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Paleogene Foraminferal Assemblages and Stratigraphy of the Section Penetrated by AG-1 Borehole, Dahomey (Benin) Basin

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Abstract

Biostratigraphic analysis of ditch cutting samples from interval 1095 – 1635 ft (332 – 495 m) of AG-1 borehole, Akinbo Formation within the Benin Basin was carried out. The study was aimed at determining the age and delineating the well section into planktic foraminiferal biozones. The samples which were analysed using standard biostratigraphic techniques yielded fairly abundant and diverse assemblage of both planktic and benthic foraminiferal species. Typical Paleogene species recovered include planktic forms: *Turborotalia cerroazuelensis frontosa, Turborotalia cerroazuelensis pomeroli, Turborotalia boweri, Turborotalia pseudomayeri, Turborotalia rohri, Morozovella subbotinae, Acarinina primitiva, Globigerina velascoensis* and *Globigerina triloculinoides*. The benthic assemblage consists of *Eponides pseudoelevatus, Lenticulina midwayensis, Anomalinodes umbonifera, Anomalinoides midwayensis, Nonion oyae, Cibicides succedens and Bolivina afra.* The foraminiferal assemblages indicated that the studied section spanned Late Paleocene to Middle Eocene, P4 - ? P12 standard planktic zones. However, the widely recognized P8/P9 boundary index datum – First Appearance Datum (FAD) of *Turborotalia cerroazulensis frontosa* occurring at 1315 ft (398 m) enabled the delineation of the section into two broad biostratigraphic intervals: P4 – P8 (P4a – E5) and P9 -? P12 (E6 -? E11) zones. The 162-metre thick dark grey shale section of AG-1 borehole spanned about 18.2 Ma, suggesting an average sediment deposition rate of approximately 9 metres per million years.

***Keywords*:** Biostratigraphy, Foraminifera, Paleogene, Dahomey, Benin, Basin

Introduction

The Dahomey Basin is an expansive basin that traverses a significant portion of the continental margin of West Africa. The basin extends from Ghana to Togo and Benin Republic through the southwestern Nigeria where the Okitipupa Ridge separated it from the Tertiary Niger Delta. The basin was formed in the Mesozoic due to rifting of the African

and South American Plates which resulted in opening of the Atlantic (Burke *et al*., 1971; Whiteman, 1982; Gebhart *et al*., 2019). The discovery of oil and gas accumulations and occurrence of other economic deposits in the Nigerian end of the Dahomey Basin has continued to arouse the interest of researchers and explorationists. Over the years the focus of geoscience researches on Dahomey Basin has been on lithostratigraphy, tectonic evolution and hydrocarbon potential of the basin. Some authors like: Billman, 1976; Lehner and Ruiter, 1977; De Klasz, 1977; Omatsola and Adegoke, 1981; Adediran and Adegoke, 1987 have discussed the tectonic framework of the basin. Four stages of evolutionary models have been proposed for the Dahomey and other Gulf of Guinea basins by Adediran and Adegoke (1987). They are: Stage 1 (intra-cratonic stage) marked the deposition of thick sequences of detrital sediments which are mostly immature sandstone and fresh water shale. Stage 2 (syn-rift stage): the periodic tectonic activity, erosion and sedimentation which led to the deposition of silt and reworked sandstones with some intercalated shale of fluvial-lacustrine provenance within the formed grabens. Stage 3 showed the build-up of sand-shale sequence in the northern part of the basins and evaporates in the southern part an evidence of inception of marine incursion into the basin consequent upon rifting of the African and South American plates. In stage 4, there was deposition of marine sediments that were rich in fauna and flora which represent the end of the development stage of the Gulf of Guinea basins.

The stratigraphy of the Benin Basin is composed of Cretaceous to Tertiary sedimentary sequence. The oldest section of the sequence is Maastrichtian onshore. However, offshore exploration wells drilled by oil companies (Folawiyo Oil) encountered sediments of Neocomian age. The youngest strata are of Pleistocene to Recent stage. The sedimentary sequence of the basin has been divided into two chronostratigraphic parts – The Cretaceous Abeokuta Group and the Tertiary sequence (Omatsola and Adegoke, 1981). The Abeokuta Group is subdivided into three formations; the Ise (oldest), Afowo, and Araromi Formations (youngest). The Tertiary unit comprises the Ewekoro, Akinbo, Oshosun, Ilaro, Ogwashi - Asaba and Benin Formations. The Ise Formation lying on the Basement Complex non conformably and it is the oldest formation in the basin. The formation comprises alluvial fan of terrestrial sands, grits, siltstones and basal conglomerate. Palynomorphs recovered by Shell-BP palynologists give the Formation a Neocomian age.
On top of the Ise Formation is the Afowo Formation. Omatsola and Adegoke (1981) noted that Afowo Formation is equivalent to the outcropping unit which earlier authors (Fayose, 1970; Dessauvagie, 1975; Adeleye, 1975; Billman, 1976) called the Abeokuta Formation. The formation principally consists of coarse to medium-grained sandstones with thick but variable inter-beds of shale, siltstones and clays with the shale component progressively increasing up-section. The lower section is composed of an alternation of brackish and loose fluviatile sands. The Formation is Turonian to Maastrichtian on the basis of its palynomorph contents (Billman, 1976) and marine foraminifera (Omatsola and Adegoke,

1981).

Conformably overlying the Afowo Formation is the Araromi Formation marked by a sequence of fine to medium-grained basal sands that is overlain by shale and siltstones with thin interbeds of limestones and marls. The shales are light grey to black, essentially marine and with very high organic matter content. The formation contains abundant foraminifera, ostracodes, and palynomorphs on the basis of which it has been dated Maastrichtian to Paleocene (Adegoke *et al.*, 1980, Okosun, 1987). The Araromi Formation is the youngest of the Cretaceous strata of the Abeokuta Group.

Tertiary sequence in the Benin Basin began with the deposition of some lens shaped, sandy, shelly, glauconitic with phosphatic limestone of the Paleocene Ewekoro Formation. The Ewekoro Formation rests conformably on the Araromi Formation in most parts of the basin. The limestone is interbedded with bluish to white marl.

The mostly shaly Imo Formation lies unconformably on the Ewekoro Formation in places where the latter is encountered. The Imo Shale however lies directly but unconformably, on Afowo Formation where the Ewekoro Formation is missing. This is so because Ewekoro Formation on a regional scale is lensoid in shape. Ogbe (1972) described the makeup of the formation as containing dark fine textured shale that is occasionally silty with some silty glauconitic marl and conglomeratic at its base. In the western Nigeria end greenish-grey shales are seen in the subsurface and the Ewekoro Formation. This formation was named by Ogbe (1972), Akinbo Formation. This rich fossiliferous formation has been dated early to middle Eocene on account of its microfossil assemblage.

The Imo shale has Oshosun Formation overlying it with characteristic mudstone and claystone. The Oshosun Formation was encountered both in the onshore and offshore. The Oshosun Formation is fairly fossiliferous. At the onshore part, molluscs, foraminifera and fish remains have been recovered (Adegoke, 1969). Foraminifera and nannoplankton occur at the offshore (Billman, 1976). It has been dated Middle Eocene (Lutetium) on the basis of the fossil content (Adegoke, 1969; Billman, 1976). Bankole *et al.* (2005) assigned the age late Paleocene to early Eocene to the formation. The next succession in the Benin Basin sequence is the greenish-grey clayey sand stone and sandy claystone strata of the Ameki Formation which occur as a thin veneer above the Oshosun Formation (Reyment, 1969). Despite yielding abundant fossils in its type locality in eastern Nigeria, sediments of the Ameki Formation in the Benin Basin are not richly fossiliferous. The few species (mainly molluscs) recovered from the formation indicate a Lutetian to Bartonian age. Overlying the Ameki Formation in Eastern Nigeria is the Ogwashi-Asaba Formation which consists of a variable sequence of clay, sand, and thin lignite seams. Plant remains contained within the formation indicate Oligocene – Miocene stage.

Resting on the Ogwashi-Asaba Formation is the Benin Formation which is the youngest of the Benin Basin sequences. The Benin Formation consists of yellow and white, occasionally cross-bedded sand, pebbly beds and clays with some sandy clay lenses. Plant remains and planktonic foraminifera recovered from the formation indicate a Miocene age.

Previous foraminiferal biostratigraphic studies of the Benin (Dahomey) Basin centred principally on the stratigraphic taxonomy and occurrence of foraminiferal species in the basin (Reyment, 1965; Adegoke, 1969; 1977; Adegoke *et al.* 1970; 1980; Fayose, 1970; Fayose and Asseez, 1972; Nwachukwu *et al.*1992; Okosun and Alkali, 2012). Okosun and Alkali (2012) recovered mainly tropical planktonic species from the sediments of the Gulf of Guinea and delineated four bathymetric biofacies based on the distribution and dominance of planktonic foraminiferal assemblage and they include; *Globigerinoides ruber, Globigerinoides trilobus, Globoquadrina* sp. and *Globorotalia menardii.* Also, Okosun and Alkali (2012) delineated six planktic and two benthic foraminiferal biozones within the Araromi GSN 1131 borehole in the Eastern Dahomey Basin. The planktic zones are *Planorotalites pseudobulloides, Planorotalites inconstans, Morozovella angulata, Globorotalia pseudomenardii, Morozovella velascoensis* and *Morozovella subbotinae.* Benthic zones*: Anomalinoides umboniferus* and *Anomalinoides midwayensis.* Adegoke (1975) in a study of the polyhaline lagoons sediment of the Gulf of Guinea reported that the commonest genera of the lagoons were *Ammobaculites, Ammonia, Elphidium, Quinqueloculina* and *Triloculina*. The study observed that the diversity and abundance of foraminifera vary considerably from lagoon to lagoon and the calcareous species are common in deep waters with the agglutinated forms dominating the sandy near-shore water. Adegbie and Dublin-Green (1994) reported high diversity and abundance of foraminifera which was as a result of sediments that are rich in nutrient brought by various rivers from continent into the Gulf of Guinea. They opined that foraminiferal species that are warm water tolerant were abundant and some cold-water species that were found might have been influenced by cold currents such as the Canary and Benguela. Okosun and Alkali (2012) delineated six planktonic and two benthic Paleogene foraminiferal zones and correlated them to interregional using planktonic foraminiferal zonation schemes designed by Toumarkine and Luterbacher (1985) and Berggren *et al* (1995).

This study is aimed at establishing the biozonation of Paleogene strata of the Akinbo Formation as penetrated by AG-1 borehole. The exploration for hydrocarbon in the Benin Basin, a frontier basin requires that potential hydrocarbon source beds and reservoir sands be correlated across outcrop sections and wells drilled within the basin. This requirement can be met most effectively through a biostratigraphic zonation of encountered sections, which the study is providing.

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Materials and Methods

The materials for this study are thirty (30) ditch cutting samples from AG – 1 borehole drilled within the Akinbo Formation of the Benin/Dahomey Basin in southwestern Nigeria. The location of the borehole is indicated in Figure 1. The borehole was sampled at intervals of 60 ft. (18 m) between intervals 1095 – 1630 ft (330–494 m). Conventional foraminiferal sample processing method was employed in the sample preparation. Twenty (20) grams of each of the dried sample were soaked in kerosene for about twenty minutes. Samples were decanted of kerosene and subsequently soaked in water for about twenty-four hours. Kerosene that was used for water molecule to penetrate the samples, this was done to aid

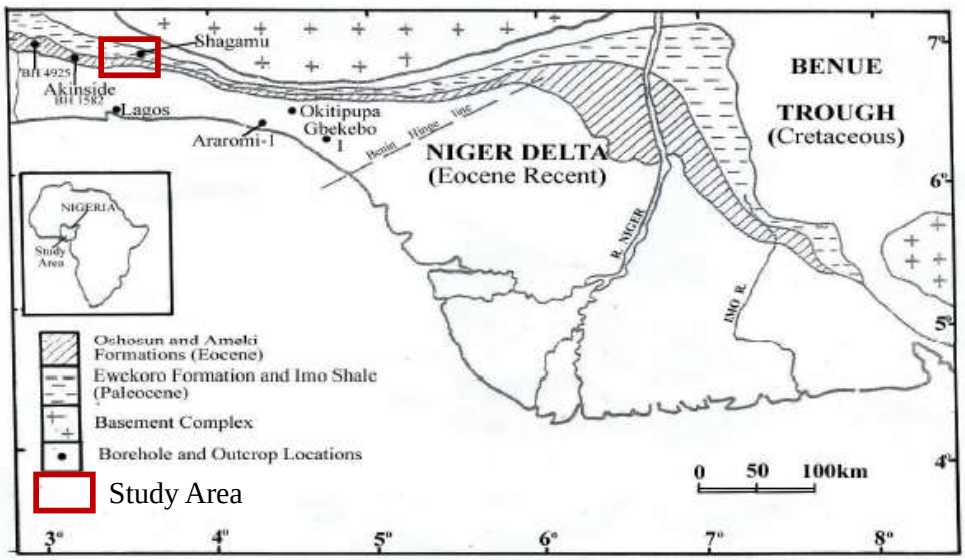

Figure 1: Geological map of Sedimentary Basins in Nigeria and the study area (After Petters and Olsson, 1979).

the disaggregation of the samples. 63 µm sieve was used in washing the disaggregated samples under a jet of water until the samples were freed of mud. The recovered residues were dried in the oven at 50–70ºC for approximate 30 minutes. Foraminiferal species were picked from the dried residues and analysed under stereoscopic reflected light binocular microscope. The Toumarkine and Luterbacher (1985) and Petters (1982) identification schemes of species were used in this study. The species are shown in Figure 2. The figured specimens are in the repository of the Department of Geology, Obafemi Awolowo University, Ile - Ife, Nigeria.

Results and Discussions

Biostratigraphy and Age

Forty-eight (48) foraminiferal species in total were recovered from the studied section of AG-1 borehole. Twenty-four (24) of these are planktics and the remaining twenty-four (24) are benthics (calcareous and agglutinated forms). Other microfauna recovered from the

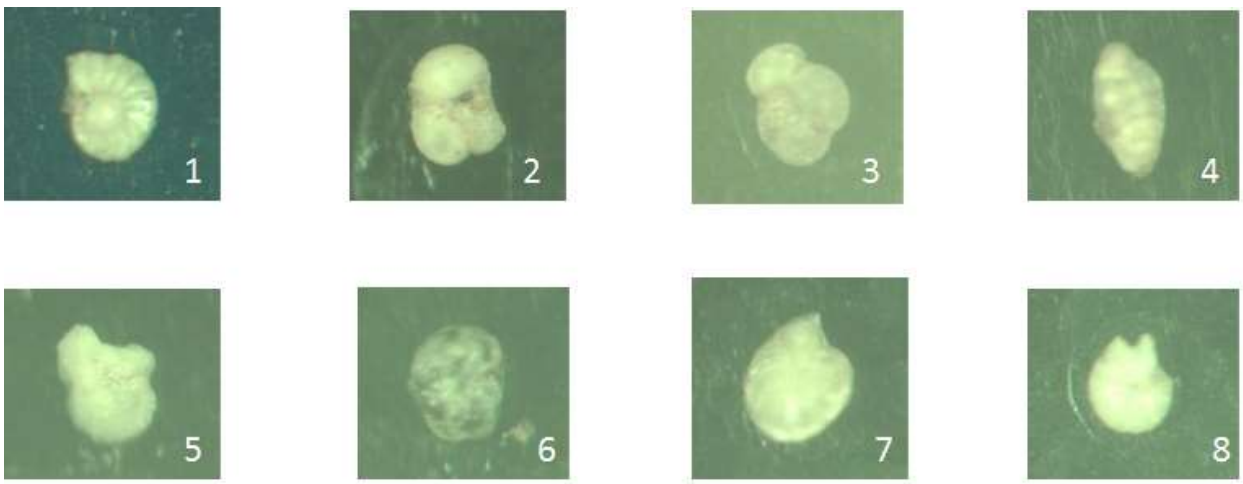

Figure 2: Photographs of Recovered Species: 1. *Nonion oyae* **2.** *Turborotalia cerroazulensis frontosa* **3.** *Turborotalia praecentralis* **4.** *Uvigerina hourqi* **5.** *Morozovella subbotinae* **6.** *Globigerina velascoensis* **7.** *Eponides pseudoelevatus* **8.** *Lenticulina midwayensis*

borehole section are ostracods, pelecypods, scaphopod and echinoid spines. The foraminiferal assemblages in this well occur in ratio 1:1 in terms of the number of planktic and benthic species. However, the benthic forms are more abundant in number of individual forms (Figure 3). Some diagnostic Paleogene foraminiferal taxa occur within the AG-1 borehole.

This includes planktic species such as *Turborotalia cerroazuelensis frontosa, Morozovella subbotinae, Globigerina velascoensis* and *Globigerina triloculinoides*. Benthic forms include *Bolivina ihuoensis, Eponides pseudoelevatus, Eponides eshira, Hopkinsina danvillensis, Anomalinoides umbonifera, Lenticulina midwayensis* and *Anomalinoides midwayensis.* The stratigraphic distributions of these species are shown in Figure 4.

The Paleogene foraminiferal zonation schemes adopted in this study are of Blow (1979), Berggren *et al*. (1995), Berggren and Pearson (2000). These authors divided the Paleogene into alpha-numerically designated biozones some of which have been recognized in AG-1

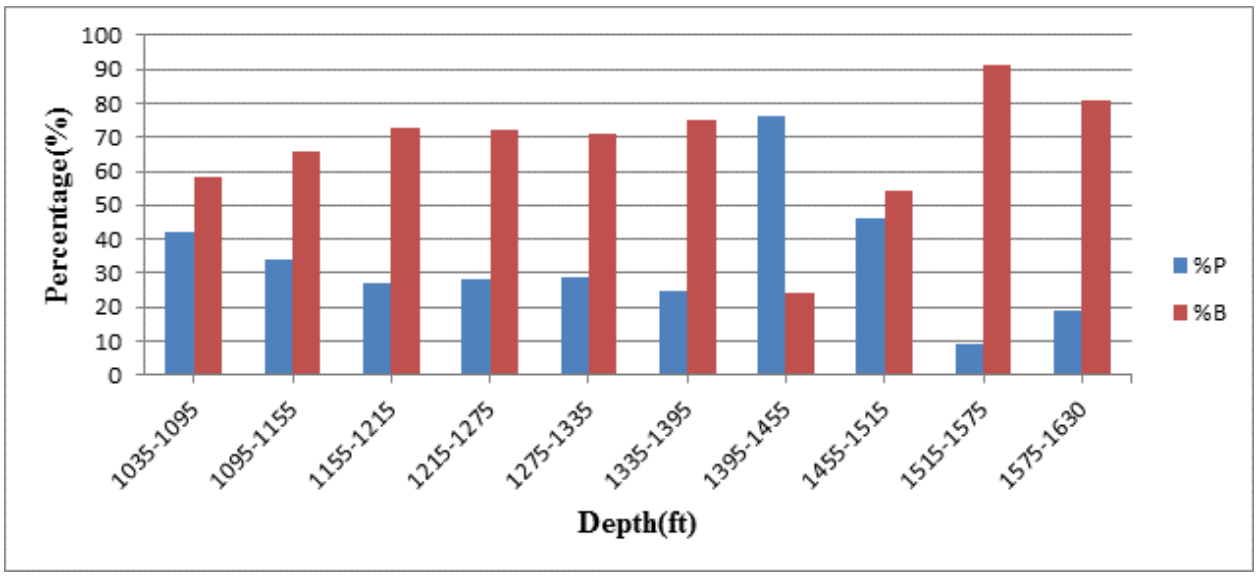

Figure 3: Percentage abundance of individual forms of planktic (P) and benthic (B) foraminifera recovered from AG – 1 we

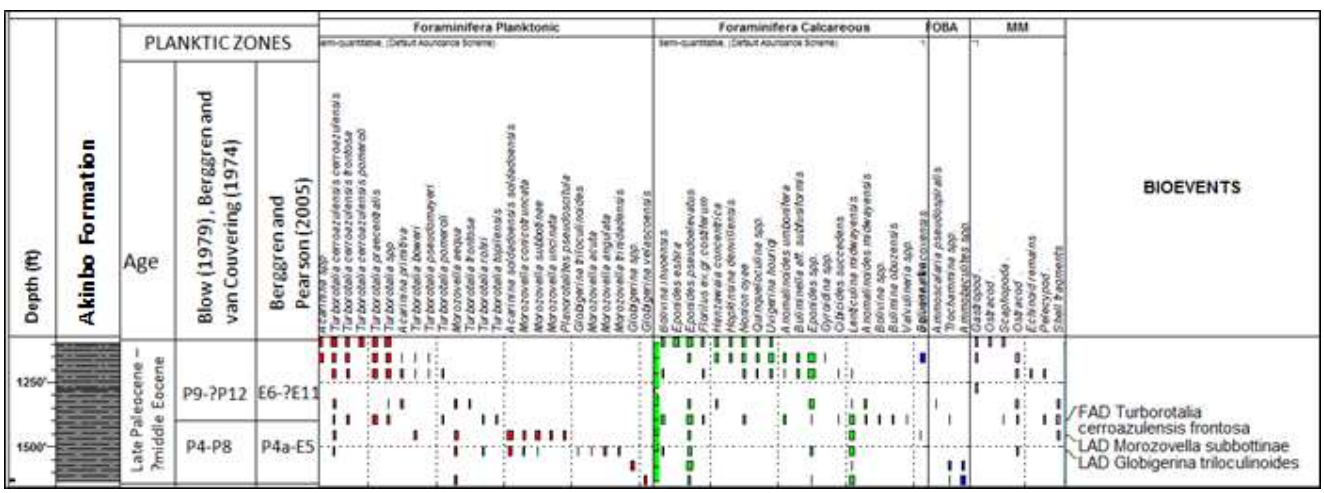

Figure 4: Biostratigraphic Distribution of Foraminiferal Species Recovered from AG-1 Borehole.

borehole. However, some of the boundary markers used in the above zonation schemes was not recovered here; therefore biostratigraphic intervals have been ranged across two or more zonal intervals of these established schemes. The zones delineated within the AG-1 borehole are discussed below.

Planktonic foraminiferal Zones

***Planorotalites (Globanomalina) pseudomenardii – Morozovella aragonensis*, P4-P8 of Blow (1979); P4a– E5 of Berggren and Pearson (2000)**

This combined zonal interval comprises five zones of Blow (1979) and nine zones of the revised Paleogene planktonic foraminiferal zonation system of Berggren and Pearson (2000). The first appearance datum of *Turborotalia cerroazulensis frontosa* has been used to mark the upper limit of the P4a – E5 zonal interval in this borehole. The base is tentatively placed at the bottom of the interval analysed. The boundary marker and nominate species which have been used in established schemes to delineate zonal boundaries were not recovered in AG-1 borehole. However, recorded planktonic foraminiferal assemblages comprising *Morozovella subbotinae, Morozovella acuta, Planorotalites pseudoscitula, Globigerina triloculinoides, Globigerina velascoensis, Acarinina soldadoensis* are Paleogene species characteristic of the P4 – P8 zones of Blow (1979), Berggren *et al*. (1995) and the P4a – E5 of Berggren and Pearson (2000). Benthic species within this interval include *Eponides pseudoelevatus*, *Lenticulina midwayensis* and *Bolivina afra.* The Last Appearance Datums (LADs) of *Morozovella subbottinae, Globigerina triloculinoides* and *Globigerina velascoensis* identified within this interval are further diagnostic of P4-P8 zone. Berggren and Pearson (2000) had subdivided this zonal interval into the following Paleocene - Eocene planktonic foraminiferal zones: P4a, P4b, P4c, P5 (Paleocene); E1, E2, E3, E4, E5 (Eocene). This interval correlates in part with *Globorotalia pseudomenardii – Morozovella subbotinae* zones of Okosun and Alkali (2012).

The Subzone P4a. *Globanomalina pseudomenqrdii l Parasubbotina variospira* Concurrent-range Subzone. The subzone was delineated as the Concurrent range of the nominate taxa from the Lowest Occurrence of *Globanomalina pseudomenardii* to the Highest Occurrence of *Parasubbotina variospira.* An age range of 59.4-59.2 Ma; late Paleocene (late Selandian) was assigned to this interval. Correlation: P4 of Blow (1979), P4a of Berggren *et al*. (1995), *Globorotalia pseudomenardii* zone of Okosun and Alkali (2012).

The Subzone P4b. Referred to as *Acarinina subsphaerica* Partial-range Subzone. It is a partial range of the nominate taxon *Acarinina subsphaerica* from the HO of *Parasubbotina variospira* to the LO of *Acarinina soldadoensis.* Estimated age is 59.2-56.5 Ma; late Paleocene (late Selandian-Thanetian). Correlation: P5 of (Blow, 1979), P4a – P4b of Berggren *et al*. (1995), *Morozovella velascoensis* (Okosun and Alkali, 2012).

The Subzone P4c. *Acarinina soldadoensis l Globanomalina pseudomenardii* Concurrent-range Subzone. The zone is defined as the concurrent range of the nominate taxa from the LO of *Acarinina soldadoensis* to the HO of *Globanomalina pseudomenardii.* The interval was dated 56.5-55.9 Ma; late Paleocene (late Thanetian). Correlation: P5 of Blow (1979), P4c of Berggren *et al*. (1995), *Morozovella velascoensis* (Okosun and Alkali, 2012).

The Zone P5. *Morozovellavelascoensis* Partial-range Zone. The zonal interval is characterised by the partial range of the nominate taxon between the HO of *Globanomalina*

pseudomenardii and the LO *of.Acarinina sibaiyaensis.* Age: 55.9-55.5 Ma; latest Paleocene (latest Thanetian). Correlation: P5 of Blow (1979), P5 of Berggren *et al*. (1995), *Morozovella velascoensis* (Okosun and Alkali, 2012).

Zone El. *Acarinina sibaiyaensis* Lowest-occurrence Zone. This is a zonal interval between the LO of the nominate taxon *Acarinina sibaiyaensis* and the LO of *Pseudohastigerina wilcoxensis.* Age is estimated to be 55.5-55.35 Ma; earliest Eocene (earliest Sparnacian). Correlation: P5 of (Blow, 1979), P5 of Berggren *et al*. (1995), *Morozovella velascoensis* (Okosun and Alkali, 2012).

Zone E2. *Pseudohastigerina wilcoxensis l Morozovella velascoensis* Concurrent-range Zone. The zone is defined as the biostratigraphic interval characterized by the concurrent stratigraphic ranges of the nominate taxa between the Lowest Occurence of *Pseudohastigerina wilcoxensis* and the Highest Ocucurence of *Morozovella velascoensis.* Age: 55.35-54.5 Ma; earliest Eocene (earliest Sparnacian-late Sparnacian). Correlation: P5 of Blow (1979), P5 of Berggren *et al*. (1995), *Morozovella velascoensis* (Okosun and Alkali, 2012).

Zone E3. *Morozovella marginodentata* Partial-range Zone. The zone is characterized by the partial range of the nominate taxon between the HO of *Morozovella velascoensis* and LO of *Morozovella formosa.* Age: earliest Eocene (latest Sparnacian – early Ypresian), 54.5-54.0 Ma. Correlation: P6 of Blow (1979), P6a of Berggren *et al*. (1995).

Zone E4. *Morozovella Formosa* Lowest-occurrence Zone. Definition: Interval between the LO of the nominate taxon *Morozovella formosa* and the LO of *Morozovella aragonensis.* Age: early Eocene (early Ypresian), 54.0 - 52.3 Ma. Correlation: P6 of Blow (1979), P6b of Berggren *et al*. (1995), *Morozovella subbotinae* (Okosun and Alkali, 2012).

Zone E5. *Morozovella aragonensis l Morozovelia subbotinae* Concurrent-range Zone. Definition: Concurrent range of the nominate taxa between the LO of *Morozovella aragonensis* and the HO of *Morozovella subhotinae.* Age: early Eocene (Ypresian), 52.3-50.8 Ma. Correlation: P7 of Blow (1979), P7 of Berggren *et al*. (1995).

***Acarinina pentacamerata – Morozovella lehneri,* E6 – ?E11 of Berggren and Pearson (2005), P8 – P12 of Blow (1979).**

Early – middle Eocene planktonic foraminiferal assemblage comprising *Turborotalia cerroazulensis frontosa, Turborotalia cerroazulensis pomeroli, Turborotalia boweri, Turborotalia rohri, Turborotalia pseudoayeri, Acarinina primitiva* dominate this zonal interval. These planktonic species are associated with benthic species such as *Hanzawaia concentrica, Eponides pseudoelevatus, Cibicides succedens, Nonion oyae* and *Anomalinoides umbonifera.* The base is marked by the first appearance datum of *Turborotalia cerroazuelnsis frontosa*. The top of this zonal interval is tentatively placed at the topmost sample studied within the borehole section with the occurrence of *Turborotalia cerroazulensis frontosa* at this horizon taking as the last appearance datum of the species. In the species stratigraphic distribution chart of Toumarkine and Luterbacher (1985), the first

appearance and the last appearance datum of *Turborotalia cerroazulensis frontosa* coincide with the P8 / P9 and P12 / P13 of Blow (1979).

This zonal interval comprises six zones (E6, E7, E8, E9, E10 and E11) of the revised planktonic foraminiferal zonation schemes of Berggren and Pearson (2005) and four zones (P9, P10, P11 and P12) of Blow (1979). The combination of zonal intervals of these established zonation schemes is necessitated in this work owing to non-recovery of boundary marker species.

Zone E6. *Acarinina pentacamerata* Partial-range Zone. Definition*:* Partial range of the nominate taxon between the HO of *Morozovella subbotinae* and the LO of *Acarinina cuneicamerata.* Age: late-early Eocene (late Ypresian), 50.8-50.4 Ma. Correlation: P8 of Blow (1979), P8 of Berggren (1995).

Zone E7. *Acarinina cuneicamerata* Lowest-occurrence Zone. Definition*:* zonal interval between the LO of the nominate taxon *Acarinina cuneicamerata* and the LO of *Guembilitrioide snuttalli.* Age:late-early Eocene (latest Ypresian), 50.4-49.0 Ma. Correlation: P9 of Blow (1979), P9 of Berggren *et al*. (1995).

Zone E8. *Guembelitrioides nuttalli* Lowest-occurrence Zone. Definition*:* Zonal interval between the LO of the nominate taxon *Guembelitrioides nuttalli* and LO of *Globigerinatheka kugleri.* Age: early middle Eocene (Lutetian), 49.0~45.8 Ma. Correlation: P10 of Blow (1979), P10 of Berggren *et al*. (1995).

Zone E9. *Globigerinatheka kugleri – l Morozovella aragonensis* Concurrent-range Zone. Definition*:* Concurrent range of the nominate taxa between the LO of *Globigerinatheka kugleri* and the HO of *Morozovella aragonensis.* Age*:* middle Eocene (Lutetian), 45.8-43.6 Ma. Correlation: P11 of Blow (1979), P11 of Berggren *et al*. (1995).

Zone EIO. *Acarinina topilensis* Partial-range Zone. Definition*:* Partial range of the nominate taxon between the HO of *Morozovella aragonensis* and the HO of *Guembelitrioides nuttalli.* Age*:* late- middle Eocene (late Lutetian), 43.6-42.3 Ma. Correlation: P12 of Blow (1979), P12 of Berggren *et al*. (1995).

Zone Ell. *'Morozovella' zehneri* Partial-range Zone. Definition*:* Zonal interval characterized by the partial range of the nominate taxon between the HO of *Guembelitrioides nuttalli* and the LO of *Orbulinoides beckmanni.* Age*:* late middle Eocene (late Lutetian – early Bartonian), 42.3-40.5 Ma. Correlation: P12 of Blow (1979), P12 of Berggren *et al*. (1995). The 162-metre thick dark grey shale section of AG-1 borehole spanned about 18.2 Ma, suggesting an average sediment deposition rate of approximately 9 metres per million years. The summary of the biostratigraphic zones age of the AG-1 borehole is indicated in Table 1.

Table 1: Summary of the Biostratigraphic Zones and Age of the AG-1 Borehole Section

STRATIGRAPHIC INTERVAL	ZONE	AGE	BIOEVENTS
1395 – 1630 ft	P4 – P8 (P4a-E5)	Late Paleocene – Early Eocene	**Top:** FAD of *Turborotalia cerroazuelensis frontosa* at 1395 ft. **Base:** LAD of *Globigerina triloculinoides* at 1515 ft.
1095 – 1395 ft	P9 – ?P12 (E6-?E11)	Early Eocene - ?Middle Eocene	**Top:** Upper limit of foraminiferal occurrence. **Base:** FAD of *Turborotalia cerroazuelensis frontosa* at 1395 ft.

Conclusion

The determination of age and delineation of the well section into planktic foraminiferal biozones was carried out in this study. The AG-1 borehole yielded relatively abundant but less diverse assemblages of foraminiferal species. The borehole section have been delineated into P4 - P8 (P4a - E5) and P9 - ?P12 (E6 - ?E11) planktic foraminiferal biostratigraphic intervals and dated Late Paleocene to probable Middle Eocene based on recovered assemblages and the recognition of the First Appearance Datum of *Turborotalia cerroazulensis frontosa*. The borehole encountered 162-metre thick sequence of dark grey shale of the Akinbo Formation deposited within a period of 18.2 Ma, suggesting an average deposition rate of approximately 9 metres per million years for the formation.

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Conflict of Interest Statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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