

Palynological Evaluation of Potential Source Rocks at Imiegba, Benin Flank of The Anambra Basin, Nigeria

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ABSTRACT

Outcrop samples from an exposed section of the Mamu Formation along the Imiegba road, South western Anambra Basin were processed and analyzed for their palynological studies for age and environment of deposition determination. The basal part was characterized by the maximum development of *Cingulatisporites ornatus* Zone which was dated Maastrichtian. The upper part of the sequence comprising the shale, sandstone and mudstone facies belong to the *Spinizonocolpites baculus* Assemblage zone. The Continuous occurrences of *Longapertites marginatus*, associated with *Cingulatisporites ornatus*, *Cyathidites* sp, *Proxapaertites cursus*, *Deltodospora* sp puts the age at Maastrichtian – Paleocene. The recovery of mostly continental taxa assemblages with occurrences of marine forms (*Andalusiella Polymorpha*, *Andalusiella* sp, *Paleocystodinium gwolzoensis*) indicate a Continental to Marginal marine/inner neritic environment.

Keywords: Palynology, Benin Flank, Biostratigraphy, Environment of deposition and Mamu Formation.

1. INTRODUCTION

The Mamu Formation (of the Anambra Basin) consists of sandstones, shales and sandy shales with coal seams while dark blue to grey shales and mudstones frequently intercalate the sandstones to form a characteristic stripe stratigraphy[13], [15]. While several researchers have conducted studies on the formation[7][1][12][15][6][5], these works have mainly been restricted to the Southeastern part of the basin. Just few reports are available on the lithostratigraphy and biostratigraphy of Mamu Formation in the western Anambra Basin[11][2][4]; thus providing the basis of this study.

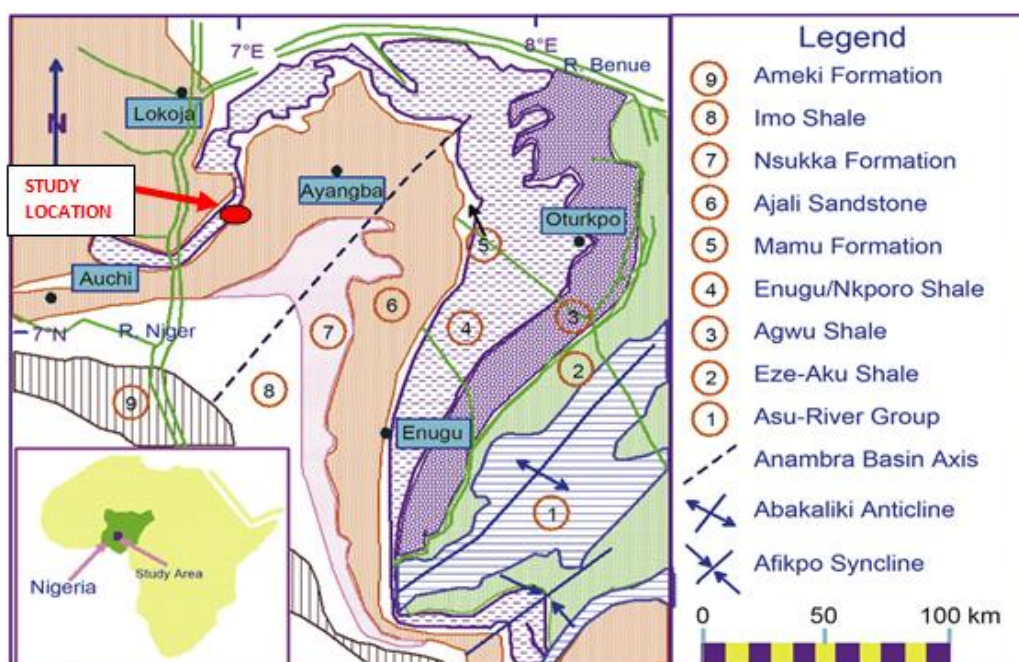


Fig.1. Geologic Map of the Anambra Basin and study location (Modified after[8])

Five (5) outcrop samples were obtained from the road-cut exposure of the Mamu Formation along Apana – Imiegba road, Imiegba, Edo State. These samples were subjected to palynological analysis to evaluate the potential source rocks and determine their age and depositional environment.

1.1 Location and geology of study area

The study area is located at coordinates N07° 11' 28.3" and E006° 26' 48.1" in the western part of the Anambra Basin along the Apana-Imiegba road in Etsako East LGA of Edo State. The study is carried out in part of the Mamu Formation in the Benin Flank of the Anambra basin. The Mamu Formation is described as a distinctive sedimentary sequence of sandstone, shale, mudstone and sandy shale with interbeds of coal seams[9].

2. METHODS AND MATERIALS

20gm of each sample was soaked in dilute hydrochloric acid (HCl) to remove carbonates, then in (60%) grade hydrofluoric acid (HF) overnight to remove silicates. This was followed by a sieving process with a 5µm mesh. The retrieved debris of the samples were mildly oxidized, followed by heavy mineral liquid separation of the macerals using Zinc bromide (ZnBr₂) at 2.1g/cc. The collected residue was mounted on glass slides with DPX mountant. The preparation method was in accordance with standard methods[14][16].

Frequency count of pollen, spores, dinoflagellates, fungal spores, microforaminiferal wall linings and other stratigraphically significant forms present were determined for each sample. Also, photomicrographs of important structures and forms were taken using a Nikon Koolpix P6000 digital camera attached to the microscope and sent to a laptop to view.

Table 2: Summary of the collected samples

SAMPLE	LITHOLOGY	ELEVATION
5	Claystone	159 m
4	Grey Shale	156 m
3	Grey Shale	153 m
2	Coaly Shale	152 m
1	Coal	151 m

3. RESULTS AND DISCUSSION

Discussion of result is divided into two:

3.1. Biozonation

Sample 1 (Coal)

This sample recorded a proportion of high occurrence of spores such as Cyathidites sp, Cingulatisporites ornatus, Lycopodium sp , Polypodiaceoisporites sp, with few occurrence of Verrucatosporites sp, Laevigatosporites sp,

Acrostichum aureum and the counterpart pollens such as Longapertites marginatus, Proxapertites operculatus, Perforicolpites digitatus, Cupanieidites sp, Arecipites sp, Inaperturopollenites gemmatus, Psilatricolporites sp, Monocolpopollenites sphaeroidites, Retitricolporites sp, Monoporites annulatus, Erecipites sp, Echitricolporites triangulatus, Syndemicolpites typicus, Ephedripites sp, Arecipites crassimuratus, and Arecipites exilimuratus. This assemblage suggests that the age of the sediment is not older than the Maastrichtian and younger than the Paleocene. This is also corroborated based on the Quantitative occurrence of Cyathidites sp which has been suggested to occur between the Maastrichtian -Paleocene boundary.

Sample 2 (Coaly shale)

The presence of Monocolpopollenites sphaeroidites, Proxapertites cursus, Ephedripites sp, Longapertites marginatus, Cyathidites sp, Echitriporites triangulatus, Crototricolpites densus, Psilatricolporites sp with few occurrences of pteridophyte spores such as species of Verrucatosporites sp, Laevigatosporites sp in this sample indicates Maastrichtian – Paleocene age.

Sample 3 (Grey shale)

The paucity of palynomorphs and absence of distinct marker species were recorded in this sample. The occurrences of Deflandrea sp, Diatom frustule, Verrucatosporites sp, and Zonocostites ramonae are long ranging species and, therefore make it difficult to assigned a definite age, i.e. undiagnostic.

Sample 4 (Grey shale)

The single occurrence of Caryapollenites sp which is an Early Eocene marker species in the [3] in this sample may be due to contamination. However, the presence of dinoflagellate cysts such as Senegalinium bicavatum (a Campanian specie), Andalusiella polymorpha, Andalusiella sp, Paleocystodinium gwolzoensis, Lingulodinium machaerophorum, Impagidium dispertitum which constitute eighty percent of the palynomorphs recorded in this sample and older pollens namely, Longapertites marginatus, Proxapaertites cursus and Constructipollenites ineffectus justify the age as Late Maastrichtian - Paleocene.

Sample 5 (Claystone)

The presence of microfloral elements which are not so different from the ones encountered in Sample four above such as Smilaciptes sp, Laevigatosporites sp, Senegalinium bicavatum, Echitriporites trianguliformis, Syncolporites sp, Crototricolpites densus, Polypodiaceoisporites sp, Cingulatisporites ornatus, Cupanieidite sp, Inaperturopollenites gemmatus, Paleocystodinium gwolzoensis, Deltodospora sp, limit the age to Maastrichtian - Paleocene.

It is interesting to note the presence of Cyathidites sp in Sample 1 and 5 as Cyathidites sp has been used to suggest K-Pg boundary in some literature [10].

The age of the exposure studied was determined based on the polynomorphs listed below which proposed Maastrichtian - Paleocene age. The index palynomorphs are *Cyathidites* sp, *Longapertites marginatus*, *Proxapaertites curvus*, *Deltodospora* sp, *Spinizonocolpites echinatus*, *Andalusiella polymorpha* and *Andalusiella* sp. This corresponds with the P100 zone that indicates an age range of Maastrichtian to Early Paleocene[3]. Two zones have been established in this work; Zone 1 is the *Cingulatisporites ornatus* Zone which is represented by the maximum development of *Cingulatisporites ornatus*. Zone 2 is the *Spinizonocolpites baculus* Assemblage zone which is represented by *Spinizonocolpites echinatus*, *Longapertites marginatus*, *Cingulatisporites ornatus*, *Constructipollenites ineffectus*, *Echitriporites trianguliformis*.

3.2 Paleoenvironment Interpretation

Sample 1 (Coal), Sample 2 (Coaly shale), Sample 5 (Mudstone)

The scarcity of dinoflagellate cysts and microforaminifera wall lining coupled with the presence of pteridophyte and brackish water spores (*Verrucatosporites* sp, *Laevigatosporites* sp, *Acrostichum aureum*) and continental pollens such as *Psilatricolporites* sp, *Monoporites annulatus*, *Erecipites* sp, *Echitricolporites triangulates*, *Longerapertites marginatus*, *Cupanieidites* sp, *Arecipites* sp, *Inaperturopollenites gemmatus*, *Psilatricolporites* sp, *Monocolpopollenites sphaeroidites*, *Retitricolporites* sp, *Syndemicolpites typicus*, *Ephedripites* sp, *Arecipites crassimuratus*, *Arecipites Exilimuratus*, *Proxapaertites operculatus*, *Perfotricolpites digitatus* indicate continental environment.

Sample 3 (Grey shale) and Sample 4 (Grey shale)

The presence of *Deflandrea* sp and Diatom frustule in Sample 3 and the predominance of dinoflagellate cysts such as *Andalusiella Polymorpha*, *Andalusiella* sp, *Paleocystodinium gwolzoensis*, *Impagidinium dispertitum*, *Lingulodinium machaerophorum*, *Senegalinium bicavatum* and *Spiniferites ramosus* indicate a nearshore environment and marine environment.

It can then be said that the environment of deposition of the Mamu Formation at Imiegba is that of progradation with occasional transgressive phases giving rise to the observed paralic sequences which matches works done by previous researchers of the Mamu Formation[2][4].

Table 3: Palynostratigraphic Zonation.

Sample No	Elevation (m)	Zonation (After Lawal & Moullade, 1986)	Characteristics	Age	Paleoenvironment
5	159m	<i>Spinizonocolpites</i>	Continuous occurrences of <i>Longapertites</i>		Continental
4	156m				Nearshore/Marginal Marine

3	153m	<i>baculus</i> Assemblage zone	<i>marginatus</i> , associated with <i>Cingulatisporites</i> <i>ornatus</i> , <i>Constructipollenites</i> <i>ineffectus</i> , <i>Echitriporites</i> <i>trianguliformis</i> .	Maastrichtian	Marine
2	152m			– Paleocene	Continental
1	151m	<i>Cingulatisporites</i> <i>ornatus</i> Zone	Maximum development of <i>Cingulatisporites</i> <i>ornatus</i> associated with <i>Cyathidites</i> sp.		

4. CONCLUSION

Five (5) outcrop samples were obtained from the road-cut exposure of the Mamu Formation along Apana – Imiegba road. These samples were subjected to biostratigraphic analysis to evaluate the potential source rocks and determine their age and depositional environment.

The palynomorph assemblages recorded in the samples indicate that rocks of the formation cannot be older than the Maastrichtian and younger than the Paleocene indicating a Maastrichtian – Paleocene age. This was based on index spores, pollens and dinoflagellates. These include *Longapertites marginatus*, *Cingulatisporites ornatus*, *Proxapertites cursus*, *Echitriporites trianguliformis*, *Deltospora* sp, *Senegalinium bicavatum*, *Andalusiella polymorpha* and *Andalusiella* sp, all of which are dated to be Maastrichtian – Paleocene age.

The high proportion of continental miospores in the studied exposure shows continental origin for the sediments encountered in the Mamu formation of the Imiegba area. However, the occurrence of dinoflagellates, foraminifera test linings is indicative of occasional marine incursions (Marginal marine – Inner Neritic).

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