

Foraminiferal biostratigraphy of the upper part of the type-section of Ekenkpon Formation, Calabar flank, southeastern Nigeria.

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ABSTRACT

Foraminiferal biostratigraphic analysis was carried out on the recent landside section near Ekenkpon village in Cross River State of Nigeria, which exposed part of the type-section of the Ekenkpon Formation in the Calabar Flank sedimentary basin. The nine metre (9-m) high section consists of flaggy, dark gray, fissile shales frequently intercalated with marl beds. Though rare to moderately abundant, the foraminiferal assemblage recovered revealed a dominant occurrence of the planktonics (*Heterohelix pulchra*, *Heterohelix moremani*, *Heterohelix globulosa*, *Hedbergella planispira* and *Hedbergella delrioensis*) over the benthonic forms (*Ammobaculite* sp. and *Praebulimina* sp). The absence of typical Cenomanian index forms, like *Rotalipora balernaensis* and *Globigerinoides caseyi* from the planktonic foraminiferal recovery, is a clear indication that the recently exposed section represents only the upper part of the Ekenkpon Formation (Late Cenomanian to Early Turonian age). The scanty and dwarfed nature of the benthonic foraminiferal recovery, coupled with equally dwarfed pelecypods and abundant thalassinoides recorded within this study section, is an indication of the fluctuating oxygen concentration which characterized shallow aerated oxic and anoxic marine settings worldwide during this geologic period.

INTRODUCTION

The Southeastern Nigerian sedimentary basin, also referred to as the Calabar Flank (Murat, 1972), is characterized by crustal block faulting trending in a NW-SE direction and consists of mainly Cretaceous sediments (Fig. 1). One major handicap with field sampling in the Calabar Flank is the rarity of fresh exposures as most of the exposed sections are either too small or have been highly weathered or even eroded following several years of heavy rainfall that is characteristic of this tropical area. The recent major landslide event that occurred at Ikot Okon Urua near Ekenkpon village due to fracture and subsequent lateral drifting apart of the two flanks of the fractured plane therefore provided an excellent opportunity to study a considerable exposure of mainly dark-grey fissile shales intercalated frequently by marl beds. This recently exposed section which constitutes part of the type-section of Ekenkpon Formation of Petters, *et al* (1995), is located at km 24.8 along Calabar-Itu highway and lies between latitudes 5° 33' 30"N and 5°37'05"N and longitudes 8°45'42"E and 8°50'42"E. The landslide section has an average height of about nine metres (9m) and is separated into two flanks by a steep sided corridor that extends up to one hundred and sixty-eight metres (168m) and sixteen metres (16m) in length and width respectively (Fig. 2). Several studies have been carried out on smaller sections of the Ekenkpon Formation exposed at various localities. However, none of the previously studied sections have clearly defined the upper part of this formation.

Petters (1980), studied parts of this formation previously known as Eze-Aku Formation and assigned the age of Cenomanian-Turonian based on the recovered foraminiferal species. Nyong and Ramanathan (1985), using foraminifera, noted the repeated alternation between oxygen rich and oxygen starved (oxic and anoxic) depositional periods in this formation. Akpan (1985), studied the Trace fossils occurring in this formation and suggested a paleoenvironment that witnessed variations in oxygen concentration at the different intervals he studied. Petters *et al* (1995), renamed this formation the Ekenkpon Formation after defining the Type-section near Ekenkpon village.

The samples collected for this study were processed for foraminiferal microfossil. Although the recoveries were rare to moderate in abundance, they still provided a strong basis on which this biostratigraphic analysis has been made. This work was therefore carried out based on the advantage of utilizing foraminiferal recovery from fresh samples obtained from the recent and most extensive exposure of Ekenkpon Formation to clearly define the age of the exposed interval and the associated paleoenvironment. It is hoped that with the establishment of the age of this section, other sections that will be studied subsequently will be compared with this one in an attempt to establish the full thickness, age, paleoenvironment and boundaries of the Ekenkpon Formation.

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Manuscript received by the Editor September 5, 2007; revised manuscript accepted December 12, 2007.

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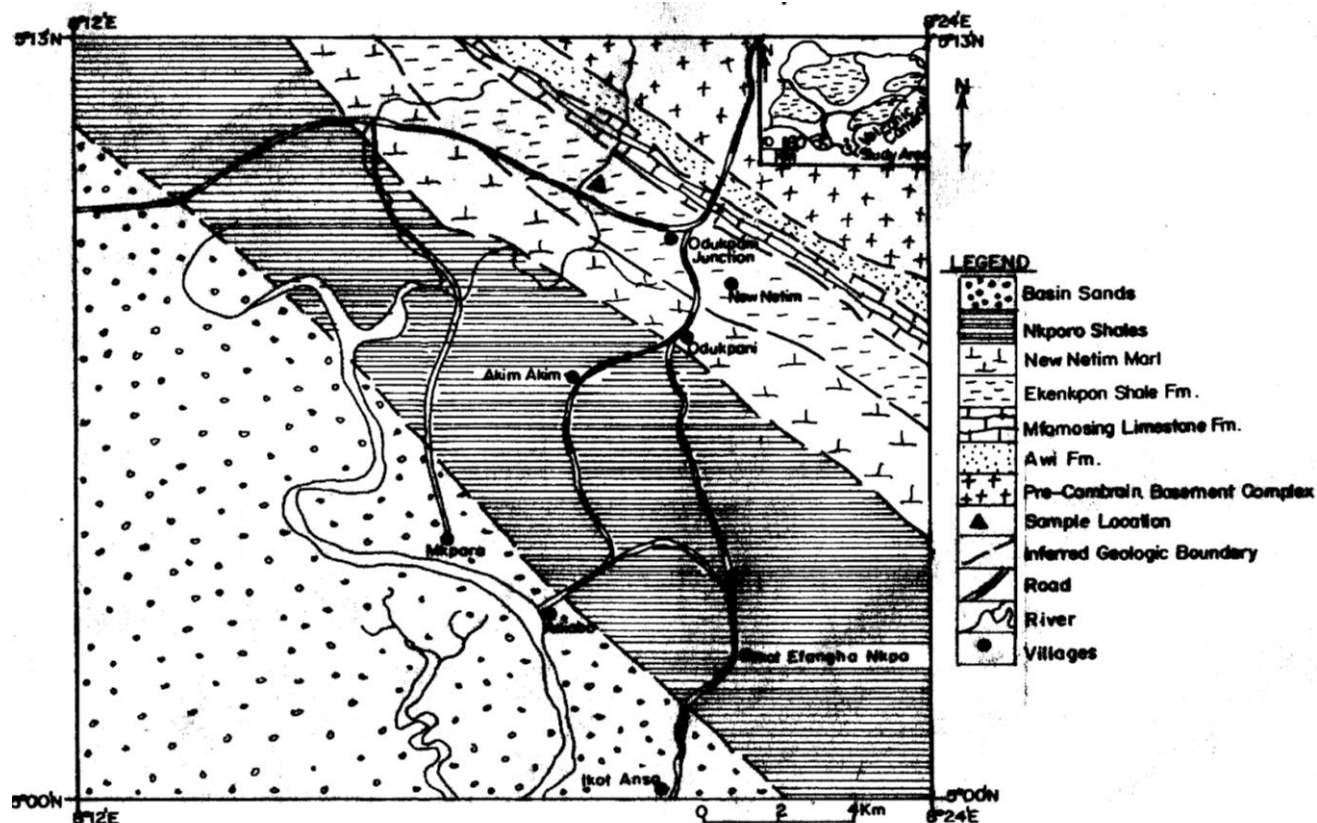


FIG.1-Geologic sketch map of the Calabar Flank showing sample location

Geologic setting

The Calabar Flank is an epeirogenic basin in the easternmost part of the sedimentary basins in Southern Nigeria (Murat, 1972; Nyong and Ramanathan, 1985). This basin is bounded by the Precambrian Oban massif in the North and the Tertiary-Recent Niger Delta hinge line in the South respectively. It also extends to the Cameroon Volcanic ridge in the East and the Ikpe platform in the West. Petters (1980), considered it as the southeastern extension of the Benue Trough or Benue aulacogen (Fig 1).

Northwest-Southeast trending basement structures underlie the Calabar Flank and define the Ituk High and Ikang Trough, thus relating the Calabar Flank to the South Atlantic cretaceous marginal basins with similar horst-and-graben structures (Reijers and Petters, 1997). The attitude of these fault blocks and eustatic changes in the sea level within the adjacent South Atlantic, together with the geology of the provenance areas, controlled the stratigraphic development of the Calabar Flank (Essien *et al* 2005).

Recent definition of the Calabar Flank as a distinct geologic province with its own peculiar tectonic style and attendant stratigraphic evolution (Nyong, 1995), culminated in the revised lithostratigraphic subdivision of this geological province that is currently in use (Petters *et al* 1995). The stratigraphic succession in the Calabar Flank consists of mostly Cretaceous sediments. The basal Neocomian-Aptian Syn-rift fluvial sandstone, the Awi Formation,

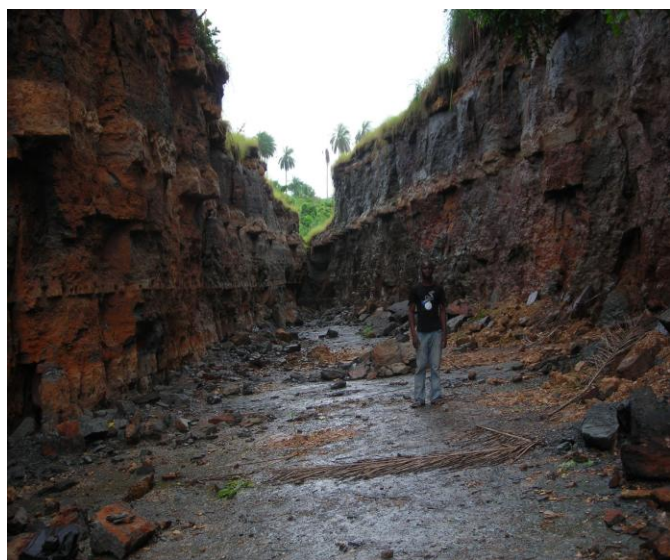


Fig. 2. Landslide section at kilometre 24.8 along Calabar- Itu highway

marked the on set of sedimentation in the Calabar Flank. The Albian and Late Cretaceous marine post-rift Odukpani Group (Petters *et al* 1995), which consists of the Mid Albian Mfamosing Limestone (Akpan, 1992), the late Albian-Turonian Ekenkpon Formation and the Coniacian New Netim Marl directly overlies the Awi Formation. This is in turn unconformably overlain by the late Campanian-Maastrichtian Nkporo Shale (Reijers and Petters, 1997 and Edet and Nyong, 1993). Tertiary to Recent regressive sands and gravel beds overlie the Cretaceous succession.

MATERIALS AND METHODS

Detailed field study was carried out at the landslide location and the thicknesses of beds, lithologies, structures as well as body and trace fossils were clearly noted. Samples obtained from the study section (interval 0.00m-6.07m) through spot sampling method were utilized for this study (Fig.3). Since most of the beds were of varying thicknesses, the sampling intervals were irregular, hence sampling was done at the top and base for smaller beds while the middle section was also sampled for thicker beds. Standard paleontological foraminiferal separation procedures in line with Pessango (1967), Zingula (1968) and Braisier (1980), were adopted during this study. These include the treatment of samples in anhydrous Sodium Carbonate for proper disintegration before wet-sieving through 63 μ mesh sieve and drying at optimum temperature. Separation of the fossils was done under the Wild Heerburg binocular microscope. Analysis and interpretation of various foraminiferal taxa were done based on appropriate published manuals and monographs. Field lithologic description was complemented by examination of the residue under a binocular microscope. Published articles on the lithofacies of the Calabar Flank were also considered (Reyment, 1965; Murat, 1972; Kogbe 1976 and Petters, 1980).

Paleoenvironmental interpretation of the study interval was done based on foraminiferal data. The occurrence of dwarfed body fossils in black shales and thalassinoides (Fig.4) also aided in paleoenvironmental interpretations.



Fig.3. Sample collection at the landslide section along kilometer 24.8 Calabar- Itu highway



Fig. 4. Thalassinoides recovered from the landslide section at kilometer 24.8 along Calabar – Itu highway.

RESULTS

Lithostratigraphy

The analyzed interval of the landslide section exposed lithofacies of Ekenkpon Formation. The sediments were mainly shales with frequent intercalation of Marl beds. A lithostratigraphic summary of the landslide section showing the thicknesses of the various beds and their corresponding lithologic descriptions is presented in Table 1.

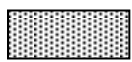
Table 1. Lithostratigraphic summary of the landslide section, Km 24.8 Calabar – Itu highway.

DEPTH (M)	LITHOLOGY	LITHOLOGIC DESCRIPTION	LITHOSTRATIGRAPHY
10.04	Regoliths	Mostly clay and silt	EKPENKPON FORMATION
7.00	Shale	Dark-grey fissile shale with pelecypods	
6.00	Marl	Thin marl band with shell fragments.	
5.50	Shale	Dark-grey fissile shale with shell fragment	
4.60	Marl	Thin band of marl with calcareous indeterminate and shell fragments.	
4.50	Shale	Grey-shale with shell fragments.	
3.20	Marl	Mudstone band with shale fragment.	
2.20	Shale	Grey organic rich shale with pelecypods and shell fragment.	
1.80	Marl	Mudstones band with Thalassinoides traces.	
1.50	Shale	Very thin grey fissile shale with calcareous indeterminate and shell fragments.	
1.40	Marl	Calcareous mudstone band with thalassinoides traces.	
0.00			

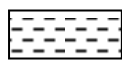
Table 2. Stratigraphic summary chart of the landslide section, km 24.8 Calabar – Itu highway.

LITHOSTRATIGRAPHY	STAGE	DEPTH (M)	LITHOLOGY	Gavelinella sp.	Ammobaculite sp.	Hedbergella planispira	H. delrioensis	Heterohelix pulchra	Whiteinella sp	Praebulimina sp.	H. moreimani	H. globosa	Pelecypods	Shell fragments	Calcareous indet.
EKENKPON FORMATION	LATE CENOMANIAN – EARLY TURONIAN	10.04													
		7.00													
		6.00		/									/		
		5.50			○									●	○
		4.60												○	
		4.50				/	/							●	
		3.20												●	
		2.20												○	
		1.80												●	
		1.50												/	
		1.40												○	
		0.00				/		○		/	/	/			

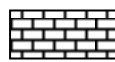
LEGEND



Regoliths



Shale



Marl

● 6 – 15

○ 2 – 5

/ 0 – 1

Biostratigraphy

The Ekenkpon Formation represents an interesting period in the stratigraphic framework of South-Eastern Nigerian sedimentary basin. It was a period in which, though principally shales were deposited, fossils were only recorded at particular intervals while other intervals were completely barren of fossils. Fossils observed and or recovered included not only foraminifera, but also body fossils (pelecypods) and

trace fossil (thalassinoides).

The recovered foraminifera include both the planktonic and the benthonic forms. In terms of abundance, the foraminiferal recovery could be described as rare to moderate with low species diversity, while the benthonic forms (Ammobaculites, Sp. Praebulimina Sp. and Gavelinella Sp.) were scanty and dwarfed, the planktonic forms (Heterohelix moremani, Heterohelix globulosa, Hedbergella

planispira, Hedbergella delrioensis and Whiteinella Sp.) were relatively more dominant. Foraminiferal biostratigraphic summary of the landslide section is presented in Table 2.

Petters (1980; 1983), used a similar foraminiferal assemblage to assign the Cenomanian-Turonian age to the Eze-Aku Formation in the Benue Trough and to define the Turonian age in the Gulf of Guinea respectively. Bassey (1991), also used these species among others to indicate the Cenomanian-Turonian in the subsurface of the Calabar Flank. It has been ascertained that the foraminiferal assemblage recovered from the landslide section belongs largely to the Cenomanian-Turonian Ekenkpon Formation. However, index forms such as Rolatipora balernaensis, Globigerinelloides caseyi, Globigerinelloides bentonensis and Favusella washtensis that would have precisely define the Cenomanian interval are completely absent from this section. The occurrence of Lower Turonian index forms (Heterohelix moremani and Heterohelix pulchra) within the study interval therefore implies that this newly exposed section constitutes the upper part of the Type section of the Ekenkpon Formation.

Paleoenvironment analysis

Benthic foraminifera are generally mostly affected by ecological conditions of their environment and they thus react appropriately to various environmental settings (Petters, 1980; Akpan, 1985; Nyong & Ramanathan, 1985). It was observed that certain intervals of the studied section were completely devoid of any fossil while some other intervals contained only a few Planktonic forms (mostly Heterohelix and Hedbergella). The Planktonic and a few dwarfed benthonic forms were also found to occur together at certain intervals. Other intervals played host mostly to dwarfed pelecypods and thalassinoides.

From the foregoing, it could be deduced that the bottom oxygen concentration was too low (anoxic) during certain periods for benthonic organisms to survive, thus only a few planktonic forms, particularly Heterohelix and Hedbergella, did during periods with water depths not shallower than they could inhabit. Apart from restricted ecologic setting, the dominance of Heterohelids in the study section could also be attributed to shallow water depths as these forms are reputable in colonizing shallow water habitats (Douglas and Rankin, 1969 and Sliter, 1972). These conditions are in conformity with those reported earlier by Petters (1978; 1980), for the adjoining Basin (Benue Trough) as well as those of the Cenomanian-Turonian of the Western interior of North America (Eicher and Worstell, 1970). On the other hand, improved bottom conditions (fairly oxic) as well as shallower water depths could be suggested for the intervals with dense thalassinoides traces and abundant dwarfed pelecypods. The deposition of sediments of the studied interval was suggested to have taken place in a marginal to shallow marine setting.

CONCLUSION

The fresh section studied for this work was exposed by a recent landslide event that occurred within the Calabar Flank and it constitutes part of the Type-section of Ekenkpon Formation of Petters et al (1995). Due to rarity of fresh samples in this region, the landslide section provided an excellent site for several geologic studies.

In spite of the rare to moderate abundance of lowly diversified foraminiferal assemblage recovered during the study, the data set provided the basis for not only confirming that the studied section belongs to the Cenomanian-Turonian Ekenkpon Formation but also precisely delineating this section as the upper part of the Ekenkpon Formation due to the absence of Cenomanian index fossils. The authors believe that with the establishment of the upper part of the Ekenkpon Formation, efforts would be geared in the near future towards establishing other lower sections of this formation and putting them in the correct framework with reference to this studied section. Variable oxygen concentration and associated fluctuating depositional environment already reported in the Ekenkpon Formation by other workers was also noticed in the studied section.

ACKNOWLEDGMENT

The authors are grateful to the Department of Geology, University of Calabar, and the Management of South-Sea Petroleum Consultants, Port-Harcourt.

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