AGE OF THE MFAMOSING LIMESTONE, CALABAR FLANK, SOUTH EASTERN, NIGERIA.

BY

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ABSTRACT

Palynological analyses of outcrop samples and cores from two (2) wells were used in the determination of the age of the Mfamosing Limestone. Quantitative palynological analyses of the shaly intercalations in outcrop sections and the shales immediately overlying this limestone formation reveals the presence of index Albian-Cenomanian palynomorphs such as *Classopollis jardinei, Ephedripites procerus, Ephedripites striagatus, Elaterosporites protensus* and *Elaterosporites sp.* The palynological analyses points to a Mid Albian – Early Cenomanian age for the Mfamosing Limestone.

Keywords: Mfamosing Limestone, Age, Palynomorph, Albian - Cenomanian.

INTRODUCTION

The actual age of the Mfamosing Limestone has been a subject of discussion over the years by various workers Reyment 1965, Dessauvagie 1968, Nair *et al.*, 1982, Zaborski 1982, Ramanathan and Nair 1984, Akpan 1992. This research is a contribution to this on-going debate using palynology. The approaches used in this research include: detailed field mapping, sampling of outcrops and cores and laboratory analyses of these samples for the determination of the age of the Mfamosing Limestone. Samples used for this research were obtained from limestone outcrops and from two wells, ODBH4/2 and ETBH3/2 located at Odukpani and Etankpini villages in the study area respectively. The samples were mainly the interbedded shale horizons within the limestone unit in some outcrop sections and the shales immediately overlying the limestone. These intercalated shales are evidence of rhythmic cyclic deep marine incursions during the pronounced Mid-Albian marine transgression in the South Atlantic. These samples were subjected to palynological investigation to identify the various age diagnostic forms which is the basis for age determination for the carbonate buildup.

The formation under study is the Mfamosing Limestone (Petters,1982) near Calabar, South Eastern Nigeria. This carbonate platform is located within the Calabar Flank (Murat 1972) and represents the thickest carbonate body in Nigeria (Reijers and Petters,

1987) (Fig. 1 and 2).It is about 50m thick at outcrop (type section) and 450m thick in the subsurface on the Ituk high (Reijers and Petters,1987).

GEOLOGIC SETTING AND STRATIGRAPHY

Geologically, Calabar Flank is unique in many respects; it is that part of the southern Nigerian sedimentary basin that is bounded by the Oban massif to the north and the Calabar hinge line delineating the Niger Delta basin in the south (Fig. 2; Nyong 1995). It is also separated from the Ikpe platform to the west by a NE-SW trending fault. In the east, it extends up to the Cameroun volcanic ridge. It served as the gateway to all marine transgression into the Benue Trough and is located between two hydrocarbon provinces, the Tertiary Niger Delta and the Cretaceous Douala basin in Cameroun (Reijers and Petters, 1987).

Structurally, the Calabar Flank consists of basement horsts and grabens that are aligned in a NW – SE direction like other South Atlantic marginal basins in West Africa (Reijers and Petters, 1987). The Calabar Flank shows striking stratigraphic similarities with other coeval marginal basins of the South Atlantic. They were all produced during the opening of the South Atlantic Ocean and the first marine incursion in Middle Albian accounted for the deposition of Mfamosing Limestone particularly on the horst and relatively stable platform areas and their Flanks (Fig.2).

Sedimentation started in the Calabar Flank with deposition of fluvio-deltaic clastics of probably Aptian age on the Precambrian crystalline basement complex, the Oban Massif

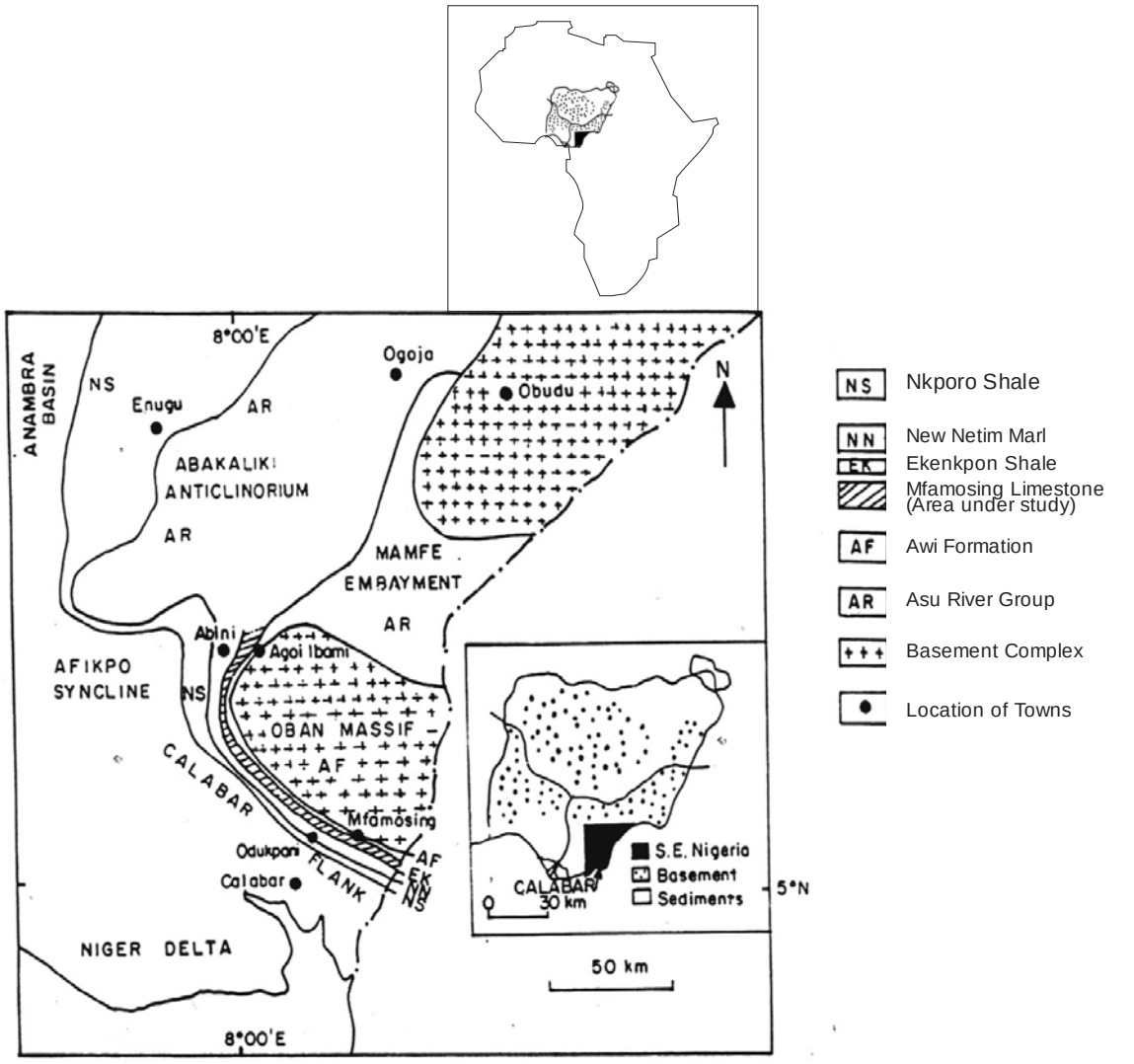

FIG.1 Geologic sketch map of south – eastern Nigeria showing Mfamosing Limestone of the Calabar Flank (Modified after Petters *et al.*,1995).

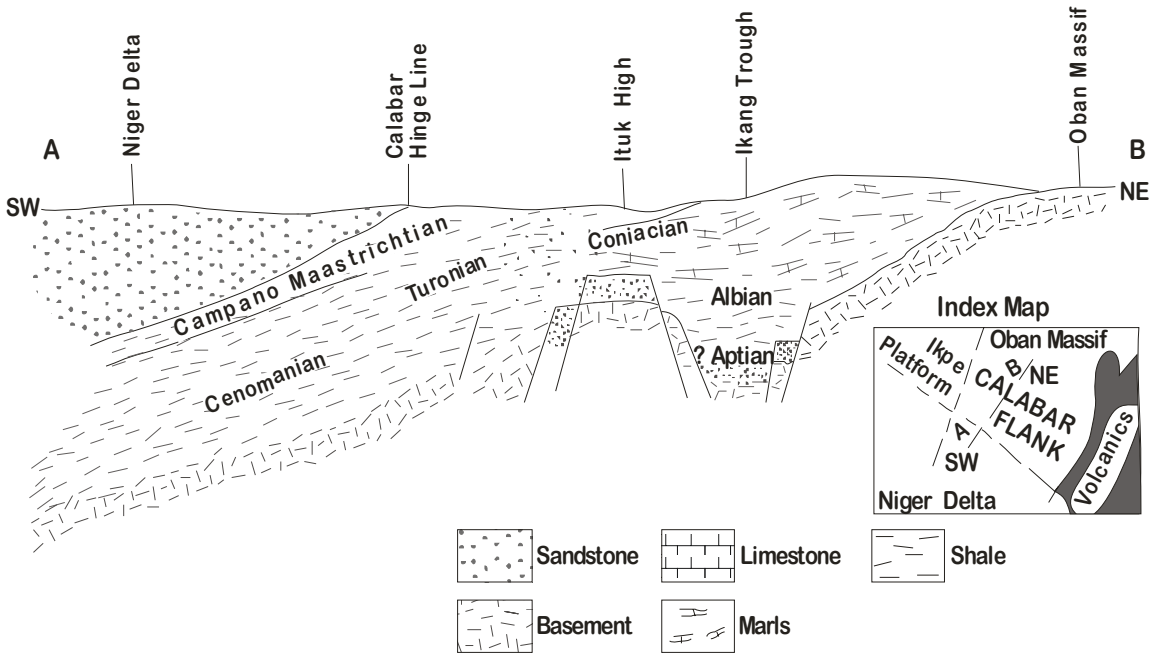

FIG. 2 Structural elements and conceptual subsurface distribution of Cretaceous sediments in the Calabar Flank (After Nyong,1995).

(Fig. 1). These sediments belong to the Awi Formation (Adeleye and Fayose, 1978). The earliest marine transgression into the Calabar Flank occurred in the Mid-Albian times with the deposition of platform carbonate of the Mfamosing Limestone. This carbonate body was deposited in a variety of depositional environment.

The Mfamosing Limestone is overlain by a thick sequence of black to gray shale unit, the Ekenkpon Formation (Petters et al., 1995). This formation is characterized by minor intercalation of marls, calcareous mudstone and oyster beds. This shale unit was deposited during the Late Cenomanian-Turonian times.

The Ekenkpon Shales are overlain by a thick marl unit, the New Netim Marl (Petters *et al.*, 1995). This unit is nodular and shaly at the base and is interbedded with thin layer of Shales in up-section. Foraminiferal (Nyong, 1995) and Coccolith evidence (Perch – Nielson and Petters, 1981) suggest Early Conciacian age for this marl unit.

The New Netim Marl is unconformably overlain by a carbonaceous dark gray Shales, the Nkporo Formation (Reyment, 1965). This Shale unit was deposited during the Late Campanian – Maastrichtian times. The Nkporo Shales caps the Cretaceous sequence in the Calabar Flank.

The Nkporo Shales sequence is overlain by a pebbly sandstone unit of the Tertiary Benin Formation.

PREVIOUS WORK

The age of the Mfamosing Limestone has been a subject of discussion by several researchers. Various researchers have ascribed different ages based on different criteria.

Reyment (1965) assigned a Cenomanian age to the rocks which constitute the Odukpani Formation in which the Mfamosing Limestone forms the basal unit. Dessauvagie (1968) reported the occurrence of a foraminiferal species *Trocholina odukpaniensis* from this limestone and proposed a Late Albian age base on this. Nair *et al.*, (1982), described the limestone sequence to be barren of foraminifera suitable for reliable age dating but deduced a Late Albian to Early Cenomanian age based on ammonite biostratigraphic analyses. They concluded that the limestone can not be younger than Late Albian. (Ramanathan and Nair 1984) in correlating Gboko Limestone in a quarry section with the Mfamosing Limestone recorded the occurrence of forms such as *Anomalina plummerae*, *Gavelinella intermedia, Patellina subcretacea, Ammobaculites coprolithiformis, Ammobaculites fisheri and Ammobaculites irregulariformis*. Based on these species, they suggested an age ranging from Late Aptian to Albian for the Gboko Limestone and correlated it to the Mfamosing Limestone in the Calabar Flank. Akpan (1992) recorded for the first time the Itierid gastropod, *Peruviella dolium* in the basal sections of the Mfamosing Limestone and on that basis, assigned a Mid – Albian age to this limestone unit.

Forster (1978) and Forster and Scholtz (1979) presented ammonite biostratigraphic evidence for a Late Albian age for the top of the Mfamosing Limestone. Cenomanian age has also been proposed based on ammonite evidence (Reyment, 1965).

An ammonite biostratigraphy by Zaborski (1982) revealed Upper Albian - Lower Cenomanian ammonites, including well known taxa such as *Mariella m. ochleti, Puzosia* cf *antanimangaensis*, *Pachydesmoceras cf., radaodyi, Desmocers d., latidorsatum* and *Flickia quadrata*, from the base of the shale immediately overlying the Mfamosing Limestone. Based on these he proposed an Albian age for the subjacent Mfamosing Limestone. These, together with the discovery of an actual Albian ammonite from the hard ground at the top of the Mfamosing Limestone gave evidence for an Albian age for the limestone unit.

METHODOLOGY

Extensive field mapping of the Mfamosing Limestone was carried out along its depositional strike a distance of 163km. A total of thirty two (32) samples were collected from outcrops and from two (2) wells, ODBH42 (Odukpani village) and ETBH32 (Etankpini village), located in the study area (Fig. 3).

The shale units interbedded within the limestone were subjected to palynomorphs preparation to free the pollen and spores from enclosing matrix for picking and identification. Age determination was achieved by the use of age diagnostic taxa.

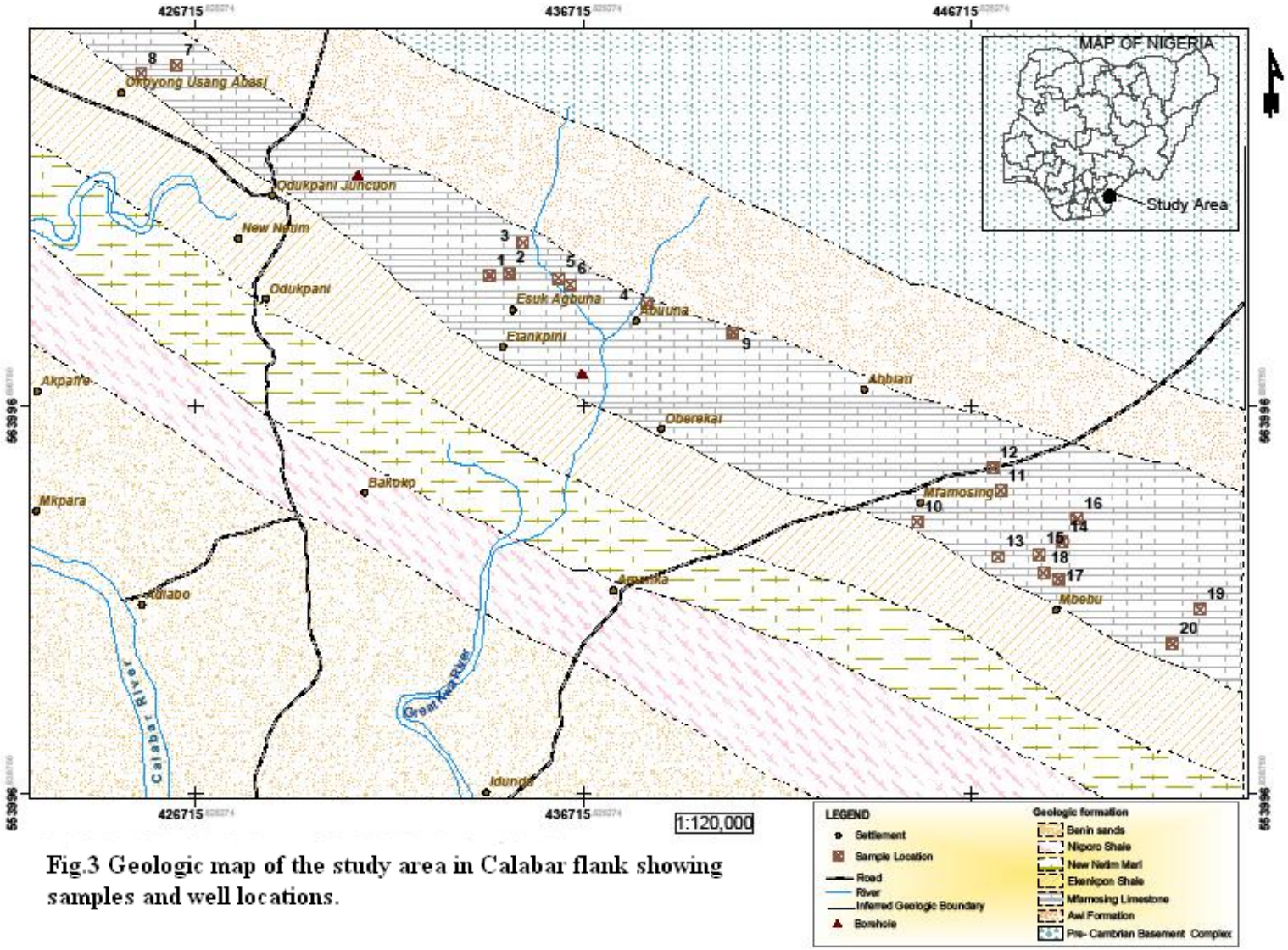

Fig.3 Geologic map of the study area in Calabar flank showing samples and well locations.

RESULTS

The palynomorphs recovered from the shales immediately overlying the Mfamosing Limestone and the shales intercalating this limestone body were used for the determination of age of the limestone formation.

PALYNOMORPHS AND AGE DETERMINATION

A total of thirty two (32) samples were analyzed for palynomorph assemblages. These samples include twenty outcrop samples and twelve cores from two wells (ODBH4/2 and ETBH3/2) in the study area.

The outcrops samples yielded bissacate pollen, and associated elements like fungal spores and chitinous microforaminiferal test linings (Fig. 4).

The summary of the different species of pollen and spores recovered from the two wells are shown in Fig. 5 and 6.

Age interpretations were attempted with the use of important index palynomorphs.

DISCUSSION

The presence of *Elaterosporites* group and *Triorites africaensis* Jardine and Magloire 1965, suggest an Albian – Cenomanian age for the analysed samples.

These species have already been recorded in Nigeria by Jan D Chene` 1978. Other important Albian index palynomorphs recorded include *Classopollis jardinei, Steevesipollenites giganteus, Trifossapollenites polygonalis, Ephedripites procerus,* and *Ephedripites striagatus.*

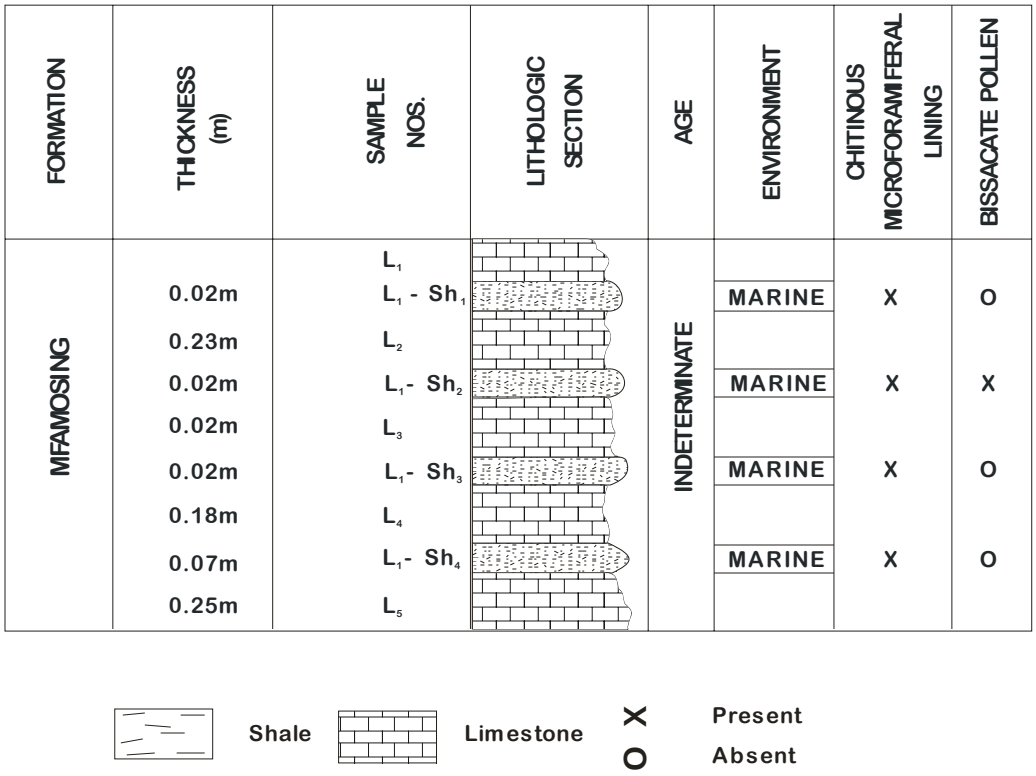

FIG. 4 Palynomorph distribution in a studied section (Mfamosing village) in the study area.

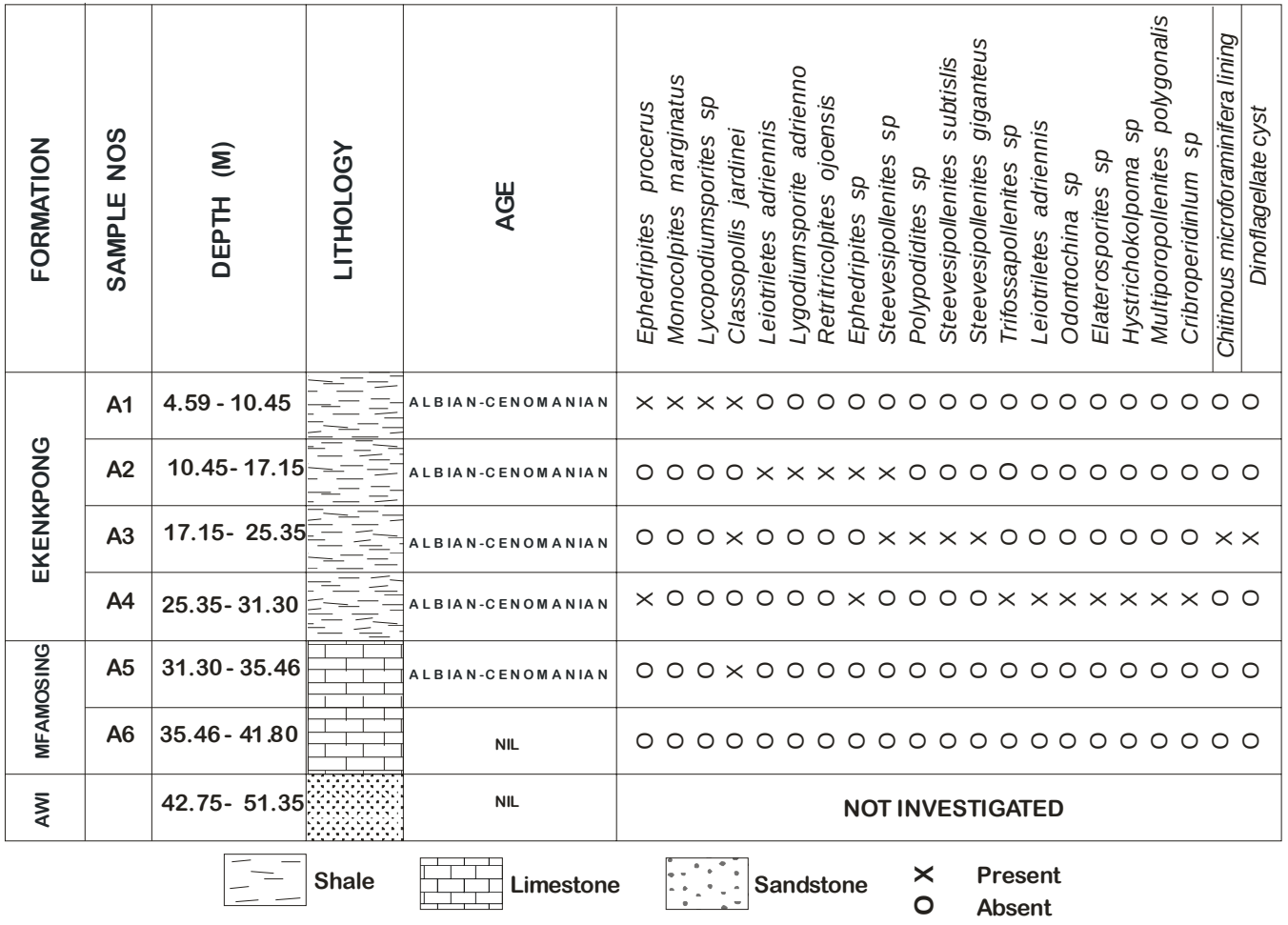

FIG. 5 Palynomorphs distribution chart for well ODBH4/2 (Odukpani village) in the study area

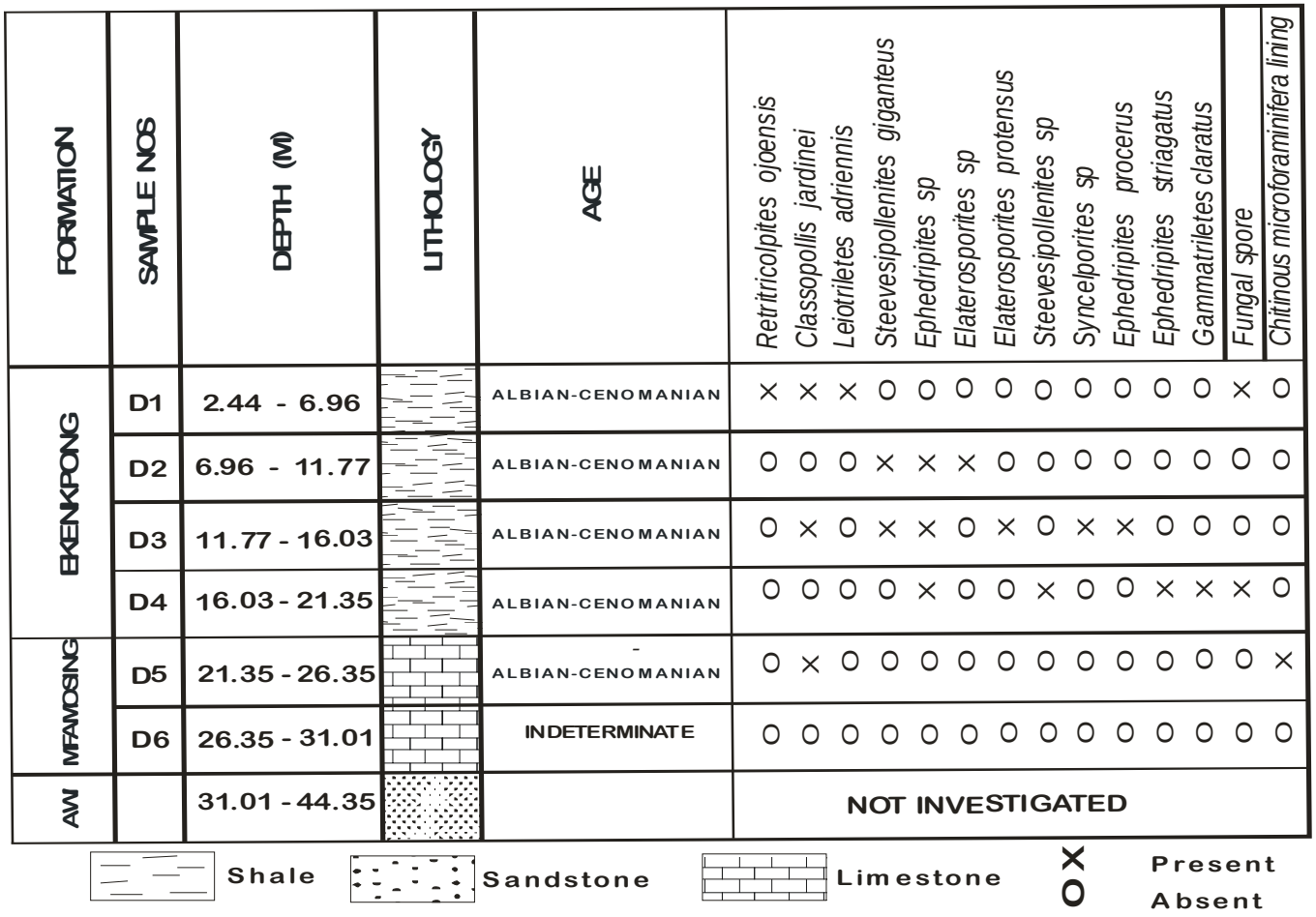

FIG. 6 Palynomorphs distribution chart for well ETBH3/2 (Etankpni village) in the study area

The above index palynomorphs association indicates a Mid Albian – Early Cenomanian age, for the Mfamosing Limestone.

In well ETBH3/2 in Etankpini village, cores analyzed revealed the presence of *Classopollis jardinei* (85%) in 2.44m-6.96m interval in association with other palynomorphs. At 6.96m-11.77m interval, *Steevesipollenites giganteus* (6%) and *Elaterosporites sp (20%)* are also found. Within 11.77m-16.03m, *Classopollis jardinei* (50%), *Elaterosporites sp (20%), Elaterosporites protensus (40%)* and *Steevesipollenites giganteus* (10%) were recovered.

Between 16.03m-21.35m there was absence of Albian – Cenomanian index palynomorphs except for the presence of *Ephedripites striagatus* and fungal spore. Samples analyzed between 21.35m-26.35m indicate the presence of chitinous microforaminiferal test linings (Fig.6).

The above association in well ETBH3/2 indicates age ranging from Mid Albian – Early Cenomanian.

Fig.7 shows the different palynomorph zones for the Cretaceous and the ranges of different species from the studied wells in the study area.

PALEOENVIRONMENT

Paleoenvironmental interpretation based on identified palynomorphs in the light of their ecological preferences and the relative proportions of palynomorphs groups, indicate that the Albian – Cenomanian sediments were deposited in a marginal marine environment with vegetation on wetlands, under a relatively dry climate.

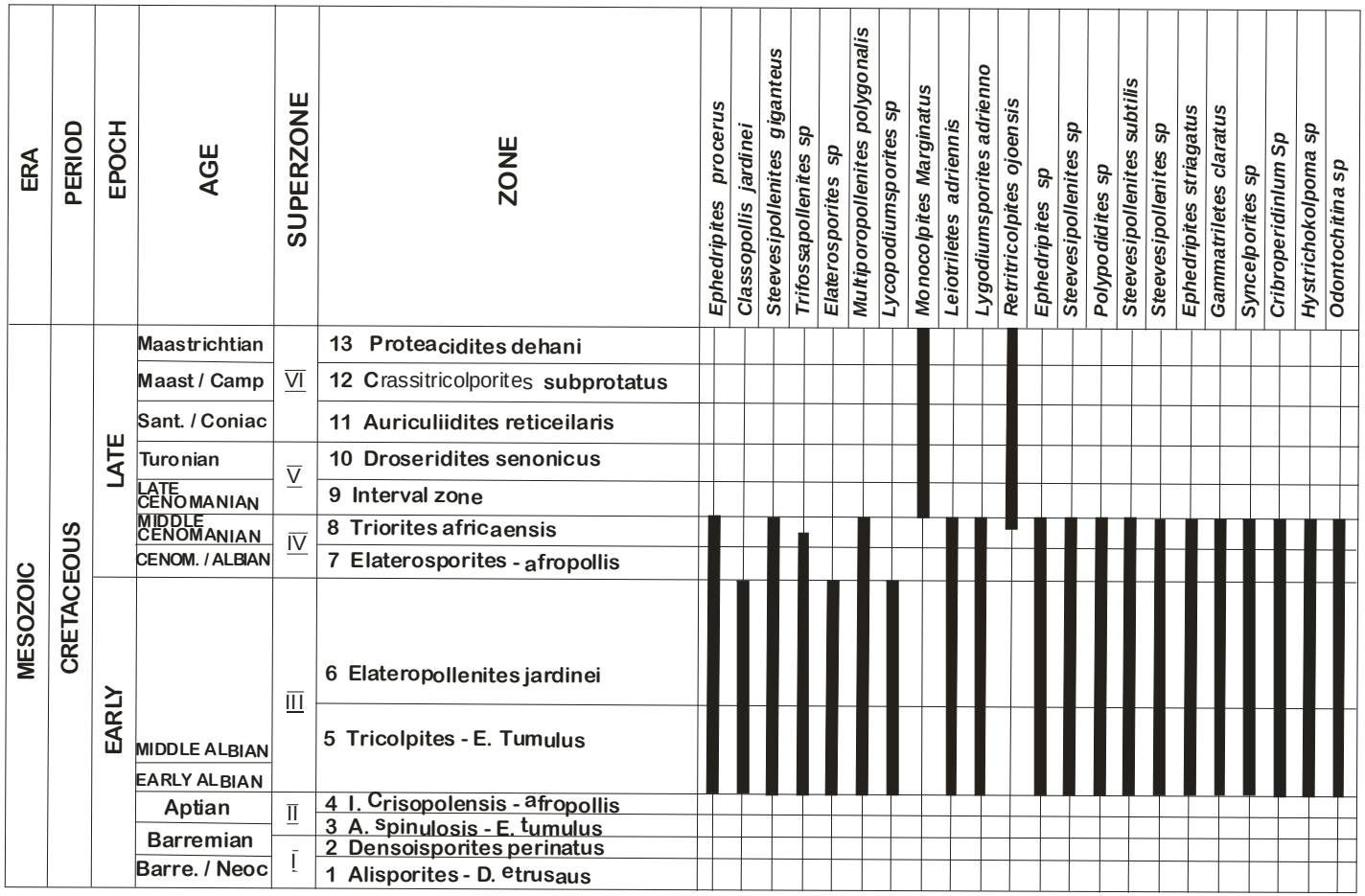

FIG.7 Ranges of key sporomorphs markers for the Early – Late Cretaceous in the Calabar Flank from well ODBH4/2 (Odukpani village) and ETBH3/2 (Etankpini village) in the study area.

CONCLUSION

Palynological analysis reveals the presence of diagnostic Albian – Cenomanian (Lower Cretaceous) assemblages in the Mfamosing Limestone. The presence of the following pollen and spores: *Classopollis jardinei, Ephedripites procerus, Elaterosporites sp* and *Steevesipollenites sp* confirms this age.

SYSTEMATIC PALYNOLOGY

Division SPORITES H. Potonie` 1893

CLASS A TRILETES (REINSCH 1881) POTONIE` et KREMP 1954

Genus *Lycopodium sporites*

(THIERGART 1938) DELCOURT and SPRUMONT 1963

Occurrence: Sample A1, 4.59m-10.45m ODH4/2. Upper Albian-Lower Cenomanian of Nigeria.

Description: Single grain, radially symmetrical, anisopolar, rounded in polar view. Laesuratrilete without costae, not reaching the equatorial diameter. Surface reticulate. Reticulum polygonal with muri, large at the base, finer at the top.

Dimensions: Equatorial diameter: 45µ, length of the laesura:12µ. Reticulum: muri: width 2µ at the base. 0.5µ at the top, 2 to 3µ high. Luminae: up to 5.5µ wide.

Distribution: in ODBH4/2, found only in the Upper Albian – Lower Cenomanian interval.

Division 2 POLLENITES POTONIE` 1931

Class: POLYPLICATE IVERSEN and TROELS SMITH, 1950

Genus: Ephedripites BOLKHOVITINA 1953 ex POTONIE`1953

Ephedripites sp.

Occurrence: Sample D2, D4, (ODBH3/2), A2, A4 (ODBH4/2)

Lower Albian – Upper Cenomanian of Nigeria.

Description: Pollen grain of medium size, isopolar, radially symmetrical, ellipsoidal in equatorial view, polyplicate. The costae are flat and thick, the furrows are narrow and straight.

Dimensions: Size of the grain in equatorial view: 47 x 29µ. Width of the costae: up to 6µ. Width of the furrows: 1µ. Number of costae: 9-11.

Distribution: Found only in the Lower Albian – Upper Cenomanian in ODBH4/2 and ETBH3/2.

Class: TRICOLPATAE IVERSEN and TROELS SMITH, 1950

Genus: Retitricolpites (VAN DER HAMMEN 1956)

VAN DER HAMMEN and WIMSTRA 1964

Retitricolpites ojoensis JAN DU CHENE

Occurrence: Sample D1, ETBH3/2, A2, ODBH4/2. Late Cenomanian – Maastrichitian of Nigeria.

Description: Pollen grain of large size, sphaeroidal, isopolar, radially symmetrical, tricolpate. The colpi are fine and long, difficult to observe because of the coarse and irregular reticulate sculpture.

Dimensions: Size of the grain in polar view: up to 83µ in diameter. Length of the colpi: up to 30µ in polar view. Reticulum: muri: up to 4.5µ high 2µ wide. Luminae: irregular. Exine thickness: up to 2µ. Without muri.

Distribution: In well ODBH4/2 recorded at 10.45m-17.15m, in ETBH3/2 recorded at 2.44m-6.96m.

Genus: *Trifossapollenites* ROUSE 1957

The genus *Trifossapollenites* first described in the upper Cretaceous of Canada is common in the Aptian, Albian and Cenomanian of Ivory Coast and Senegal. This genus had already been recorded as a junior synomnym of *Triffossapollenites.* Stratigraphically, it seems that the Trifossapollenites group is recorded up to the top of the Cenomanian in western Africa. Systematically, it may be interesting to define some species which differ by thier size and shape.

Trifossapollenites rousei JAN DU CHENE`

Occurrence: Core sample A4, 25.35m – 31.30m ODBH4/2. Albian – Cenomanian of Mfamosing, Nigeria.

Description: Pollen grain of medium size, isopolar, radially assymetrical, prolate (1.32), elliptical with flat extremities in equatorial view. With three furrows. The principal furrow is slightly longer than the two lateral onces. Exine psilate.

Dimensions: Size of the grain in equatorial view: 33 x 25µ. Length of the furrow up to 21µ. Exine thickness: up to 2µ.

Distribution: Rare. Found only in the Albian – Cenomanian.

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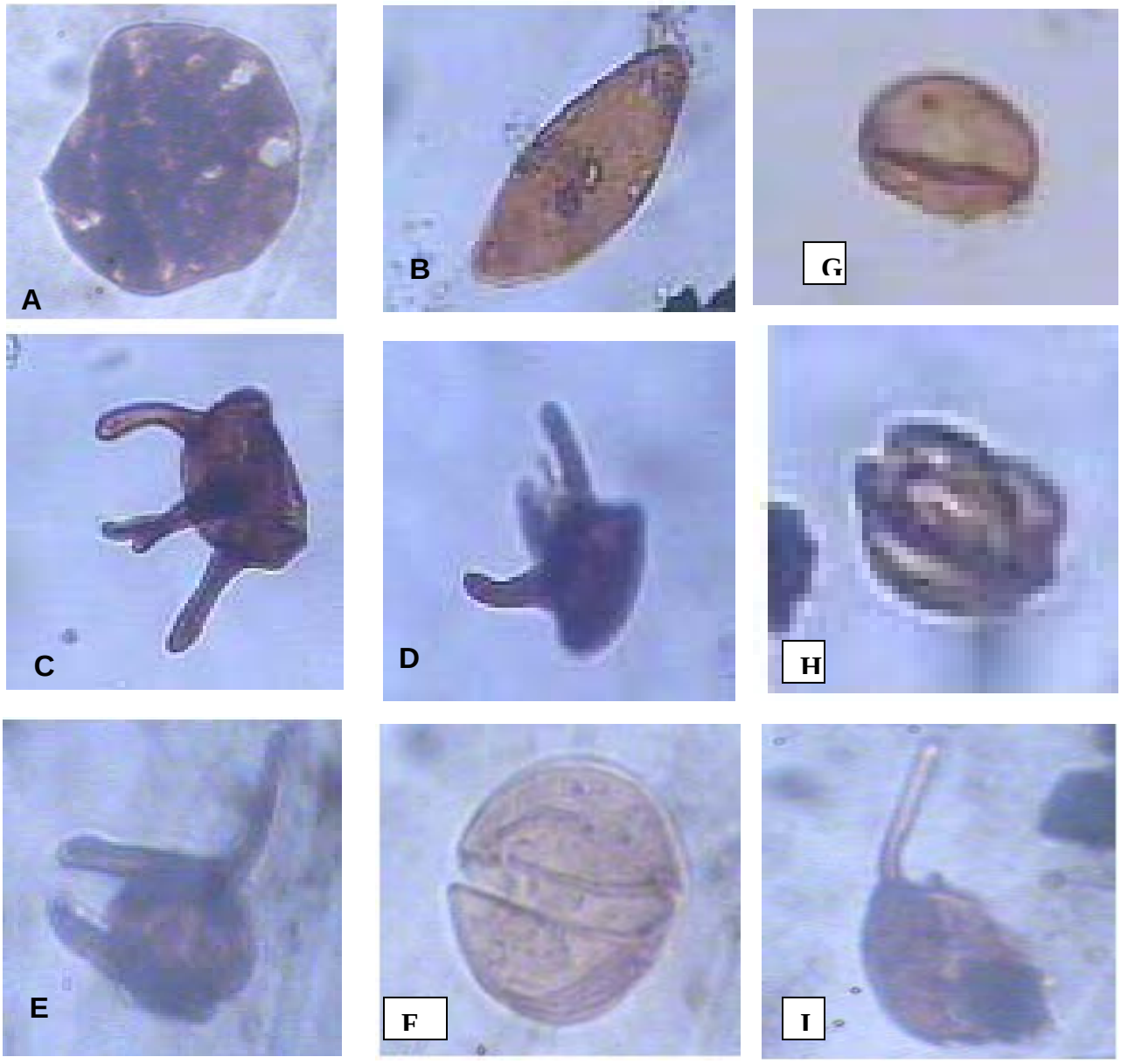
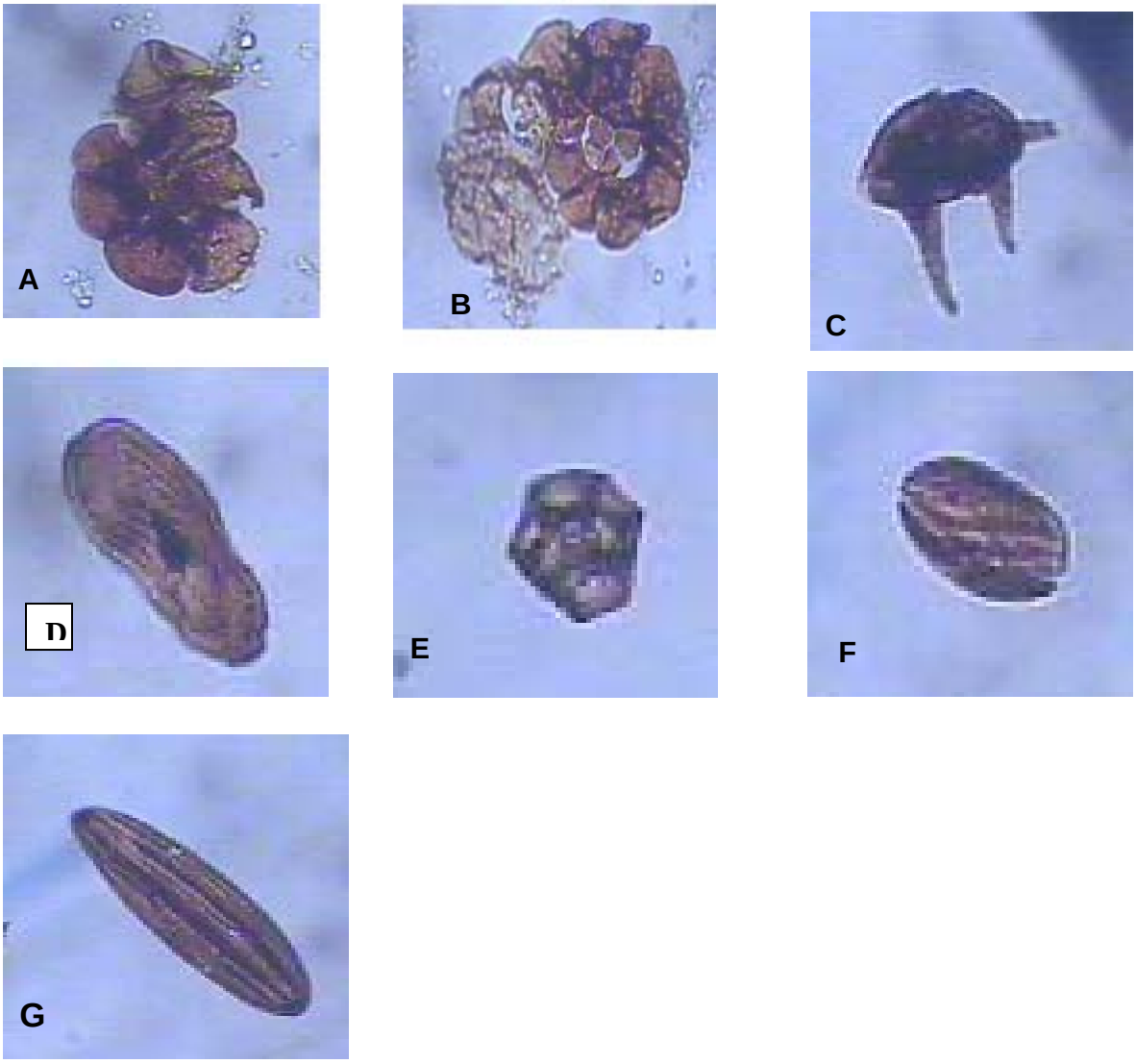
APPENDIX: I **PLATE 1**



A.Multiporopollenites sp (ODBH4/2,25.35m-31.30m),**B**. Steevesipollenites giganteus (ODBH4/2,17.15m-25.35m, ODBH3/2, 6.96m-11.77m,11.77m-16.03m) **C,D,E.** Elaterosporites sp,(ODBH4/2,10.17m-17.15m,25.35m-31.30m).X100.**F**.Monocolpites marrginatus,ODBH3/2,4.59m-10.45M **g.**Classopollis jardinel,(ODBH3/2,4.59m-10.45m,17.15m-25.35m,31.30m-35.46m **H.** . Ephedripites sp(ODBH3/2, 10.17m-17.15m,25.35m-31.30m. **I.** .Elaterosporites sp. (ODBH4/2,10.17m-17.15m,ODBH3/2, 6.96-11.77m,11.77m-16.03m

PLATE 2



A,B Foram lining,(ODBH4/2 17.15m-31.30m ,ODBH3/2 21.35m-31.01m,L1-Sh1,L1-Sh2,L1-Sh3). X100. **C**.Dinocyst indeterminate,(ODBH4/2 17.15m-31.30m.). X 100.**D**. Ephedripites procerus,(ODBH4/2 4.59m-10.45m,25.35m-31.30m,ODBH3/2 11.77m-16.03m). X 100. **E.** Cretacaeaporites polygonalis, (ODBH4/2 4.59m-10.45m). X 100. **F.** Steevesipollenites sp.(ODBH3/2 16.03m-21.35m,ODBH4/2 10.17m-17.15m,17.15m-25.35m).X 100 **G.** .Ephedripites procerus. X 100.