Geological Society of Malaysia, Bulletin 46
May 2003; pp. 401–404

Sedimentology and palaeontology of Batu Arang area, Selangor

YUSNIZAR JULAIDI AND UYOP SAID

Geology Programme, School of Environmental and Natural Resources
Faculty of Science and Technology, Universiti Kebangsaan Malaysia
43600 UKM Bangi, Selangor

Abstract: The sedimentary rock sequence at Batu Arang consists of several facies such as mudstone, siltstone, sandstone and conglomerate which can be divided into several subfacies representing different sub-depositional lacustrine environments. The overall rock sequence in the study area is a coarsening upward sequence with conglomerate as the youngest bed. The palaeontological study dealt mainly with the presence of plant fossils and palynomorphs and some leaf fossils found were identified as *Angiopteris erecta, Eugenia, Lindera* and *Macaranga.* Some palynomorphs found such as *Echitricolporites* sp., *Laevigatosporites* sp. and *Bombacacidites baumfalki* are assignable to the *Echitricolporites* Zone of Eocene-Miocene age

Abstrak: Jujukan batuan sedimen di Batu Arang terdiri daripada beberapa fasies iaitu batu lumpur, batu lodak, batu pasir dan konglomerat yang dapat dibahagikan kepada beberapa subfasies mewakili sub-sekitaran pengendapan yang berbeza di dalam sekitaran tasik. Berdasarkan log sedimen, jujukan batuan di sekitar kawasan ini merupakan jujukan yang mengkasar ke atas, di mana konglomerat merupakan lapisan yang termuda. Kajian paleontologi yang tertumpu kepada kehadiran fosil tumbuhan dan palinomorf juga dijalankan dan telah mengenal pasti beberapa fosil daun seperti *Angiopteris erecta, Eugenia, Lindera* dan *Macaranga.* Selain daripada itu, kajian palinologi mengenal pasti kehadiran palinomorf yang mewakili Zon *Echitricolporites* seperti *Echitricolporites* sp. *Laevigatosporites* sp. dan *Bombacacidites baumfalki* bersama-sama dengan *Echitricolporites* sp. yang berusia Eosen-Miosen.

INTRODUCTION

The study area is a part of the Tertiary basin which is located in the north of Selangor covering an area of approximately 15 km^2 in the western part of Batu Arang Town (Fig. 1). The rock sequence was deposited in the more or less triangular-shaped Tertiary basin overlying with marked unconformity the much older and steeply dipping meta-sediments of mainly quartzites (Renwick and Risworth, 1966). The sedimentary rock sequence called the Batu Arang Beds (Stauffer, 1973) or the Coal Measures (Roe, 1951) which was discovered by a local Malay man panning for tin ore in the Rantau Panjang Forest Reserve at about 21 m above sea level (Scrivenor, 1931). The rock

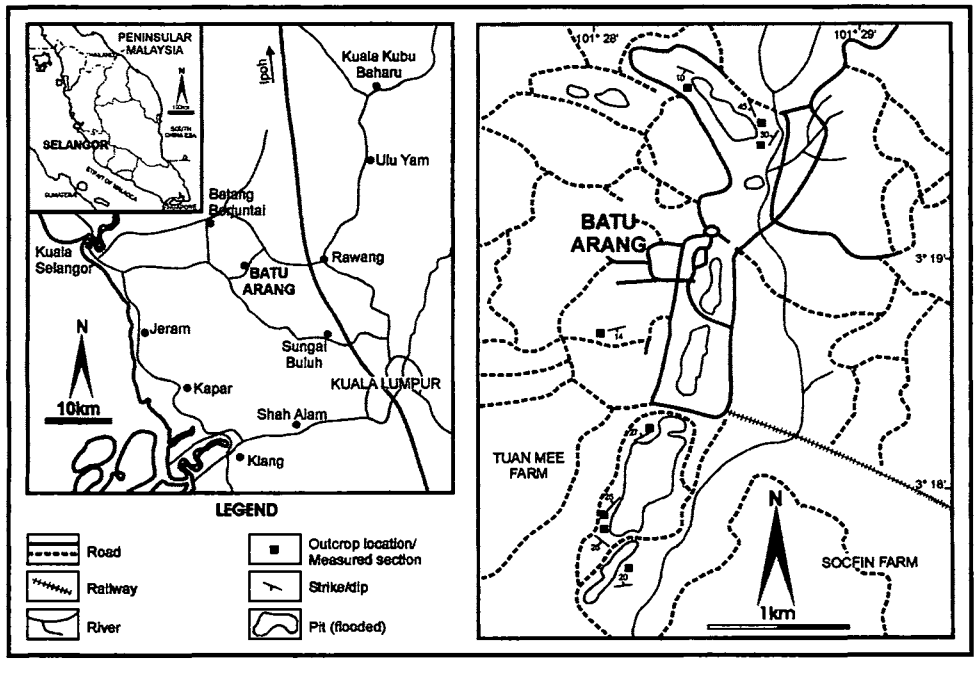

Figure 1. Map showing the study area.

sequence in this area was recognised as having two layers of thick (up to 14 m) and several thinner seams of lignitic coal. It was recorded that, the maximum thickness of the Batu Arang Beds is 265 m in the centre of the basin and it tapers to 183 m and 244 m in thickness in the eastern and northern parts respectively.

This area consists mainly of silty to sandy shales, clay and fine-grained sandstones, together with thin beds and lenses of coarse-grained sandstones and lignite seams at certain outcrops. The coal seams were identified to be intermediate between lignite and sub-bituminous coal, with resinous lustre. The occurrence of dark grey coaly mudstones and coaly siltstones is also common in the study area. The conglomerate unit is the youngest unit in the sequence, and based on the colour and type of the conglomerate, it can be divided into a lower and upper conglomerate layer. The lower conglomerate layer is a matrix-supported conglomerate and reddish in colour which is distinguished from the dark grey upper conglomerate layer of grain-supported conglomerate. The pebbles are relatively coarser in the upper conglomerate layer, and both of the pebbles in the conglomerate layers consist of various lithologies such as fragments of quartzites, quartz, shale and schist.

There was no comprehensive study in this area to determine the depositional environment and precise age of the rock sequence in the Batu Arang Area. Previous studies suggested that the rock sequence in Batu Arang was deposited in a lacustrine environment based on the data from a diamond drill bore hole. Palaeontological study had been carried out in this area since 1908. Based on the well-preserved leafs fossils and other plant fragments in coal-bearing layer, it was interpreted that the age of the sedimentary rocks in this area might be Late Tertiary or younger (Roe, 1951), and it was also suggested as Miocene in age (Scrivenor, 1931). The first palynological study in this area was carried out by Law (1961) who was able to identify some palynomorphs species. The more recent palynological study was conducted by Ahmad Munif Korani (1994) and suggested that the coals are probably Oligocene to Eocene in age, and it was interpreted that the rock sequence was deposited in a lacustrine environment under somewhat seasonal climatic conditions based on the occurrence of *Nyssapollenites* sp., *Lagerstroemia* sp. and *Pinuspollenites* sp.

MATERIAL AND METHOD

This paper mainly deals with the sedimentological and palaeontological aspects of this area. Several lithologic logs were prepared by measuring all available rock sequences exposed in the study area and subsequently a composite log showing the sedimentary structures and the sample horizons was also prepared (Fig. 2). Based on the facies analysis conducted on the prepared composite lithologic log, the sub-depositional environments are interpreted. The palynological study helps to give a more precise age determination. More than 50 samples of mainly carbonaceous rich fine-grained sandstone siltstone and mudstone that potentially containing palynomorphs were collected and processed for palynological study.

RESULT AND DISCUSSION

The rock sequence can be divided into five facies namely mudstone, siltstone, sandstone, conglomerate and coal which can further be subdivided into several subfacies such as coaly mudstone or coaly siltstone, laminated sandstone, interbedded sandstone with mudstone or siltstone and coarsening upwards sequence siltstone. Six facies members were identified and each of them represents a different sub-depositional environment (Fig. 2). Facies I which is characterised by parallel-laminated very fine-grained mudstone and siltstone which were deposited in shore terrace environment by overflows or surface currents.

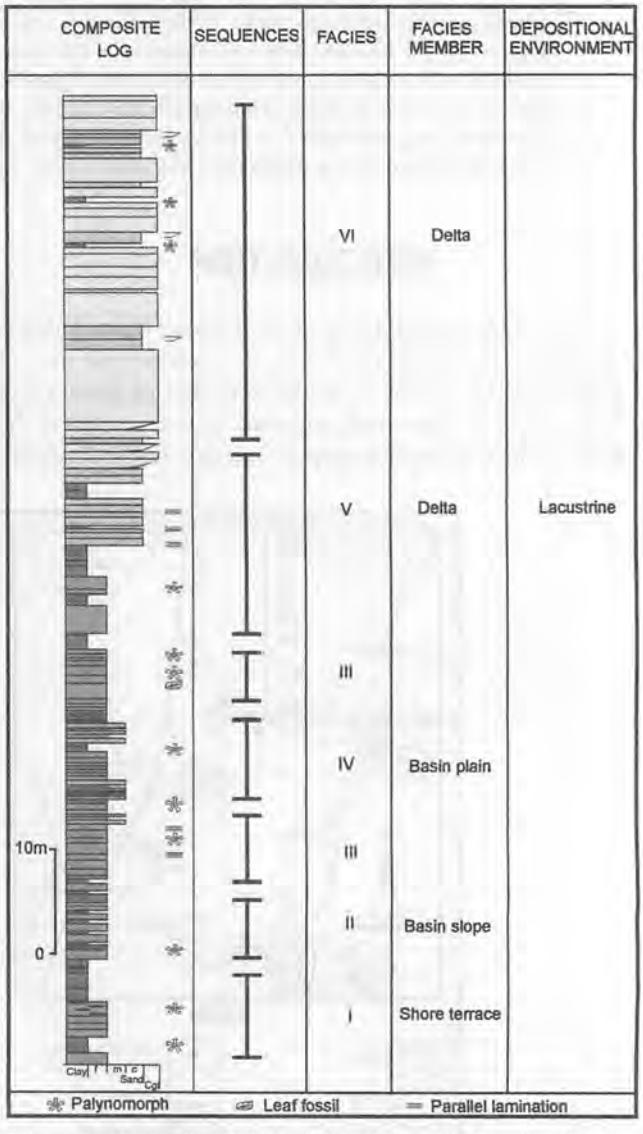

Figure 2. Generalised lithologic log of the studied section, showing the interpreted sedimentary facies, depositional environments and the horizons of samples containing leaf fossil and palynomorph.

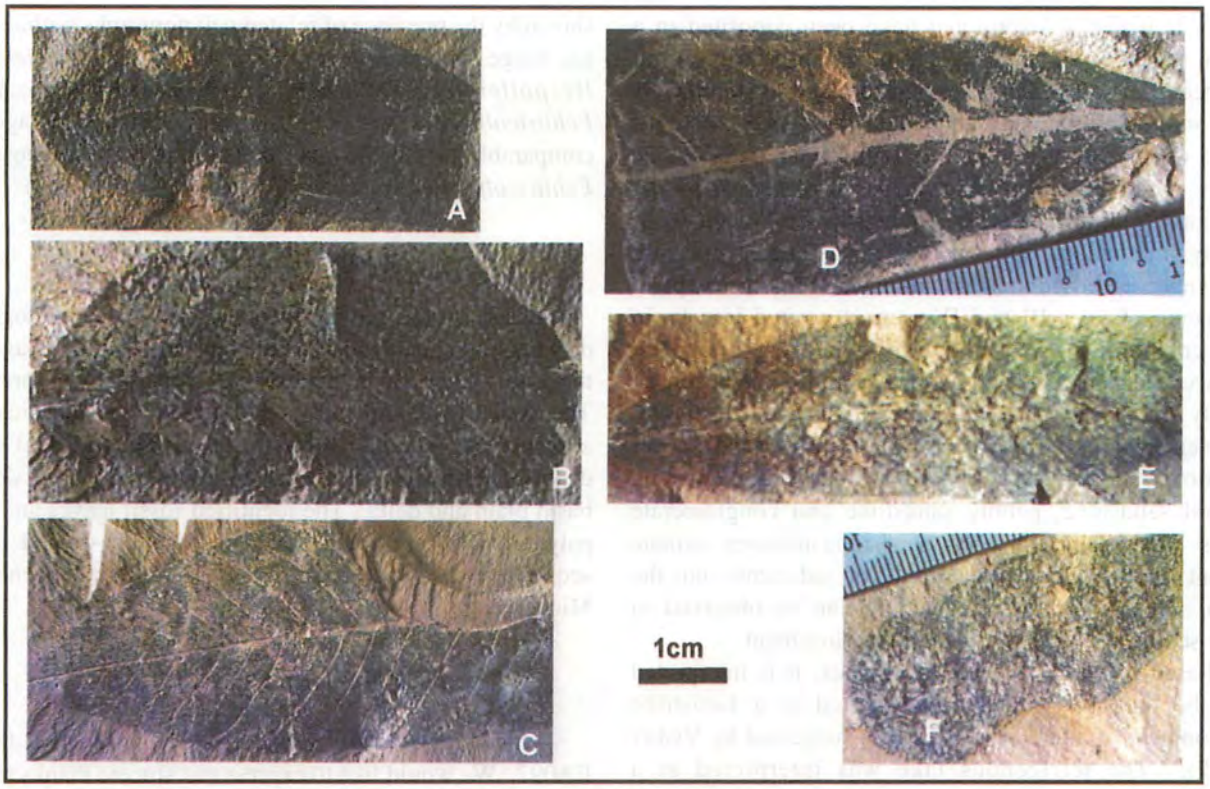

Figure 3. Some selected leaf fossils; A: *Eugenia* sp. B: *Polyalthia* sp. C: *Litsea* sp. D: *Lindera* sp. E: *Angiopteris erecta* and F: *Macaranga* sp.

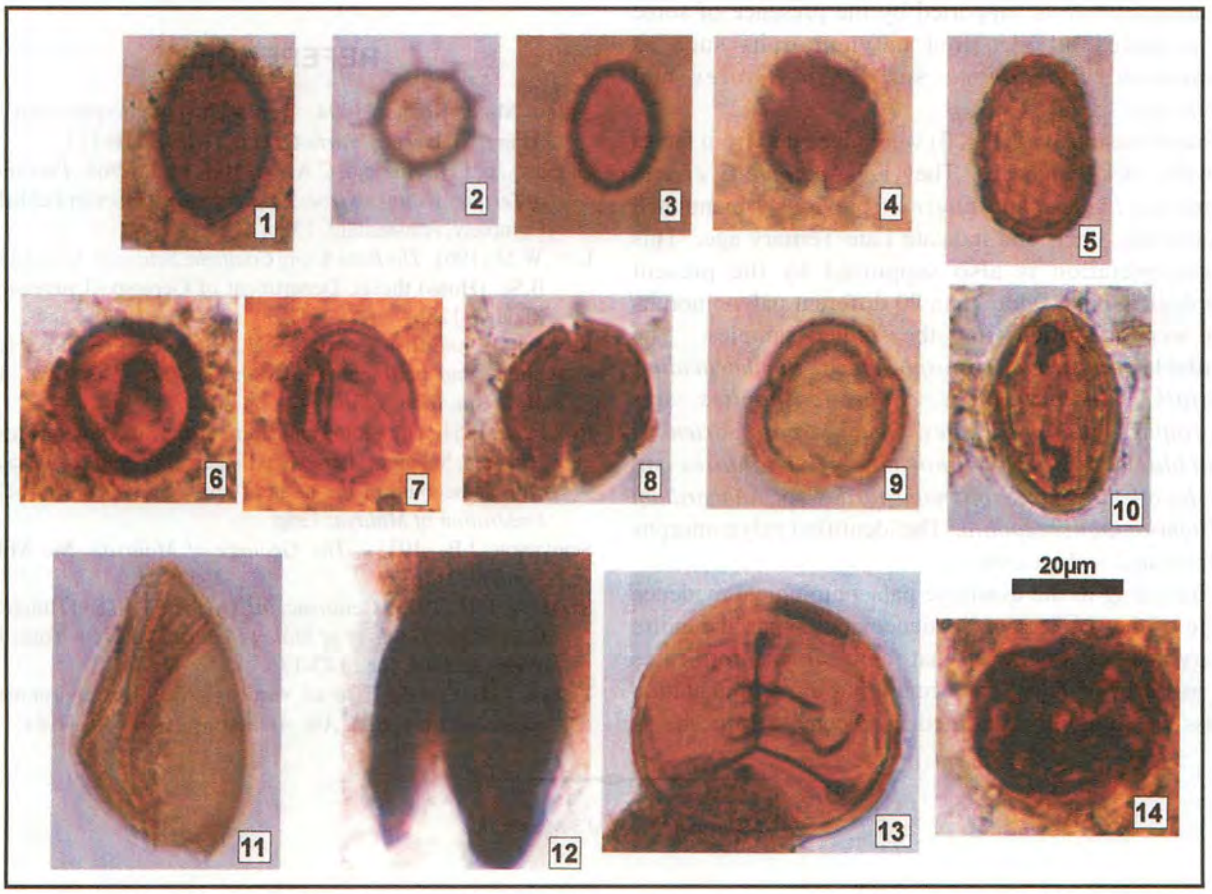

Figure 4. Selected palynomorphs from the study area; 1: *Laevigatosporites* sp. 2: *Echitricolporites* sp. 3: *Illexpollenites* sp. 4: *Bombacacidites baumfalki* 5: *Stenochlaena* sp. 6: *Sphagnumsporites* sp. 7: *Thomsonipollis expolita* 8: *Dicolpopollis* sp. 9: *Rhizophora* sp. 10: *Anacardium* sp. 11: *Cycadopites* sp. 12: *Ephedripites* sp. 13: *Deltoidospora adriennis* and 14: *Polyadopollenites* sp.

Facies II which is interpreted have been deposited in a basin slope environment is characterised by thinly interbedded parallel-laminated mudstone and siltstone layers with some fine-grained sandstone which may occur as lenses or thin layers between the mudstone and siltstone layers. In comparison, facies III is characterised by the dominant of thin siltstone layers and facies IV consist of thickly interbedded siltstone and sandstone layers with relatively coarser sediment containing leaf fossils and plant fragments. Facies III and IV were deposited in a basin plain environment. Facies V and VI which are interpreted to have been deposited in a deltaic environment consist mainly of pebbly and conglomerate layers. Facies V represented by interbedded mudstone, siltstone and coarser sandstone, and facies VI consist of interbedded coarsing upward sandstone, pebbly sandstone and conglomerate layers. The presence of pebbly sandstone indicates variable current flows affecting the supply of sediments into the basin. Occasional, graded-bedding can be observed in these sediments of the delta slope environment.

Based on the above facies analysis, it is interpreted that the rock sequence was deposited in a lacustrine environment of a terrigenous lake as suggested by Visher (1965). The terrigenous lake was interpreted as a depositional basin that received the sediments derived from the adjacent land at high altitude and under a drier climate. This interpretation is supported by the presence of some high altitude and wet area palynomorphs such as *Anacardium, Rhizophora* sp., *Ilexpollenites* and *Ephedripites.*

Some fossil leaves (Fig. 3) were identified from facies III of the rock sequence. They are *Angiopteris erecta, Macaranga, Lindera* and *Eugenia* (previously mentioned by Scrivenor, 1931) and indicate Late Tertiary age. This age interpretation is also supported by the present palynological data. More than 20 different palynomorphs genus were identified from the studied samples. The identifiable ones are *Laevigatosporites* sp., *Bombacacidites baumfalki, Ilexpollenites, Echitricolporites* sp., *Monocolpites* sp., *Ephedripites, Deltoidospora adriennis, Stenochlaena* sp., *Rhizophora* sp. *Cycadopites* sp, *Polyadopollenites* sp. *Sphagnumsporites* sp. *Anacardium* and *Thomsonipollis expolita.* The identified palynomorphs are illustrated in Figure 4.

According to the available palaeontological evidence the age of the whole rock sequence could span the entire Tertiary age. It is believed that the basin was formed as early as Early Tertiary (Paleocene), but the sedimentation process was more concentrated in Eocene to Miocene as shown by the presence of related palynomorphs within this age range such as *Ephidripites, Deltoidospora adriennis, Ilexpollenites, Taxidium* sp., *Anacardium* sp. and *Echitricolporites* sp. This palynomorph assemblage is comparable to the Miocene palynomorph assemblage of *Echitricolporites* sp. Zone (Germeraad *et al.*, 1968)

CONCLUSIONS

Based on the sedimentological and palaeontological data acquired, the depositional environment and the age of the Batu Arang Beds can be more precisely interpreted. The studied rock sequence is interpreted to be deposited in a terrigenous lake which can be divided into several sub-depositional environments such as shore terrace, basin slope, basin plain and delta. The identified fossil leaves and the palynomorph assemblage indicate that the studied rock sequence was most probably deposited in Eocene to Miocene age.

ACKNOWLEDGEMENTS

This study is partly funded by IRPA 09-02-02-0028 EA097. We would like to express our sincere thanks to all technical staff of Geology Programme, Universiti Kebangsaan Malaysia for their assistance.

REFERENCES

AHMAD MUNIF KORANI, 1994. Tertiary palynomorphs from Batu Arang, Malaysia. *Warta Geologi, 91(3)*, 116-117.

GERMERAAD, J.H., HOPPING, C.A. AND MULLER, J., 1968. *Palynology of Tertiary sediments from Tropical areas.* Elsevier Publishing Company, Amsterdam, 132p.

LAW, W.M., 1961. *The Batu Arang Coalfield, Selangor.* Unpublished B.Sc. (Hons) thesis, Department of Geology, University of Malaya, 128p.

RENWICK, A. AND RISHWORTH, D.E.H., 1966. Fuel resources (coal, lignite and petroleum) in Malaya. *Geo. Sur. Dep., West Malaysia, Ipoh*, 123p.

ROE, F.W., 1951. The geology and mineral resources of the Fraser's Hill area, Selangor, Perak and Pahang, Federation of Malaya, with an account of the mineral resources. *Geol. Sur. Dep., Federation of Malaya*, 138p.

SCRIVENOR, J.B., 1931. *The Geology of Malaya.* Mc Millan, London, 217p.

STAUFFER, P.H., 1973. Cenozoic. *In:* Gobbett, D.J. and Hutchison, C.S. (Eds.), *Geology of Malay Peninsular.* New York, John Wiley & Sons, Inc., 143-176.

VISHER, G.S., 1965. Use of vertical profile in environmental reconstruction. *Bull. Am. Ass. Petrol. Geol. 49*, 41-61.

Manuscript received 3 March 2003