulina horizon. The Orbulina horizon represent the base of the *Orbulina universa* interval at 9360 ft (2852.9 m), were *Biorbulina bilobata* was in association in and was assigned the middle Miocene equivalent to N8-9 of Blow, 1979, the zone was defined by the LDO OF *Orbulina universa* at 9360 ft (2852.9 m) and FDO of *Globigerinoides sacculifera* at 7980 ft (2432.3 m). The interval is characterised by the abundance of *Orbulina universa, Globigerinoides sacculifera* and *Biorbulina bilobate*, below this interval was assigned early Miocene to the base of the studied interval even though the index diagnostic species were not recovered. The underlying section was assigned early Miocene even though diagnostic form was not recovered to the base of the studied interval. While the overlying section 6960 ft (2121.4 m) to the top of the studied section was not investigated due to non-availability of the data

This zone could permit correlation, which form the basis of most drilling of marine sedimentary sequences and is key to hydrocarbon exploration. The zonation's also unifies bio-stratigraphic schemes and provides an improved correlation of the Niger Delta stratigraphy.

Conclusion

53 ditch cutting samples collected between 6960 ft (2121.4 m) – 10,140 ft (3090.7 m) of Kam -1 were

subjected to standard processes of foraminiferal extraction of using hydrogen peroxide.11 planktic foraminifera were recovered: *Globoquadrina dehiscens, Globigerinoides sacculifera,Orbulina universa, Globigerinoides bulloides, Globorotalia obesa, Glorotalia multisepta, ,Globigerinoides ruber,Catapsydrax disimilis,Candeina nitida,Sphaeroidina bulloides ,Biorbulina bilobata, Praeorbulina sicana.*
The delineation of the section into biozones reveals N8 – N9 zone which lies between 7980 ft (2432.3 m) to 9300 ft (2834.6 m) belonging to middle Miocene while 6980 ft (2127.5 m) – 7980 ft (2432.3 m) and 9300 ft(2834.6 m) – 10,140 ft (3090.7 m) as late Miocene and early Miocene respectively. The established N8-9 zone is correlatable with the regional planktic biostratigraphic scheme.

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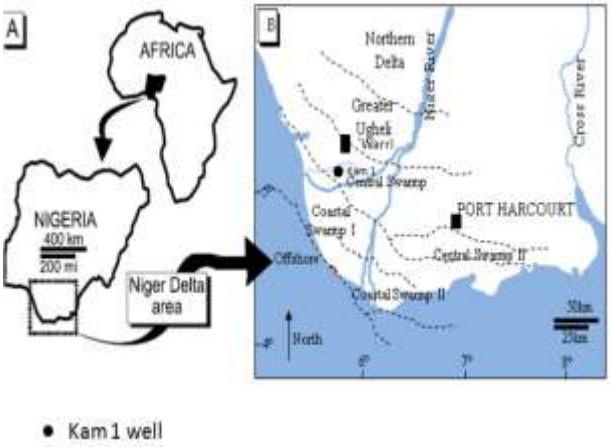

Figure 1. location of the kam-1 well studied in the central Niger Delta, Nigeria.

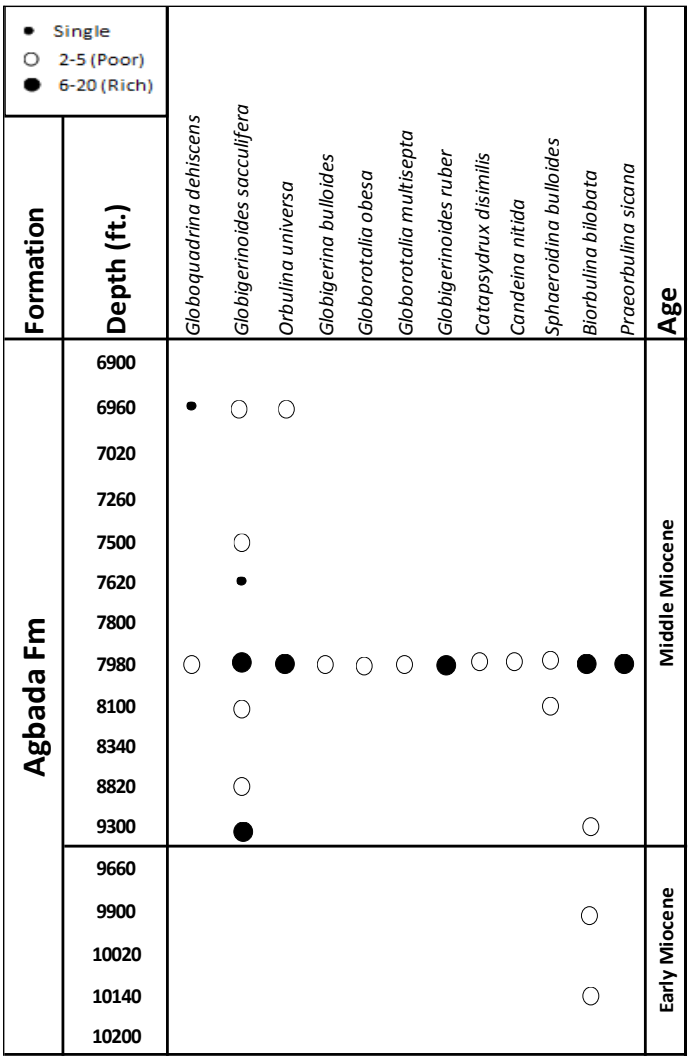

Figure 2: Planktic Foraminiferal Distribution of Kam -1 Well

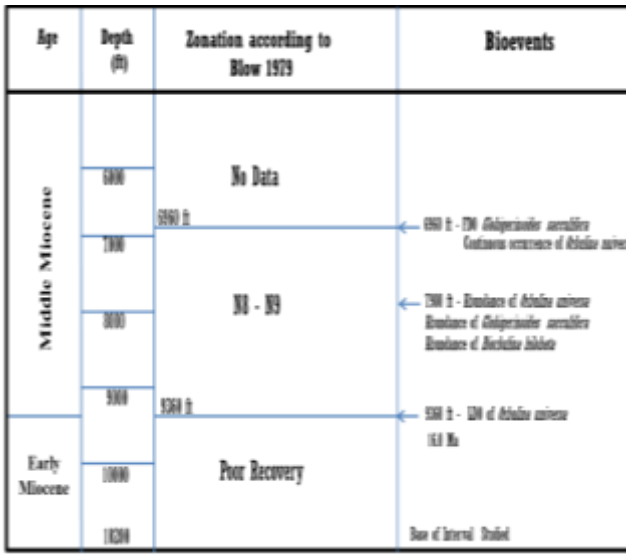

Figure 3: Kam -1 Well Biozonation