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PALYNOSTRATIGRAPHIC STUDIES OF CRETACEOUS DEPOSITS OF ANAMBRA BASIN, EASTERN NIGERIA

O F Adebayo* and A O Ojo

Geology Department, University of Ado-Ekiti,Ado - Ekiti, Nigeria

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Upper cretaceous strata of Anambra basin were spot sampled at two locations. A palynological investigation of the forty-one samples from the outcrop section, enabled the recognition of five palynological zones based on pollen and spores. The assemblage zones which are assigned upper Campanian to Maestrichtian age are: *a). Tricolpites/Syncolporites/ Matonisporites* Assemblage zone (upper Campanian). *b). Psilamonocolpites/Zlivisporis* Assemblage zone (Campanian - Maestrichtian). *c). Retistephanocolpollenites/Monocolpollenites/Propylipollis* Assemblage zone (Maestrichtian). *d). Retidiporites/Verrucatosporites/Buttinia* Assemblage zone (Maestrichtian) and *e). Rugulatisporites/Cingulatisporites* Assemblage zone (Maestrichtian). The dominance of the palynomorph assemblage by trilete spores *(Cingulatisporites ornatus, Foveotriletes margaritae, Zlivisporis blanensis,* and *Verrucatotriletes bullatus)* and monocolpites *(Monocolpites marginatus, Longapertites* sp. and *Monocolpollenites* sp.*)* indicate a swampy environment fringed by herbaceous vegetation. While the dark grey to black, fissile, sulphur stained, pyretic, lignitic and laminated carbonaceous shale suggested a tidal flat environment of deposition. This study therefore enabled the recognition of five informal palynological zones in the upper Cretaceous sediments of Anambra basin and tidal flat environment.

Key words: Palynostratigraphic, Cretaceous deposits, Herbaceous.

Introduction

Anambra basin has received a considerable geological attention since 1903 when exploration for coal started in the basin. Over 12,000 meters of sandstones, shales, limestones and coal seams accumulated in its thickest part since Cretaceous time (Agagu and Adighije 1983). Its upper Cretaceous stratigraphic setting of interbedded sandstones and shales with occasional limestones is suitable for petroleum generation and accumulation (Agagu and Ekweozor 1982; Dankoru 1993). All Nigeria's commercial coal production to date has come within the basin with over 1.7 billion tones still in reserve (David - West 1986).

Palynological studies that have made some significant contributions to the knowledge of the biostratigraphy of the basin include (Salami 1983 and 1990; Oloto 1994). Salami (1983 and 1990) studied late Cretaceous and early Tertiary pollen and spores from Southern Nigeria sedimentary basin. He found out that the environment of deposition of some lower and upper "coal measures" (Mamu and Nsukka formations) rocks is swamp or marginal marine environment periodically inundated by marine water. Mebradu (1990) suggested three palynofacies and two palynofacies changes in the Enugu/Iva valley shales from Anambra basin while Oloto put forward the first dinoflagellate and miospore biozones for Southern Nigeria sedimentary basin.

*Author for correspondence

This study unlike the previous traditional ones of dating sediments of the basin, attempts a fine stratigraphic differentiation. This is done by concentrating on identified index palynomorphs that are useful for delineating locally defined zones and provide a means of correlation with adjoining basins. The palynostratigraphic framework established here will greatly amplify the biozonation of the flora succession of the basin in future.

*Geological setting of the basin.*This basin which is adjacent to the lower Benue trough is intracratonic (Whiteman 1982). It is an immediate precursor of the Niger delta basin and trends in a NE to SW direction. A lot of work has been undertaken to elucidate the stratigraphy (lithostratigraphy and biostratigraphy), age, palaoenvironment, paleogeography, sedimentary tectonics and origin of the deposits in the basin and the adjoining sedimentary basins. Reyment (1965) and Nwajide and Reijers (1996) delineated and described a number of lithostratigraphic subdivisions. Agagu *et al* (1985) also divided the Senonian-Maestrichtian lighostratigraphic units of the Southern Anambra basin into eight sections representing three repetitive delta-building episodes. Swamp or marginal transitional to marginal marine and tidal flat environments of deposition have been suggested (Salami 1983; Allix 1987; Akande *et al* 1992; Nwajide and Reijers 1996). Fluvio-marine sandstones and shales were said to be

deposited during the tectonically active periods while marine shales were deposited during the intervening quiescent period in response to the globally documented Albian - Maestrichtian sea level rise (Berquist 1971; Douglas *et al* 1973; Mathews *et al* 1974). The paleogeographic history of this area in terms of tectonic events which gave rise to three major depositional cycles reported by Murat (1972). These are:

(a) Abakaliki - Benue phase (Middle Albian-Coniacian).
(b) Anambra - Dahomey (Benin) phase (Campanian-Early Eocene) and
(c) Niger delta phase (Late Eocene - Pliocene).

The sediments in the basin were said to be derived mainly from Abakaliki fold belt (Petters 1978; Ojoh 1992) although some clastics were basement derived. (Hoque and Ezepue 1977).

Materials and Methods

Forty-one fresh road-cut samples were collected at two locations L1 and L2, using spot sampling method. L1 is behind Ogbete market while L2 is at 1 Kilometer along Onitsha-Enugu Express way. Grey to black shales, sand shales, siltstones and shaly sandstones were studied lithologically and processed for palynomorphs. The standard maceration technique for the preparation of palynological samples were followed in this study. This consisted essentially of:

(i) Addition of 60 ml of 50% hydrochloric acid (HCl) to 20g of each sample and washing the residue with distilled water.
(ii) Addition of concentrated hydrofluoric acid (HF) in drops until 80ml has been added. Each sample was mounted on mechanical shaker for about 8 h for the reaction to complete. The residues were washed with distilled water.
(iii) Addition of concentrated nitric acid ($HN0_3$). The residues were again washed with distilled water and finally,
(iv) 5% Potassium hydroxide (KOH) (60 ml)was added, decanted the solution and the residue thoroughly washed with distilled water three times.
(v) The unsieved residues were appropriately treated and mounted in a mixture of epoxy A (3 parts) and epoxy B (1 part) following the method of double mounting (Traverse 1988). Two slides were made from each studied sample.
(vi) Counting of grains for each sample range between 100 and 150. These were semiquantatively tallied as shown in Figs 1 and 2.

Results and Discussion

The palynostratigraphic analysis is based mainly on L2 because of its thickness (30 ml), palynomorph abundance and species diversity (28) which made biozonation possible. Five informal assemblage zones were established for the studied sections which range in age from Campanian to Maestrichtian (Figs 1 and 2). The main features of the palynozones were outlined in ascending order from the base to the top of the sequence. The assemblage zone boundaries were placed where significant changes occurred simultaneously in a number of species and age determinations rely largely on index pollen and spores found and documented in the coastal basins of West Africa and South America. Photomicrographs of selected representative palynomorphs were taken.

Zone A. Tricolpites/Syncolporites/Matonispories zone. The zone is recognized in L2. Its interval extends from 0.4m at the base to 30m at the top. The lower limit of this zone is not reached at this location. The upper limit corresponds to the simultaneous appearance of *Longapertites vaneendenburgi, Inaperturotetradites lacunosus, Monocolpites* sp. and *Proxaperitites anisosulptus.* The most common species within the zone is *Tricolpites synstriatus.* The zone is characterized by *Syncolporites marginatus* and *Psilamonocolpites medius* in addition. The zone is assigned an upper Camapnian age based on *Tricolpites synstriatus* and *Syncolporites marginatus* (Van der Hamman and Wijmstra 1964; Jardine and Magloire 1965; Jan Du Chene *et al* 1978).

Zone B. Psilamonocolpites/Longapertites/Zlivisporis zone. This zone is recognized in L2 between 30m and 8.4m. Its base is fixed at the simultaneous appearance of *Monocolpites marginatus, Anacolosidites luteoidites* and *Proxapertites anisosulptus.* The top of the zone coincides with the disappearance of *Anacolosidites luteoidites* and *Psilamonocolpites medius.* The zone is characterized among others by the presence of *Longapertites vaneendenburgi* and *Zlivisporis blanensis* which appeared and disappeared within the zone. The acme of *Psilamonocolpites medius* and *Tricolpites synstriatus* occurred here. This zone is dated Campanian - Maestrichtian based on *Zlivisporis blanensis* and *Longaper-tites veneendenburgi* (Van der Hamman 1954; Pacltova 1961).

Zone C. Retistephanocolpollenites/Monocolpollenites/Prypylipollis zone. The zone is represented in L2 and present between height 8.4m and 20.lm. The base is marked by high frequency of *Retistephanocolpollenites willamsi* and *Monocolpollenites* sp. As well as the initial appearance of *Retimonoporites pluribaculensis.* The upper boundary is defined by the disappearance of *Retistephanocolpollenites williamsi* and the simultaneous appearance of *Retidiporites*

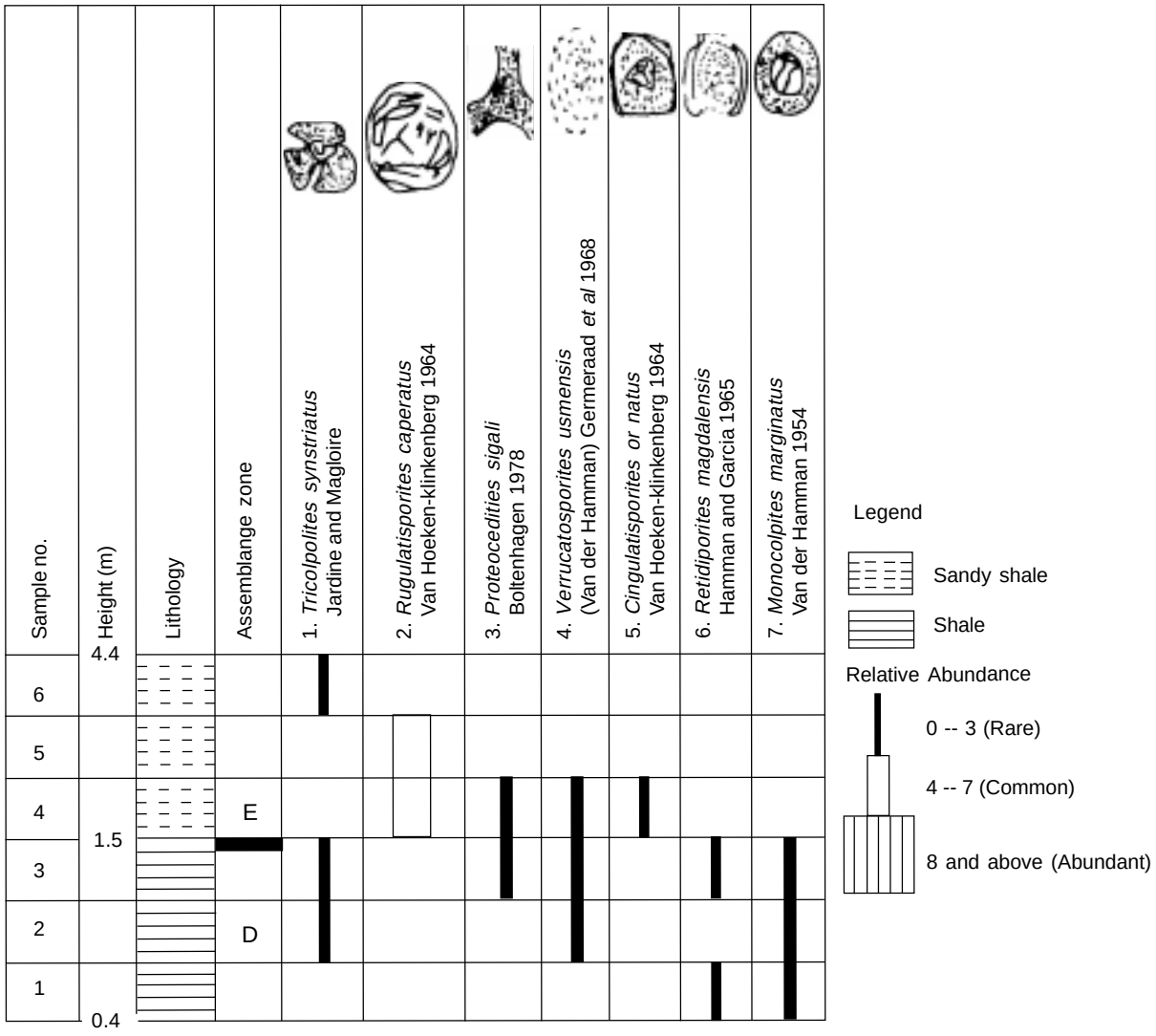


Fig 1. Stratigraphic range chart of the palynological taxa in L1.

magdalensis, Echitriporites triangulisformis and *Buttinia andreevii. Retistephanocolllenites* sp.,*Propylipollis (Proteacidites) dehaani* and *Foveotriletes margaritae* are restricted to the zone. A Campanian - Maestrichtian age is assigned to the zone based on *Propylipollis dehaani* and *Foveotriletes margaritae* (Jardine and Magloire 1965; Germeraad *et a l* 1968).

Zone D. Retidiporites verucatosporites/Buttinia zone. The zone is recognized at the interval between 20.1m and 26.1m in L2 and 0.4m and 1.5m in L1. Its base coincides with the first appearance of *Verrucatosporites usmensis, Retidiporites magdalensis, Echitriporites trianguliformis* and *Buttinia andreevii.* The upper limit is marked by the disappearance of *Longaperitites marginatus* and *Retidiporites magdalensis.* The *Monocolpites margaritae* occurred here in addition to a few poorly preserved dinoflagellates. Most species encountered in this zone also characterize the pollen sequence III of Jardine and Magloire (1965) on the co-occurrence of the foraminiferal species *Bolivina afra* Reyment. This zone is therefore, assigned to Maestrichtian age.

Zone E. Regulatisporites/Congulatisporites zone. This zone characterizes the interval between 26.1m and 29.4m in L2 and 1.5m and 4.4m in L1. Its base is fixed at the disappearance of *Longaperitites marginatus* and *Retidiporites magdalensis.* The characteristic species of the zone occur mostly in L1. These are *Longaperitites* sp., *Cingulatisporites ornatus, Proteacidites sigali* and *Rugulatisporites caperatus.* The age of this youngest zone in the study area is regarded as Maestrichtian based on *Rugulatisporites caperatus* and *Cingulatisporites ornatus* (Jardine and Magloire 1965;

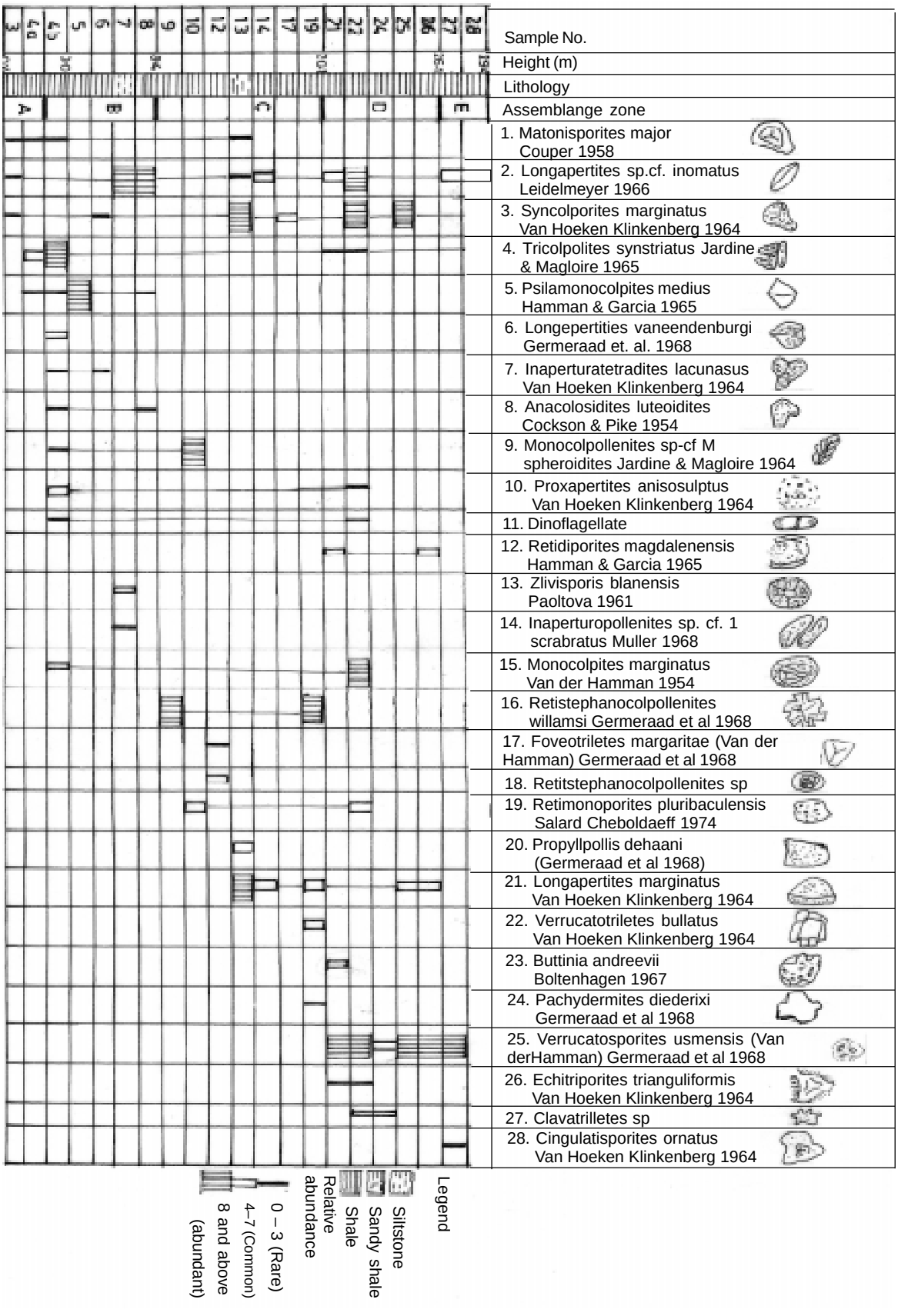
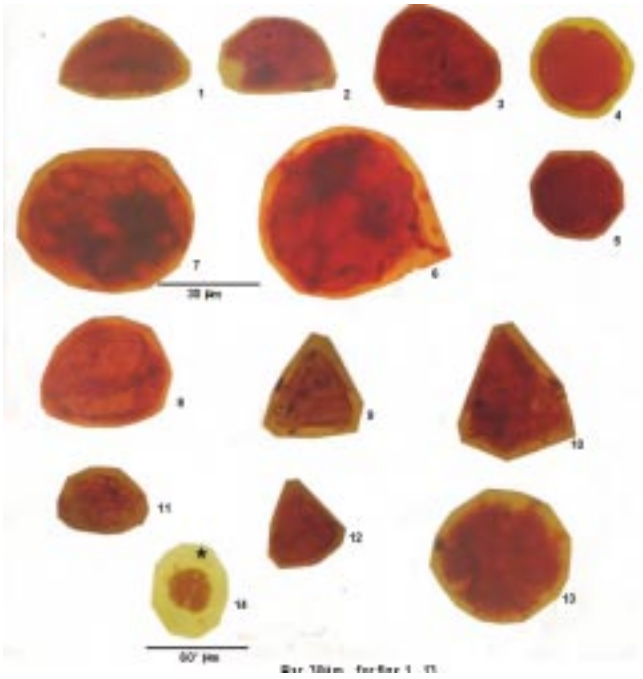


Fig 2. Stratigraphic range chart of the palynological taxa recorded in L2.



Bar 30 μm for figs 1-13
Bar 60 μm for fig 14

Plate

1, 2 *Longapertites* sp. cf *inornatus* (V.H.Kl.) Leidalmeyer 1966.
3 *Anacolosidites luteoidites* Cookson and Pike 1954.
4, 5 *Perchydermites diederixi* Germeraad *et al* 1968.
6, 7 *Zlivisporis blanensis* Palctova 1961.
8 *Inaperturopollenites* sp. cf *I. scrabratus* Muller 1968.
9,10 *Propylipollis (Proteacidites) dehaani* Germacraad *et al* 1968.
11 *Monocolpollenites* sp. cf *spheroidites* Jardine and Magloire 1965
12 *Foveotriletes margaritae* Germeraad *et al* 1968
13 *Retistephanocolpollenites williamsi* Germeraad *et al* 1968
14 *Retistephonocolpollenites* sp.

Germeraad *et al* 1968; Boltenhagen 1978; Salard-Cheboldaeff 1978).

This study delineated the five zones based on the marker species identified from the samples analysed with reference to the works of Boltenhagen (1978), Lawal and Moullade (1986), Mebradu (1990), Salami (1990) and Salard – Cheboldaeff (1990).

Paleoenvironment. With reference to the Plate 1, the brown to dark brown, fairly well preserved palynomorph assemblage indicates a swampy environment fringed by herbaceous vegetation as shown by a fairly large preponderance of trilete spores (ferns) and monocolpates (Palmae) (Salami 1990). But the dark grey to black, fissile, sulphur stained, pyritic, lignitic and laminated carbaneceous shale suggest deposition in an anoxic bottom environment in quiet water condition (Harms *et al* 1975). Hence the environment of deposition is probably tidal flat. Occasional flooding of the area of study by marine or brackish water probably occurred as indicated by the presence of more miospores in samples 4b and 22 and the incorporation of some poorly preserved dinoflagelletes at those levels (Fig. 2).

Conclusion

The knowledge of palynological zones is essential for dating formation and exploration for hydrocarbon source rocks. Outcrop samples are cheap and direct source of information on rock record. Based on the rich palynomorphs in some of the samples, the present study enabled the recognition of five informal palynological zones whose age ranges from Upper Campanian - Maestrichtian. The environment of deposition of the rock units is more of a tidal flat.

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