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Research Article

FORAMINIFERAL BIOSTRATIGRAPHIY AND PALEONTOLOGICCAL ANALYSIS STUDY OF OUTCROPS ALONG THE ENUGU-PORT HARCOURT EXPRESSWAY

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ABSTRACT

Biostratigraphic study has been carried out on outcrop samples along the Enugu-Port Harcourt Expressway in Anambra Basin between Longitudes 7° 30' and 8° 00' and Latitudes 6° 26' and 6° 30' south . An attempt was made to determine the relative age and depositional environment of the section. A lithologic analysis of the section shows that the samples are made up of shale, claystone and siltstone which are grey to dark grey and brown in colour with intercalations of medium to fine grained sandstone beds. The foraminiferal analyses yielded information on the percentages of Benthonics, Planktonics,, Calcareous forms, Arenaceous forms, the particle size distribution chart, foram diversity chart, foram abundance chart, ,planktic/benthic ratio, depositional environment, litholog and a composite log for the location. These information were used in assigning the age of the Campanian—Paleocene age to the study area.

INTRODUCTION

The study area falls within the Anambra Basin. The basin is located in the Southeastern Nigeria and covers about 40,000 sq km. The roughly triangular Anambra sedimentary basin has its southern boundary coinciding with the northern boundary of the Niger Delta Basin and the basin extends northwards beyond the lower Benue River.

A field work was carried out to map out the surface geological features and Samples were taken from exposures at road cut for laboratory analysis with a view to carrying out Biostratigraphical analysis .The structural trending pattern could not be adequately followed or traced since they have been obliterated. The study area begins is at Agbogugu junction

Location and Accessibility:

The study area is located in Enugu State. Within the Southeastern part of Nigeria between Longitudes 7° 30' and 8° 00' and Latitudes 6° 26' and 6°

30' south.

Aim, Objective and Scope of the Study:

The present study is aimed at:

- Establishing the sedimentological, faunal and floral characteristics of the outcrops with a view to predicting the age of the formation.
- Interpreting depositional environment, paleoecoiogical and paleoenvironmental trends within the basin.

Study location:

The location is situated 200m at Ozalla junction along Enugu-Port Harcourt expressway between Longitudes 7° 30' and 8° 00' and Latitudes 6° 26' and 6° 30' south The outcrop shows an inclination towards the horizontal, with the dip varying from 4° - 6° NE .

LITERATURE REVIEW:

The dating and correlation in the basin have been based m.inly cii ammonites (Reyment, 1965). On the basis of the ammonite fauna thund in the shales, sandstones and sandy-shale of the Nsukka Formation and Nkro Shale (and the Enugu Shale) Reyment (1965) divided the Maasiridii into three zones. The zone of Libycoceras afikpoensis Reyment found in the Nkporo Shale (and the Enugu Shale). The zone of Sphenodisciis

miri Reyment was found in the Western extension of the Nsukka Formation. (Fayose, 1970) and the zone of Inoceramus coxi Reyment was found in the upper part of the Nsukka Formation in the Western Nigeria.

The Campanian-Maastrichtian sequences in the basin are generally poor inmicrofauna unlike equivalent sequences in the Afikpo syncline and the Calabar Flank, which are richer in microfauna (Petters, 1980: Mode. 1991: Petters and Edet, 1996).

Okoro (1986) have noted the dominantly benthic foraminiferal assemblage in the basin to include Bolivina explicata, Bolivinafangin, Bolivina prolLta, Cave/me/ia sp., Anomalina sp., Ammobaculites sp. and Haplophragrnoides excavata and few ostracod fauna.

Agagu (1985) have recorded a sparse ostracod and foraminiferal assemblage in the subsurface sections of the Mamu and Ajali Formation which overlies the Nkporo Shale successively. He opines that the Mamu Formation consists of Ostracods and arenaceous foraminifera mainly Hap lophragmoides.. Ammobaculites and few Buliminides. Ladipo (1986) interpret the Ajali Sandstone to be a tidal shelf deposit.. based on the gross fauna! characteristics, sedimentary structures and pa1eocurrei analysis.

Oloto (1984) described the Palynological assemblage from the Danian of South-West Nigeria, which the lithologic sequence include that of Nkporo Shale.

METHOD OF STUDY

Research Procedure:

The research procedure involves first carrying Out a literature study See works carried out on the study area by previous workers, after which a preliminary field study is carries out on the study area with a visit to e 5ed to assess the outcrops (their height, accessibility and location); the research continues with a final field trip. This field trip involves the proper sampling of the beds encountered. These samples are taken to the laboratory further detailed biostratigraphic and Sedimentologic studies.

Procedure at Outcrops:

On each of the outcrop locality, observations were made recorded systematically . The procedures are as follows:

1. Drawing up of a lithologic log section taking panicuir note of

a) Bed thickness

b) Textural features, colour, grain size (spieiciw and roundness), sorting. and details on fabrics (preferred grain orientation, grain-matrix relation),

c) Sedimentary structures including:

Bedding planes: -scoured, sharp or transitional.

Bedding surfaces structures: - stratification (bedding and lamination) graded bedding., (normal or reverse), cross-bedding (planar, trough, hummocky, ripple), reactivation surfaces, pause planes, tidal bundles, massive bedding, deformed bedding. nodules, concretions and stylolytes.

Trace fossils; trails, tracks, tunnels, burrows (whether veri horizontal or inclined).

(d) Other structural features e.g. Fractures (joints and faults).

2. Based on these observations, questions are addressed,.. environments can be inferred from the trend of the grain size. rc;. types and sedimentary structures, recurrent pattern of vea lithological succession are observed and put into a sketch log and result inspected.

3. From the composition, texture, sedimentary structures, paleocurrent parameters and vertical profile, attempts are made to establish a qualitative assessment of the reservoir quality of the rocks and its lateral distribution.

4. Finally, the sandstone units are checked whether there are hydrocarbon trapping configuration sections and if there are any productive problems are hydrocarbon-charged.

Sampling Technique:

The sampling method adopted in this research takes cognizance of the aim f the work. Samples were collected at different sections of the beds in each outcrop of the study area. The sampling involves the use of the hammer and an iron rod to hit out a block of the rock and stored in a sample bag made of calico cloth. This sample bag is labeled for the sample location and sample number in which it represents.

The sampling was done to establish a chronological order, which the occurrences of structural features like unconformities, faults and folds are described. Samples were taken below and above planes of non-continuity. Samples were collected from dipping beds; they were laterally collected in order to determine the lateral variations for the different beds.

Laboratory Analysis:

Sedimentological/Foraminiferal Sample Preparano:

The samples available from the field were broken into smaller pieces in a mortar. About 50 grams of the broken sample were put into an enamel plate, mixed with water and treated with 2 grams of Sodium

bicarbonate (Na_2CO_3).

This is allowed to boil for 30 mins on a hot plate at 400°F. The essence of this is to desegregate the samples further and free the fossils from the matrix.

Each boiled sample was then washed through a stack of sieves arranged in decreasing order; 250µm for the coarse fraction, l50µm for the medium fraction and 75µm for the fine fraction using a jet of water.

Residues from each sieve size were collected in a filter paper, dried on a hot plate at 150°F and labeled for analysis. They were weighed to determine the various clay, silt and sand fraction.

Analysis of the dried samples done using stereomicroscope on smooth black surfaced picking trays, which was divided into grids. The fossils on each grid traversed were picked with a trimmed point picking brush which was constantly moistened by dipping in water. The fossil specimens were stored in slides, which were labeled against the depth of occurrence. The foraminiferal identification in this study were carried out using published references of Petters (1982), Bolli et al., (1985) and Cushman (1945).

Preservation problems, especially those of post burial, test dissolution, breakage of test (deformation) and various morphological variations were observed.

Taxonomic problems were overcome by:

1. Identification of forms to generic of species level where possible.
2. Lumping where there are indications of continuous morphological. Variation with a central rnorphotype rather than naming members of such population.
3. Fossil specimens were photographed for illustrations of key species.

AGE DETERMINATION:

The age determination of the studied section was attempted using Micropaleontological data obtained. Specific age determinations were based on the association of both benthonic and few planktonic foraminifera assemblages, since there were pauctity of diagnostic index forms

RESULTS AND INTERPRETATION

Lithostratigriphy:

A field description of the lithology is presented here alongside the laboratory description.

The basal end consists of shale, dark grey in colour and gradually changes into a feruginized siltstone

which is about 10 -15m thick, overlying the siltstone bed is a shale bed. The shale is fissile and shows evidence of weathering surfaces, overlying the shale is a claystone bed at the top, they tend to be red in colour and also show evidence of organic activity (bioturbation).

SAMPLE NUMBER	**LITHOLOGIC DESCRIPTION**
Location 8 Sample 1	Siltstone, shaly, dark grey with red ting, slightly feruginized.. weathered, indurated (hard), wavy non parallel laminae (0.6cm), non calcareous, green colour with HC1 acid.
Location 8 Sample 2	Shale, dark grey, wavy non parallel laminae (0.3 cm), platy, indurated (hard), shiny grains, slightly weathered, non calcareous.
Location 8 Sample 3	Claystone, dark brown with red ting and black ironstone parts, highly feruginized, structureless, indurated (hard), non calcareous.
Location 8 Sample 4	Shale, dark grey, wavy parallel discontinuous laminae (0.1cm), coal lens, (0.1cm wide, 1.3cm long), indurated (hard), black carbonaceous materials, non calcareous, minor bioturbations. clay filled burrows (0.2cm wide).
Location 8 Sample 5	Siltstone, grey with red to brown ting, slightly weathered, minor intercalations of wavy parallel grey shale laminae (0.1cm), burrows (0.1cm wide), oval body of siltstone (white, 0.7cm by 1.6cm), non calcareous.
Location 8 Sample 6	Siltstone, grey with brown ting, gritty, indurated (hard). slightly weathered, bioturbated, silt filled burrows (0.7cm), few black carbonaceous materials, mottled, non calcareous.

Location 8 Sample 7	Shale, dark grey, wavy non parallel laminae (0.6cm), flaggy, weathered, indurated (hard), few black carbonaceous materials. non calcareous.
Location 8 Sample 8	Shale, dark grey, wavy non parallel laminae (0.4cm), platy, indurated (hard), weathered, black and brown carbonaceous materials, non calcareous.
Location 8 Sample 9	Shale, flaggy, grains, dark grey with red ting, wavy slightly weathered, indurated few black carbonaceous non parallel iaminae (0.8cm), (hard), numerous shiny materials, non calcareous.
Location 8 Sample 10	Shale, grey with red ting, weathered, highly mottled, indurd (hard), numerous shiny grains, silty, non calcareous.

Table 1: Sample description table

SAMPLE NUMBER	MASS OF SAMPLE	SAND ($53\mu m$) WEIGHT(g)	SILT ($153\ \mu m$) WEIGHT (g)	CLAY ($300\ \mu m$) WEIGHT (g)	% WEIGHT OF SAND PROPORTION	% WEIGHT OF SILT PROPORTION
Location 8 sample 1	50g	2.1	1.4	36.2	4.2	2.8
Location 8 sample 2	50g	0.2	1.3	48.4	0.4	2.6
Location 8 sample 3	50g	0.2	0.6	48.5	0.4	1.2
Location8 sample 4	50g	0.2	25.4	49.2	0.4	50.8
Location8 sample 5	50g	--	---	---	--	---
Location 8 sample 6	50g	11.4	1.6	13.2	22.8	3.2
Location 8 sample 7	50g	1.6	2.1	46.8	3.2	4.2
Location 8 sample 8	50g	1.2	3	46.7	2.4	6.0
Location 8 sample 9	50g	0.1	3.2	46.9	0.2	6.4
Location 8 sample 10	50g	0.35	6.1	46.45	0.7	12.2
Location 8 sample 11	50g	-	-	-	-	--
Location 8 sample 12	50g	2.9	1.6	41	5.8	3.2
Location 8 sample 13	50g	-	-	46	-	-
Location 8 sample 14	50g	2.4	2	46	4.8	4.0
Location 8 sample 15	50g	1.6	1.45	46.4	3.2	2.9
Location 8 sample 16	50g	-	-	-	-	-

Table 2: Sedimentological sieve analysis

Lithostratgraphic Interpretation:

These sedimentary structures are interpreted in line with the abridged and outline detailed description of current of disposition during the time of deposition of these sediments.

Foraminifera Interpretation:

The samples 2, 20 and 26 all yielded only two fossil species with Haplophragmo ides talokaensis predominating with 91.84% while Miliammina inflata with 8.19% was the least abundant. Location 8 samples 4, 21, 22 and 27 also yielded the same fossil species as Miliarrzmina inflata and Haplophragmoides talokoensis but Millimina inflara dorninating 2 in abundance with 73.1% and Haplophragmoides talokaensis has 26.9% abundance.

This interpretation on foraminifera is in accordance with that used by Bizhleger (1965) to interpret

the depth ranges of more abundant speces of Foraminifera in the northwestern Gulf of Mexico. The depth-to-depth percentage distribution of the various benthonic. planktonic, calcareous and arenaceous foraminifera listings yielded by the various samples are presented in Tables 2.

BIOSTRATIGRAPHY:

SAMPLE NUMBER	FORAMINIFERA SPECIES	NUMBER OF SPECIES	PERCENTAGE OCCURRENCE
Location 8 sample 2	Miliammina inflata Haplophragmoides talokaenisis	4 45	8.16 91.84
Location 8 sample 4	Miliammina inflata Haplophragmoides talokaenisis	19 7	73.1 26.9
Location 8 sample 20	Miliammina inflata Haplophragmoides talokaenisis	4 45	8.16 91.84
Location 8 sample 21	Miliammina inflata Haplophragmoides talokaenisis	19 7	73.1 26.9
Location 8 sample 22	Miliammina inflata Haplophragmoides talokaenisis	19 7	73.1 26.9
Location 8 sample 26	Miliammina inflata Haplophragmoides talokaenisis	4 45	8.16 91.84
Location 8 sample 27	Miliammina inflata Haplophragmoides talokaenisis	19 7	73.1 26.9

Table 3: Table showing foraminifera distribution

Sieve Analysis Interpretation:

The study location shows dominance in clay ratio all through the outcrop but with minor differences in the ratio exhibited by the sand and silt sizes. The lower section of the outcrop shows a dominance of clay ratio but with minor incursions of silt size while the trend of clay ratio dominating transcends throughout the outcrop and also the upper section of the outcrop shows a distribution of sand-silt-clay fairly on the average side with the clay ratio still dominating but the sand and silt sizes advancing in proportion but with average contribution in the general grain size

Geologic History:

The study area is a massive exposure, which shows a fining upward sequence of sediments. The

faunal activity was only at the lower section of the outcrop but the upper half of the exposure has influence of littoral environment with presence of carbonaceous materials, as well as rootlets and there exist a coal seam at the 36m depth of the outcrop. The lower sections was predominantly sand and silt and are brown to purple, which signifies atmospheric influence of exposure after deposition as well as heavy mineral presence. This exposure portrays sediments deposited during a major marine transgressive phase during the Carnpanian to Paleocene age.

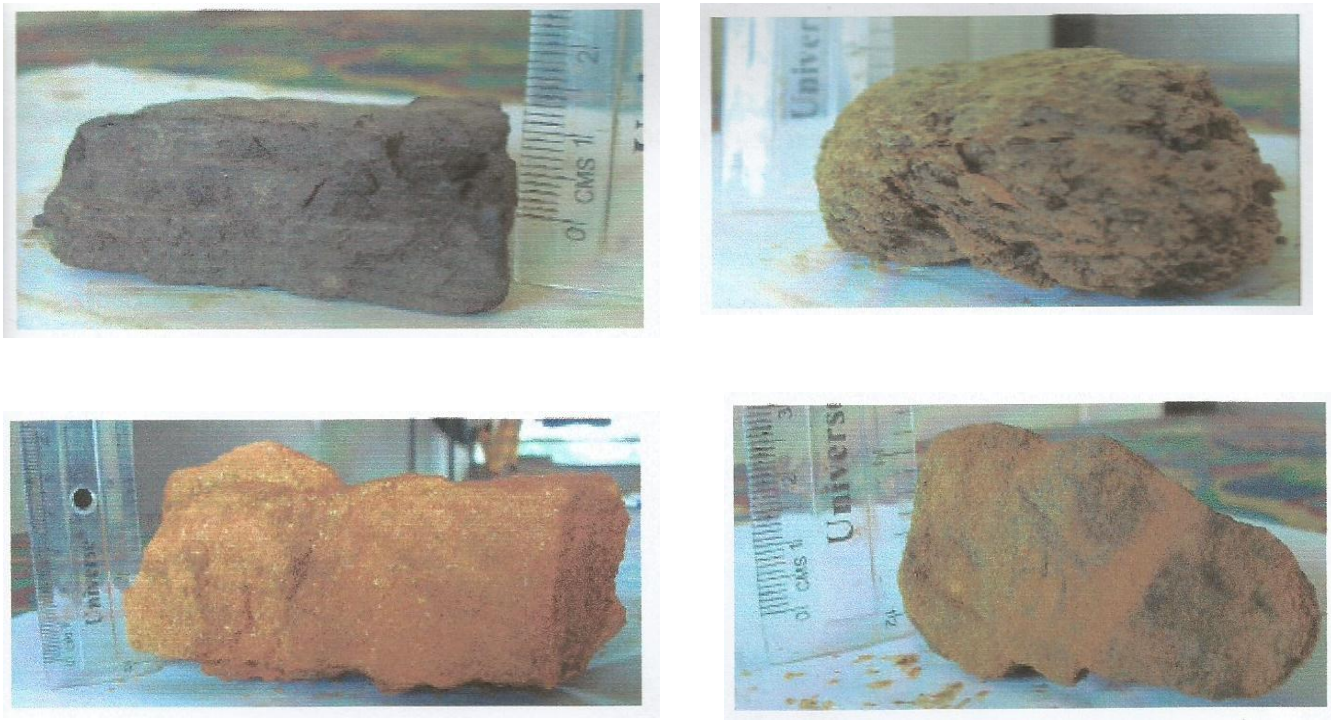
The South Central Nigerian sedimentary basin is made up of Cretaceous sediments, which were deposited during marine transgressive and marine regressive phases of eustacy. Most of these sediments describe high energy of marine water current of deposition while others describe low water current energy and the rest indicate intermediate currents. Structural features peculiar to sedimentary basin fill are also displayed within these studied outcrops.

This study area falls within the Anambra Basin and the geology of this are has been studied and described based on their biostratigraphy as well as their petroleum potentials. Key controls on sedimentation within this basin include primarily subsidence rates and eustatic sea level changes that determined the sediment distribution and fill histories. These histories are hereby delineated using key geological parameters like the sediment mineralogy, grain size, sedimentary structures as well as their biofacies composition.

Based on these parameters, the study location was deposited in quiet waters not reached by tidal influence as well as higher energy environment of a river channel environment as portrayed by the purple colour in the sandstone indicating presence of heavy minerals typical of river channel deposits, this outcrop range in age from Campanian-Paleocene. Location and belongs to the Enugu Formation deposited during Campanian Maastrichtian age deposited in an open marine environment of continental shelf to tidal flat region.

1. Sample 15 showing dark grey shale.
2. Sample 20 showing mottled claystone.
3. Sample 25 brown sandstone with cream ting.
4. Sample 19 showing structureless siltstone.

PLATE SEVEN:



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