PALYNOLOGY AND PALAEO ENVIRONMENT OF THE PATTI FORMATION, SOUTHERN BIDA BASIN, NIGERIA

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ABSTRACT

Palynological analysis of fifty samples of Ahokohoko Agya sediments in Bida Basin, North Western Nigeria, confirms a Middle to Late Maastrichtian age for the shale interval of Patt Formation. The dating is based mainly on certain well preserved marker angiosperm species such as Monocolpofenites sp, Monocolpites marginatus, Syncolpites substilis and Echitriporites tranguliformis among others. The overwhelming terrestrial derived palynfloras dominated by Palmae and Proteacean angiosperms (96.4%) are indicative of the predominance of fluctuating environment during the deposition of the dark shale units probably in a restrictive body of water.

KEY WORDS: Formation, Palynomorphs, Palaeoecology, Palaeoenvironment, Biostratigraphy.

INTRODUCTION

The age of Bida Basin has largely been determined by palaeontological evidence (Adeleye and Dessauvagie, 1972; De klazz, 1978; Adeleye, 1979, 1989) while the palynostratigraphic record of its rock units is fragmentary (Jan du Chenne et al., 1976; Mebradu et al., 1986). The terrestrial to marginal marine origin (Adeyeye, 1989; Braide 1992; Ladipo et al., 1994) of its sediments prevent independent dating and the general silicilastic nature of the basin's rocks (predominantly sandstones) which is not suitable for palynomorphs recovery hinders a complete palynological record (Traverse, 1958; Mahmoud, 2003; Salami (1985) even reported that the basin's materials were not found suitable palynologically. However, the Patt Formation which contains well exposed carbonaceous shales (among other rock units) at the center of the basin provides a good section for the recovery of palynomorphs.

In the present study angiospermous pollen from the shale unit are abundant, diverse and well preserved. They represent flowering plants that were evolving rapidly and were widely distributed during the deposition of sediments. These characteristics offer direct and strong biostratigraphic evidence for determining the age and palaeoenvironment of the Patt Formation which is significant for the proper understanding of the geology of the basin. Again the highly diverse nature of the angiospermous assemblage will enrich the basin's palaeoecological data and provide a means of correlation with other basins within and outside Nigeria.

Geologic setting of the Basin

Bida Basin is a NW – SE trending depression that is perpendicular to the main axis of the Benue Trough (Fig. 1 and 2). It lies between longitude 4°E and 7°E and latitude 7°N and 10°N and covers an area of 3,502km² with about 3km thick Upper Cretaceous sedimentary fill in its deepest part (Russ, 1957; Adeleye, 1974; Ojo, 1984; Adeniyi, 1984, 1986). Several authors considered the basin to be a rift bounded tectonostr deformed part (Kogbe, 1981; Whiteman, 1982; Ojo and Ajakaye, 1989). The evolution and development of the basin was attributed to wrench movements associated with the tectonic framework of the Nigerian sedimentary basins (Braide, 1990). Over the years, the basin has been subjected to various geological investigations and its stratigraphy and sedimentology (Jones, 1955, 1978; Adeleye, 1979) and hydrocarbon potential (Braide, 1990; Akande and Ojo, 2002).

Four mappable lithostratigraphic units and their lateral equivalents, based on lithologic and depositional characteristics, are recognizable in the two major study sections (Bida and Lokoja) of the basin. These are the Bida/Lokoja Sandstones, Sakpe Ironstones/Patti Formation, Enagi Siltstones/Patti Formation and Baratii/Agbaja Ironstones in ascending order. These lateral equivalents (Fig. 2), both within the basins and in the adjoining Anambra Basin represent the continuous depositional phases, from the south to the north and northwest, controlled by the major sea level rise and fall during the Upper Cretaceous time (Berquist, 1971; Douglas et al., 1973). The abundant oolitic ironstone deposits in the basin equally

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attracted the attention of several researchers (Adeluye, 1973, 1989; Ladipo et al., 1994, Abimbola, 1997).

The depositional environment was said to have been dominated by a continental fluvial sedimentation while the presence of intercalated concretionary/folitic ironstones and some arenaceous foraminifera have been ascribed to occasional marine incursion during the rise in sea level (Ojo and Akande, 2003).

MATERIAL AND METHODS

Stratigraphic sections of Patti Formation located between Ahoko/Ahoko Gbany, along Lokoja – Abaji Road in the central part of the basin were studied. Field data were collected on lithological characteristics, stratigraphic features and details of sedimentation. Fifty samples were processed using standard palynological procedures. Slides were prepared from unsieved residue using glycerine jelly as mounting medium.

Due to the clastic nature of the sediments, the majority of the processed samples were barren of palynomorphs. Seven samples contain palynomorphs suitable for the present work. For each sample between 150 and 200 grains were counted and recorded in semi-quantitative term (Table 1).

Palynological Assemblage

Quantitative data: The noticeable picture presented by the well preserved palynomorphs (plates 1 & 2) recovered in this study is the dominance of angiospermous pollen. The angiosperms are made up of several species of Echitriporites,

Table 1: Semi-quantitative distribution of Palynomorphs recovered in the Patti Formation Shale.

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<th>Sample No</th>
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<td>Angiosperm pollen</td>
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<td>Palynocarpites digitatus Kieser et al. 1979</td>
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<td>Syncocarpites subalatus Jansou Chene 1896</td>
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<td>Monocarpites sp.</td>
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<td>Monocarpites marginatus van Hoesten Klinkenberg 1964</td>
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<td>Constrictivillicites reflexus Klinkenberg 1964</td>
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<td>Palaeocarpites major</td>
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<td>Selukocarpites major Jan du Chene 1972</td>
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<td>Langunicolites vanhoyebughi Gemeraud at al. 1968</td>
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<td>Palaeoecinosporites sp.</td>
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<td>Palaeocarpites sp.</td>
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<td>Palaeoecinosporites sp.</td>
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<td>Echitriporites triangularis van Hoesten Klinkenberg 1964</td>
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<td>Palaeoecinosporites wrightii Gemeraud et al. 1968</td>
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<td>Inaperturotricolites reticulatus Craig Chubbakoff 1981</td>
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<td>Archaeocarpites microspilolus Anderson 1966</td>
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<td>Echitriporites pachycaulites Selenski 1955</td>
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<td>Fungal spores</td>
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<td>Aspilate fungal spore</td>
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<td>Dysosporites sp.</td>
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<td>other fungal spores</td>
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<td>Acinarch</td>
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<td>Microstachidium linear Jaspel</td>
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<td>Echitriporites sp. sahu Suejiant 1974</td>
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- Fig. 3: Campanian-Maastrichtian Paleogeography of North and Central West Africa (modified from Kogbe, 1976 and Petters, 1978)
occurrence of minor constituents of microplankton is represented by two species of acinarth, Mirchystium and Ballisphaeridium, in samples 1–3.

Quantitative data: Generally, the trend of the occurrence of the palynofloral in the studied samples is similar (Table 1, fig. 3). The percentages of angiosperm pollen vary from 76% to 98%, fungal spores and fungal fruiting from 1% to 12% and acinarth from 1% to 3%. Monocolpates (eg. Monocolpites marginatus and Echiformicolpites major) and tricolpates (e.g. Echitroplacites trilobificus) are the most abundant, reaching up to 29.8% and 19% respectively (fig. 4). Longapertitites veneenbourghi, Retiliporites sp. and Ancopites pachyexinus are rare, although they are significant from a stratigraphic point of view. Tricolpates, steppanocolpates and tricolpate pellate forms, which are regular and often high in distribution, constitute other important taxa. For example, Synkolporites subtilis varies from 2.7% in sample 2 to 12% in sample 7 while the percentage of Retistephanocollenchites williamsi varies from 5% in sample 2 to 11.5% in sample 6.

Biostratigraphy

Palynological age: Only the relative abundance of stratigraphically significant angiospermous species was used in assigning age to the shale unit of the Patti Formation. This is due to the paucity of age diagnostic organic - walled microplanktons probably because of the terrestrial nature of the formation.

The recovered palynomorph assemblage is closely comparable to those of the Maastrichtian interval of coeval tecto-subtropical Africa, South - America and India (Van Hoek - Klinkenberg, 1964; Jardine and Magloire, 1966; Hasegawa, 1975 a,b; Jain, 1975; Jan du Chene et al., 1975 a,b; Saland Chaboldaef, 1981; Bakshi and Deb, 1981; Shrank, 1987; Edet and Nyong, 1994; Shrank and Mahmoud, 1998, 2000d; Mahmoud, 2003). The present palynoflora association encompasses several Palmae Palynomorphs that are found in rocks of Maastrichtian age (Herngreen et al., 1996; Mahmoud 2003). This is clearly evident from the occurrence of Palmae (Monocolpites) as well as syncolpates (Synkolporites) and tricolpates (Echitroplacites trilobificus, Proteaceae) angiosperms. Contemporary angiospermous palynomorphs of Campanian – Early Maastrichtian ages such as Foveocolpites giganteus/gigantoreticulatus, Propopylis (Proteaceae) dehaani and spores (Zilisporis bleniensis and Verrucosisporites sp.), (Jardine and Magloire, 1965; Mahmoud, 2003) are absent in the present assemblage. The shale unit of the Patti Formation may therefore post-date these molisporae. The Upper Maastrichtian assemblage described from southern and northeastern Nigeria (Van Hoek - Klinkenberg, 1964; Jan du Chene, 1977; Lawal and Moullade, 1986; Sali, 1988; Edet and Nyong, 1994) contains essentially the same angiospermous elements as recovered in the present study. Again, the assemblage is comparable to the sequence II of Jardine and Magloire (1965), the transatlantic Proteaceae dehaani zone of (Gernraed et al., 1966). Assemblage zone C and C of Adhaya and Ojo (2004) as well as assemblage zone IV of Lawal and Moullade dated Upper Maastrichtian. Therefore, in accordance to the Granulatisporites subgranulosus recorded by Mebradu et al. (1988), the presence of well preserved Echitroplacites trilobificus, Monocolpites marginatus, Synkolporites subtilis, Perinetysyncolpites giganteus and Constrictocolpites ineffectus further suggest and confirm a Middle to Late Maastrichtian age for the Patti Formation shale.
Palaeoecological Interpretation

Palaeoecological deductions were based on the field data, the bulk composition of the recovered palynomorphs and their botanical affinities. The dark-light grey, fissile and carbonateous shale and well laminated siltstones which are interbedded rhythmically by concretionary or massive and bioturbated ironstones indicated deposition by suspension setting in a quiet, low energy environment probably in a restricted body of water (Harms et al. 1975; Braide, 1992; Adebayo and Ojo, 2004). However, occasional marginal marine or brackish condition seemed to have existed as shown by the presence of bivalve moulds, few acritarch specimens (Mirchystidium and Ballisphaerium), pyritised Ammobaculites and Millilamina species (in some samples processed separately for foraminifera) and concretion ironstones (Hubert, 1963; Staplin, 1961; Sarjeant, 1974 Norris, 1978). The brackish water must have been brought to the basin through the trans-Saharan seaway (Furon, 1963; Berr, 1972). The northerly connection of the basin with the Tethys Sea was probably via the Sokoto area of the Illumenen Basin during the Campanian-Maastrichtian marine transgression (Kogbe, 1976 and Adebayo, 1979) (Fig.3). The absolute dominance of the palynomorph assemblage by Palmae (Monocolpitesites) and Proteaceae (Echitipores) angiosperms (Table 1) is indicative of terrestrially derived palynoflora. This view is supported by the abundant woody and plant materials that are land-derived. Thus the prevailing environment during the deposition of Patt Formation shale is fluviatile. The total absence of Nypa-like mangrove pollen (Spinoscopolites) and the marine dinocysts equally support a continental setting with relatively dry conditions in the basin during the Maastrichtian (Shrank, 1994, Mahmoud 2003).

CONCLUSION

The palynofloras of Ahoko /Ahekoi Gbaya shale section of Patt Formation, Bida Basin, are overwhelmingly of terrestrial origin. They are dominated by angiosperms (Monocolpitesites sp, Monocolpites marginatus, Echitipores trianguliformis, Retistephanocolpites Williamsii), Fungal spore and fruiting bodies and acritarchs (Mirchystidium and Ballisphaerium) occur in minor amounts. The age of the formation based mainly on the angiosperm assemblage is Middle to Late Maastrichtian. The Palmae and Proteacean pollen association is indicative of terrestrially derived plant materials which are deposited in a predominantly fluviatile environment.

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