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ANALYSIS OF FORAMINIFERA IN CERTAIN PART OF AFIKPO AND ITS ENVIRONS, EBONYI STATE SOUTHEASTERN NIGERIA

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ABSTRACT: The study area is geographically bounded by latitude 5^0 51'N - 5^0 57'N and longitude 7^0 51'E – 7^0 58'E. The area is of the Nkporo shale. Fresh samples of shale were collected from different locations of Amuzu, Amangbara, Anofia Nkanu, Amacha and Ozizza. The samples were analysed and viewed under the microscope, to find out the presences of foraminifera. The fora encountered during the research include: *Gavelinella cenomanica, Ramulina Sp, Robertina Sp, Flourensina intermedia, Gavelinella intermedia, Eggerellina mariae, Vaginulina kochii*. Most of the fora encountered were calcareous benthic suggesting a shallow marine environment for Afikpo. The fora encountered in the area indicate that it lived at the time where the environment was favourable for its existence. The *RobertinaSp*, which is abundant in the samples, indicates Campanian – Maastrichtian age for Afikpo and its environs. The fora encountered in the study area are very important for biostratigraphy and can give relative dates to rocks as well as sediments. It was also observed in the study area that foraminifera like *Eggerellina mariae* and *Globigerina* belong to the unrestricted genera which inhabit wide range of salinities. This means that it may to large extent tolerate unfavourable environment for its existence. Benthic foraminifera, mostly calcareous benthic make up the highest abundant in the shales of the study area which also suggest that Afikpo and its environs was deposited in the shallow marine environment.

KEYWORDS: Maastrichtian, Afikpo, Nkporo Shale and Micro-fossil.

1 BACKGROUND

The study of foraminifera has a long history, their first recorded "mention" is in Herodotus (fifth century BC) who noted that the limestone of the Egyptian pyramids contained the large benthic foraminifera Nummulites. Foraminifera are found in all marine environments, they may be planktic or benthic in mode of life. The name foraminifera is derived from the foramen, the connecting hole through the wall (septa) between each chamber. Fora are found in both freshwater and marine environment. Species diversity is usually high in tropical areas. There are an estimated 4,000 species of fora living in the world's oceans today. Of these, fourty (40) species are planktonic, that is they float on the water. The remainder live on or in the sand, mud, rocks and plants at the bottom of the ocean. Foraminifera are found in all marine environments, from the intertidal to the deepest ocean trenches, and from the tropics to the poles, but species of fora can be very particular about the environment in which they live. Some are abundant only in the deep ocean, others are found only on coral reefs, and still other species live only in brackish estuaries or intertidal salt marshes.

The Anambra Basin, which is a post Santonian synclinal sedimentary structure located southern Benue trough contains over 5,000m thick of upper- cretaceous to recent sediments, which represents the third phase of marine sedimentation in the Benue Trough (Ladipo, 1988; Akande and Erdtmann, 1998). The area has attracted numerous studies Tattam (1944), Grove (1951), Simpson (1954), Reyment (1965), Murat (1972), Obi et al (2001), Oboh-Okuenobe et al (2005), Nwajide and Reijers (1996) and Onyekuru and Iwuagwu (2010), recorded that Nkporo Shale consists of dark fossil shales and mudstones with occasional thin beds of sandy shale and sandstone. Thin bands of shaly limestone may be present. They are of shallow water origin and rich in fossil assemblages. It has a wide distribution of zone of libycoceras afikpoense. Tattam (1944),

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Simpson (1955),Reyment (1965), Murat (1972), Dessavggie (1974), Obi et al (2001), Oboh-Okuenobe et al (2005), Nwajide and Reijers (1996) described that Mamu Formation contains a distinctive assemblage of Sandstone, Shale, Mudstone and Sandy Shale, with Coal Seams at several horizons. There are many characteristics which influence foraminifera distribution such as, sediment type, food availability, oxygen levels and hydrostatic pressure. However, some species can tolerate a wide range of unfavorable conditions. Low concentrations of foraminifera in benthic regions may indicate an environment under stress. The foraminifera that exist in Afikpo and its environs *are Eggenellina mariae, Robertina, Flourensina intermedia, Ramulina Sp, Gavelinella, cenomanica, Gavelinella intermedia, Vaginulina Kochii* and many others. Most of the foraminifera encountered were calcareous benthic suggesting a shallow marine environment for Afikpo and its environs.

1.1 STATEMENT OF THE PROBLEM

The problem associated with foraminfera is that they are affected by high temperature. High temperature prevents the diversity of foraminifera. These factors limit the existence of fora in the area. Another factor which limits the existence of foraminifera is excavation of solid minerals in the area. This factor is responsible for the extinction of many foraminifera species. Other observed problems which could also limit the existence of foraminifera are bush burning, erosion, land slide, oil spillage and unfavourable climatic condition.

1.2 AIM AND OBJECTIVES OF THE STUDY

The aim of this research is to determine the types and species of foraminifera that exits in the study area.

The objective of this research project work is as follows:

- To map and demarcate the lithologic unit underlying the area
- To determine the nature of sediment age and environment of deposition using micropalaenotogical analysis.

2 METHODOLOGY

The location within the study area is Amuzu, Amangbara, Anofia Nkanu, Amacha and Ozizza. as shown in Figure 1.

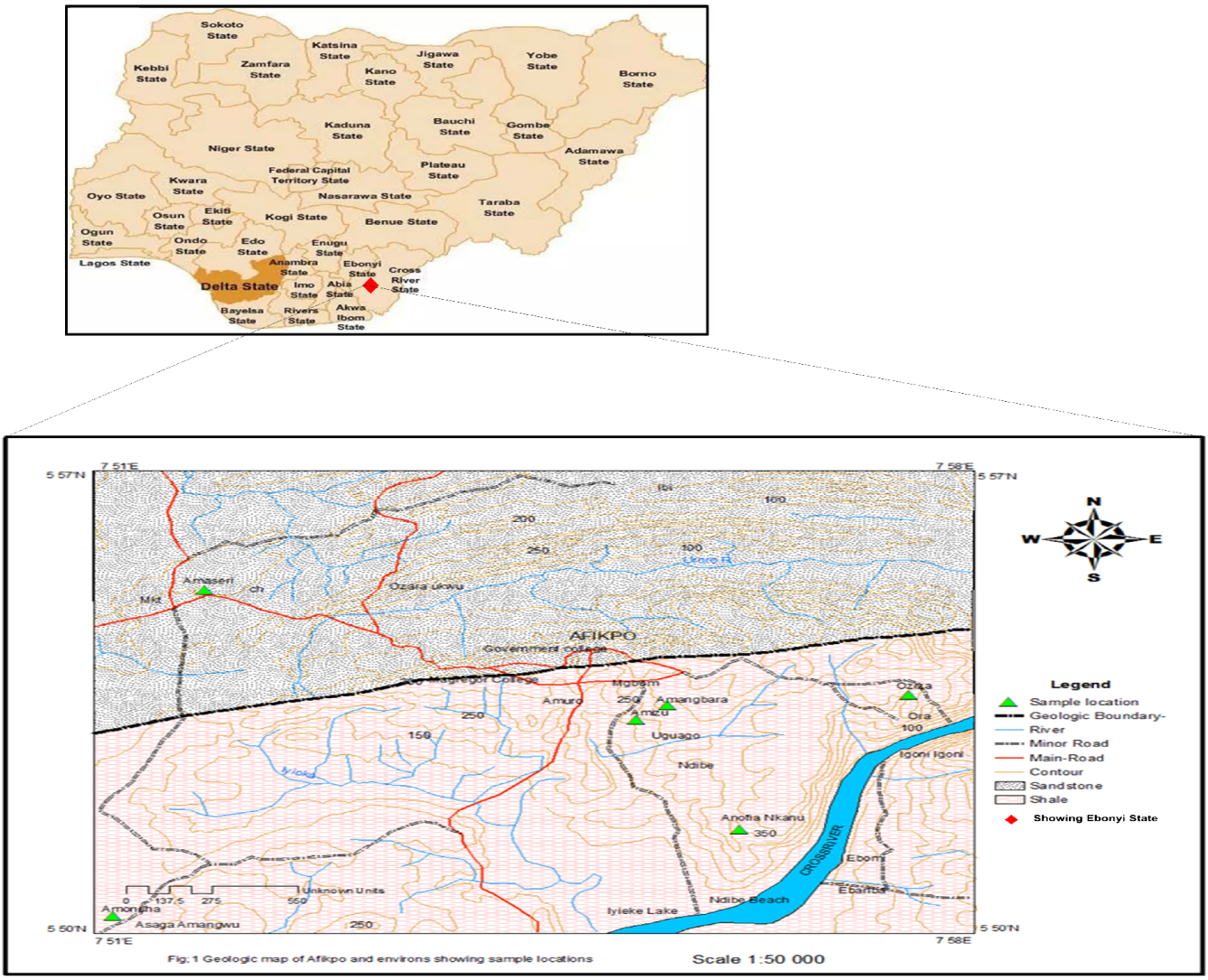


Fig. 1 Geologic map of Afikpo and environs showing sample locations

Fig. 1. Showing Geological Map of the Study Area and Sample Collection Site

2.1 FIELD MAPPING METHOD

An exposure of various places within the study area was visited with the basic knowledge of field mapping techniques and map interpretation. The rocks samples were observed based on the following features: (textures), compositions (mineralogical composition), and structures with the aim of determining the presence of fora.

2.1.1 LABORATORY METHOD

The methods employed for the analysis is discussed below:

Sample disaggregation: About 15-20mg of the fresh shale samples collected from the field were disaggregated or broken into very small fragment with the use of mortar and pestle. This is the first stage in the preparation of the samples the disaggregated sample ranges in size from 1mm-10mm. After the disaggregation, each sample is placed in a separate metal bowel and covered with its lid for the next stage of preparation.

- White spirit treatment (soaking): After the mechanical disaggregation of the sample using mortar and pestle, white spirit was poured in each of the samples. Care was taken to ensure that the sample were properly soaked samples were covered with lids to avoid contamination. This chemical treatment is to further disintegrate the sample and to allow for easy washing and concentration of the microfossils. This was left standing in a fume cupboard, until the rock was saturated after 24 hours, the next stage in samples preparation was carried out.

- Treatment of the sample with de-ionized water**:** In this stage of sample preparation, the excess solvent (white spirit) in each sample was poured- off from the samples, and de-ionized water was poured into each sample bowl; the samples were properly covered by the chemical. It was left in the bowl for 24 hours to enable the rock samples to disintegrate. The reason for this treatment is to enable the light and floating fossils to settle to the bottom, so that they would not be easily decanted away.
- Washing and sieving of samples: Very tiny meshed sieve of about 200mesh (<63ųm sieve) was used in washing the samples. The washing processes enable the mud and disintegrated shale materials to pass out through the sieve and concentrate the fragments containing the microfossils. The fora concentrate settle; afterward the supernatant fluid is decanted away.
- Drying: The sample fragments are either sun-dried or oven-dried to make them ready for study under the microscope in this study, the concentrate was sun dried from a period of 2days (48- hours); after which the dry samples were bottled and labelled according to the locations the samples were gotten from. This is marked the end of the preparation of the shale samples for microscope viewing. The dried sample residue was separated in a "nest" of sieves and small fragment of the sample was used in the next stage.
- Sample Picking (Light Microscope Work)

After the samples have been prepared as described above, the stage was set for studying the sample under the microscope, to identify their microfossil contents each sample was spread on a flat tray and mounted on the microscope. The samples were then viewed through the microscope at a magnification of x40. The picking of the fora from the dried sample residue was done under the reflected light, using a binocular microscope, and the brush was moistened in small dish of water, pointed by using the thumb and the f ore finger, and placed in a hovering position over the field of the microscope. The microfossil picking brush was lowered over the specimen desired and allowed to touch the surface, to which the specimen with adhere.

The picked fossil was removed and transferred into a coated-surface micro-slide that contains water gum, and was allowed to dry. After which the microfossil picking brush was removed with a rotating withdrawal motion, which facilitates the transfer of the fossil into the slide. This was later covered with cover slip (slide cover).

Conscious effort was made to identify as many microfossils as possible in each sample. Each microfossil seen in a sample was identified and named using a comprehensive microfossil album.

- Digital Camera Work

Digital camera was used to obtain the images of the fora seen. The slide containing the fossils, with cover slip covering the digital camera was placed at the top of the eyepiece of the microscope, which viewed through the microscope, and captured the image of the fossil. Lastly, the pictures were transferred to a computerized printing and the slides kept for future use.

3 GEOLOGY OF THE STUDY AREA

The study area of the Nkporo formation is unconformable overlying the Ezeaku formation in the Afikpo sub-basin (Murat,1972). The shales are dark grey, very fissile and soft shale and consisting of mudstone with occasional thin interbeds of sandy shales, fine sandstone and marks with coatings of sulphur and numerous white specks of *Remulina* explicate. Other benthonic foraminifera mostly *Robertina Sp* described by Agagu *et al* (1985) include *Bulimine fang, Buliminaprolixa , Globobulimina Opima, Ammobaculites phummerae, Bolivina miocenica, Bulimina alstica, Bulimine robusta, Bolivina anambra and Gavetinela Sp.*

Other fossil taxa has been reported in the Nkporo shale Odebode, (1987) and Petters (1980) reported the presence of *Gabonita Sp*. (Petters and Edet 1996) reported the presence of *Nonionella Sp, Preabulimma Sp, Heterohlix Sp, Afrobolivia Sp, and Ammobaculities Sp;* among others. But planktonic foraminifera are generally rare (Agagu, *et al* 1985, Zaborski (1983). Gebhardt (1998), described the Ammonite biostratigraphy of the Nkporo formation and noted that the dominant genera is the *Cybicoceras afikponses.*

The lithological and microfuna association in Nkporo Formation suggests a restricted shallow marine environment. The marine origin of the Nkporo Formation is also suggested by the occurrence of the ammonite, *libycoceras afikpoenses* together with *inoceramus*, crab, fish teeth, bryozoans, and *echinords* (Reyment, 1965., Simpson, 1954) based on molluscs and fish remains. Reyment (1965) also describe the maastrichtian zone of *libycorceras afikpoense* in the Nkporo formation while

Murat (1972) used an upper Santonian age. Reyment (1965), and Zaborski, (1983) therefore suggest a Campanian to Maastrichtian age for the Nkporo shale.

4 PHYSIOGRAPHY OF THE STUDY AREA

4.1 TOPOGRAPHY

The studied area has characteristically undulating topography. This is manifested in the arrangement of the ridges, valleys and plains in the area. The valleys and low lying plains are underlain by shales which are more susceptible to erosion than sandstones which under lie ridges. The ridges are more erosion resistant than valleys and the ridges run in ENE-WSW direction, while the low lying plains occur north and south of the ridges. The plans attain the general height of about 30m above sea level while the ridges rise to about 45 meters above sea level.

4.2 DRAINAGE

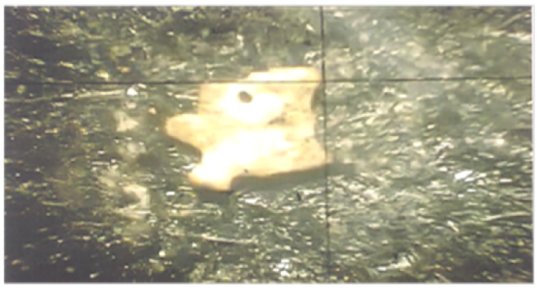
Drainage simply means the arrangement in which a stream erodes the channel of its networks of tributaries; it depends on the soil type, vegetation, relief and topography. The drainage pattern of the mapped area appears dendritic in nature, suggesting that it is possibly controlled by River such as the Lyioka River, Wowo River and Azu river drain the area. All of these flow northeast- wards and empties into the Cross River which is the major River that drains the area.

5 DICUSSION

The study area of Afikpo and its environs consist predominantly of shale and sandstone. It can be subdivided into six units which are Unit A, Amuzu Shale., Unit B, Amangbara Shale., Unit C, Anofia Nkanu Shale., Unit D, Amacha Shale., Unit E, Ozizza Shale These units consist of shales of different grade while Unit G consist of sandstone ranging from fine to coarse grains.

5.1 LOCATION SCE/02850/01 (AMUZU)

In the dark-grey, carbonaceous and fissile shale sample collected from Amuzu location, relative abundance of Robertina Sp was witnessed. Other foraminifera identified in these samples include: moderate abundance of *Ramulina Sp, Flourensina intermedia.* As shown in Plate.1.



(a) *Ramulina Sp*

(b) *Flourensina Intermedia*

(c) Robertina

Plate 1: Foraminifera indentified at Amuzu

5.2 LOCATION SCE/02850/02 (AMANGBARA)

The thick laminated, dark- grey and carbonaceous shale sample collected from Amangbara (SCE /02850/02) yielded *Gavelinella* intermedia is the relative abundance. The samples were also marked by the common occurrence of other forums such as *Vagmulina kochii, sacammina Sp* as shown in plate 2

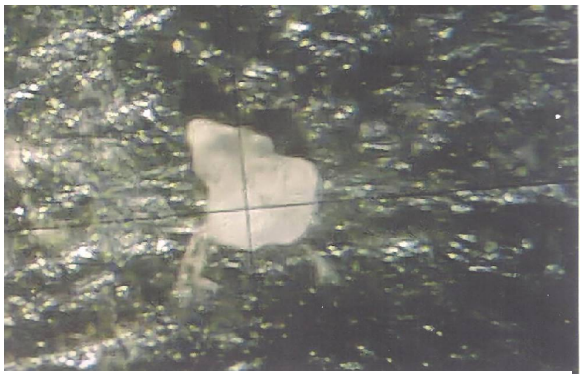
5.3 LOCATION SCE/02850/03 (ANOFIA NKANU)

The laminated black and carbonaceous shale sample collected from Anofia Nkanu (SCE/02850/03) *Eggerellina mariae* yielded moderate abundant. The samples were also marked by the common occurrence of other fora such as *Gabonitas Sp, Epistoma Sp, Eggerellina mariae, Globigerina* (plantonic.

5.4 LOCATION SCE/02850/04 (AMACHA)

Sample from the dark-grey fissile shale of Amacha location (SCE/02850/04) yielded abundant of *Remulina Sp*, moderate abundance of *Eggerellina mariae* and rare occurrence of *Globigerina* (Plantonic), as shown in Plate.2.

(a) *Ramulina Sp*



(b) *Eggerellina mariae*

(c) *Globigerina*

Plate 2: Foraminifera identified at Amacha

5.5 LOCATION SCE/02850/05 (OZIZZA)

Foraminifera identified in the dark-grey sample of Ozizza location (SCE /02850/05) yielded very abundant occurrence of *Robertina Sp, moderate saccammina Sp, Epistoma Sp*, and rare occurrence of *Eggerellina mariae.*

6 PALEOENVIRONMENTAL ANALYSIS

Attempt is made here to analyse the paleoenvironment of the lithofacies encountered in this work, with the help of findings and results obtained from this study. Certain characteristics of this unit are helpful in analysis of its paleoenvironment. In the first place, its dark colour suggests high carbon content which can be traced to an oxygen deficient environment. The shale is also fossiliferous, pynetic and has parallel laminations; a characteristics that suggests a stagnant and oxygen deficient reducing environment; with low energy of deposition (Kogbe 1965., Culver 2006). The presence of minerals such as glauconite, gypsum and pyrite in the shale also confirms marine environment. Micropaleontological evidences suggest a normal shallow marine environment for the units as a result of the fact that most of the foraminifera encountered in the unit were benthics, capable of tolerating normal marine salinities as well as shallow marine depths. Some of the foraminifera encountered in the Amuzu shale unit were small sized and had tapered tests, suggesting a stressed and oxygen deficient environment. Therefore, a shallow marine, stressed and reduced oxygen environment is suggested for Amuzu shale.

Foraminifera identified in the Amuzu and Ozziza indicate Campanian- Maastrichtian age (Reyment 1965; Petters 1982). Of most significance in this regard is the proven endemic West African marker foraminifera Reyment- maastrichtian; *RobertinaSp* in some samples analyzed.

7 PALEOECOLOGY

7.1 OXYGENATION

Oxygen level determines the type and characteristic o foraminifera in environments. Normally oxygen level creates a conductive environment for growth of large size foraminifera. It also enhances the secretion of $CaCo_3$ enabling foraminifera to develop calcareous walls. On the other hand, low oxygen content creates difficulty in $caco_3$ secretion and reduction in size of fora individuals. Hence aranaceous, small sized and thin shelled forams with flattered or tapered test shapes are characteristic of low oxygen environments Mode, (1991)

In extremely reduced oxygen environments (anoxic) it is only plankton foraminifera, which are able to float and get oxygen from the surface that can survive. The occurrence of calcareous and aranaceous foraminifera, the presence of tapered and dwarfed foraminifera, low to moderate dark colour of the shale in dictates a normal oxygen content at the top and reduced oxygen content at the bottom (Mode 1991).

7.2 SALINITY

Most of the foraminifera encountered in this study fall within those that tolerate normal marine salinities (32-37%) such forams include *Afrobolivinaafra, Globigerina Sp, Gabonita Sp.* Few of the foraminifera of *Eggerellina mariae* and *Globigerina* belong to the unrestricted genera which inhabits a wide range of salinities.

7.3 BATHYMETRY

Deep marine conditions are characterized by the dominance of planktics. The dominance of benthic as against planktice indicates shallower marine environments (Petters and Edet 1996). In this study benthic foraminifera were solely identified. Most of the benthic foraminifera are calcareous in nature, indicating a well oxygenated, shallow marine environment. From the above a shallow marine paleoenvironment is suggested for Afikpo and its environs.

8 SUMMARY

This research gave an insight into the Foraminifera content of Afikpo and its environs. Afikpo is rich in foraminifera which include *Gavelinella cenomanica, Ramulina Sp, Robertina Sp, Flourensina intermedia, Gavelinella intermedia, Eggerellina mariae, Vaginulina kochii* . Benthic foraminifera, mostly calcareous benthic make up the highest abundance of foraminifera in

the study area. This suggests a shallow marine environment of deposition for Afikpo and its environs. Most of the foraminifera encountered tolerate normal marine environment of deposition.

Furthermore, the large size of the foraminifera identified, couple with the dominance of calcareous forms suggest proper oxygenation of the deposition of environment.

9 CONCLUSION

From findings the study area is rich in foraminifera which could be used for analytical studies and the determination of the environment of deposition. Most of the foraminifera encountered are of the Campanian- Maastrichtian age. Some of these foraminifera encountered are very useful in paleontological study.

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