

# Paleoenvironment of Tanjung Formation Barito Basin- Central Kalimantan Based on palynological data

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## Abstract

The research area is located in the Muara Teweh, North Barito, Central Kalimantan. The cocking coal deposits are well known as they were produced from this area. Upper part of Tanjung Formation is target coal production. The study objectives are to analyze paleoenvironment and to determine the relative age of coal deposits based on palynological data. Preparing palynological analysis used standard procedure by hydrofluoric acid method. Palynomorphs data grouped into six types of ecology, and the sequence is as follows ; fresh water and lowland (41,75 %), brackish water swamp (30,10%), Peat and freshwater swamp (17,96%), marine element (7,77 %), back mangrove (1,46%) and upland element (0,97). Palmae pollen is very dominant, especially from freshwater and peat swamp that grow around coastal area i.e. *Dicolcopollis*, *Proxapertites cursus*, *Proxapertites operculatus*, *Longapertites* and *Palmaepollenites kutchensis*. Although marine fossil found, but the frequency less than one percent, that was the evidence of influence sea water to swamp area. The palynomorphs indicate the coal sedimented at upper delta plain. Fossil index of relative age consist of *Proxapertites cursus*, *Proxapertites operculatus*, *Magnastriatites howardi*, *Verrucatosporites usmensis*, *Retistephanocolpites*, and *Ixonantes* type which refer to Late Eocene.

**Key word:** Paleoenvironment, pollen, Tanjung Formation, Central Kalimantan.

## 1. Introduction

Tertiary Barito basin spread through Central Kalimantan until South Kalimantan. The northern basin bordered by West Kutai Basin, and in the west by Schwaner High, to the east by Meratus High, in the south of the Java Sea. The basin covering an area of some 75,000 km<sup>2</sup>, sediment thickness varies from about 2000 to 5000 meters. Basin formation started at the Late Cretaceous after the collision micro-continent between Paternoster and SW Borneo microcontinent ([Satyana and Idris, 2006](#)). The complete cycle sedimentation of sedimentary rock is found in this basin from Eocene to Miocene by regression and transgression series. Tanjung Formation rocks is an oldest sedimentary rock in this basin which was deposited unconformity above Pre-Tertiary basement rock. Sediment deposition process takes place in an environment fluvio-deltaic, delta front until neritic zone. The Tanjung Formation occurred since Late Paleocene until Late Eocene ([Satyana and Silitonga, 1994](#)). Coal was a sedimentary rock that filled the earliest Tanjung Formation, so that coal is the oldest sedimentary rocks that formed in the Barito basin. Tanjung Formation generates cooking coal that estimated formed in the Late Eocene ([Belkin dan Tewalt, 2007](#); [Friederich, et al, 2009](#); [Nas dan Hindartan, 2010](#)). Construction of Tanjung Formation started since

Paleocene until Late Eocene ([Satyana and Silitonga, 1994](#)). The area spread from Central Kalimantan until South Kalimantan, so very possibly to occupy various environment. Research focus on coal Tanjung Formation of Muara Teweh, Central Kalimantan. This objective of study to determine the age and depositional environment condition during the sedimentation of Tanjung Formation which was exposed in the study area.

The Tanjung coal formation are outcropping in the Northern part of Barito Basin. The coordinates of coal sample is 1°3'39,74" S and 114° 38'37,26" E within 50 km to the southwest of Muara Teweh district and about 250 km to the northeast from Palangkaraya City, situated between 1°3'39,74" S and 114° 38'37,26" E (Fig 1).

## 2. Stratigraphy Barito Basin

Stratigraphy Barito Basin in research area arranged into five Formation and an alluvium sediments (fig 2), as follows:

Tanjung Formation is the oldest rock sediment. The lower part of Tanjung Formation consists of alternating among glauconitic sandstones, shale, siltstone and conglomerate of various materials, some of which are calcareous. Conglomerate's components consist of quartz, feldspar, granite, schist, gabbro and basalt.

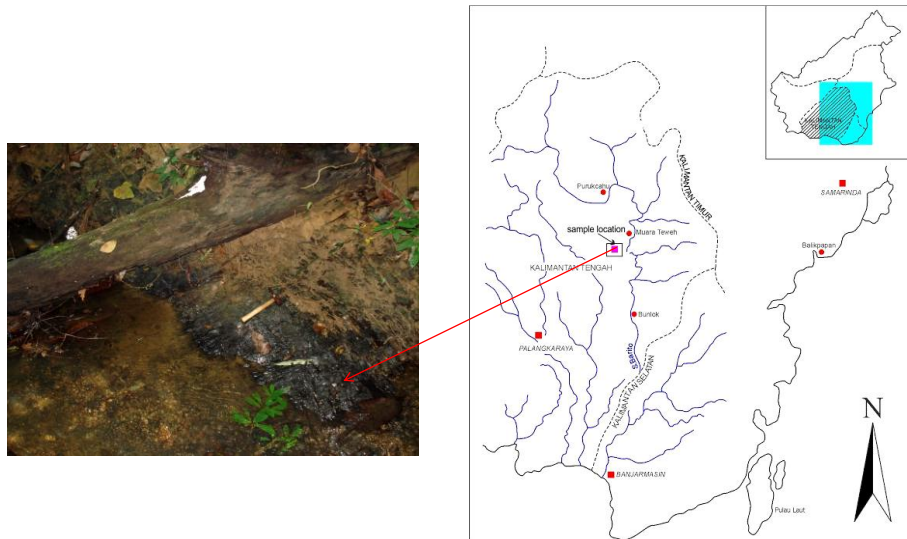


Fig. 1. Location of coal sample (right) and coal outcrop (left)

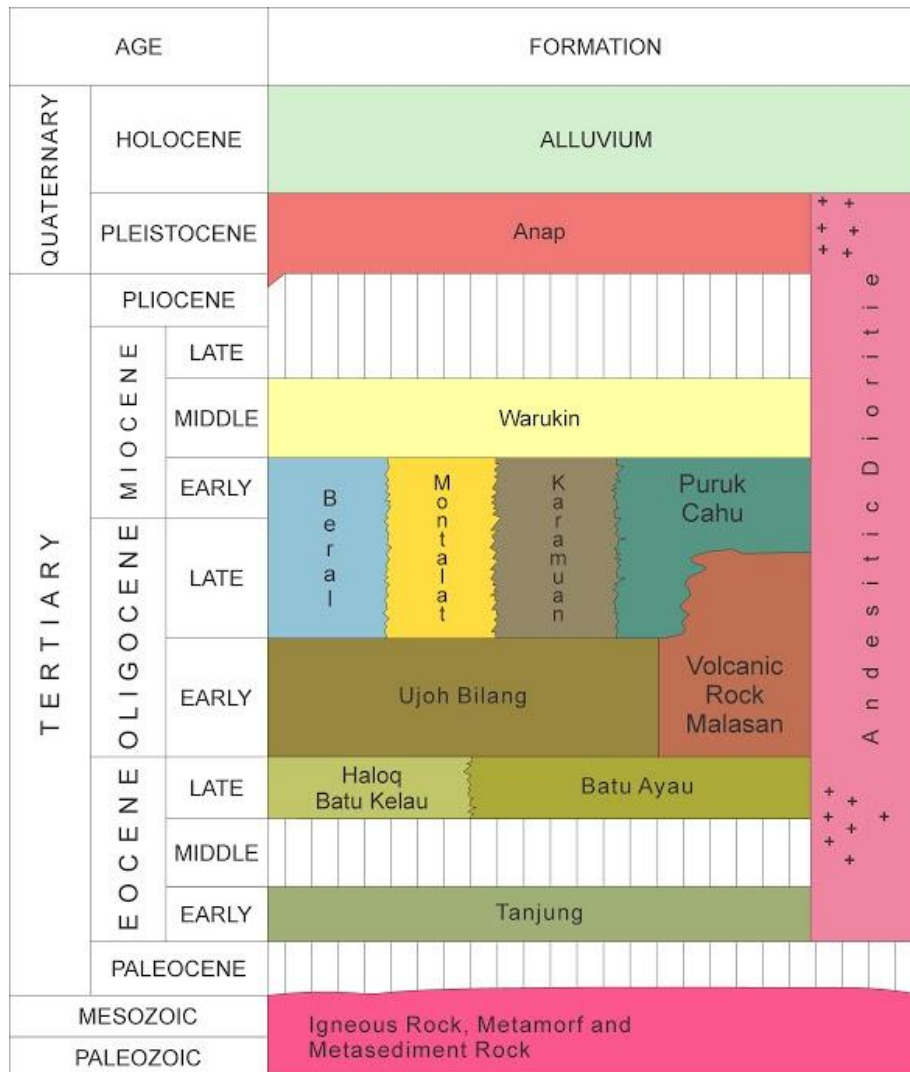


Fig. 2. Stratigraphy of research location (Modified from Supriatna et.al,1981)

The upper part consists of alternating quartz sandstone, siltstone, limestone, and coal. The relative age of Tanjung Formation is Late Eocene, it lays unconformity on the basement Mesozoic rocks, a thickness of sediment about 1,300 meters and the depositional environment is the swamp.

Berai Formation composed of gray and white limestone, fine to medium grained, partly recrystallized, contains a large foraminifera and coral, partially layered, it lays conformity on the Tanjung Formation, relative age about Middle Oligocene to Late Oligocene, deposited in Shallow marine environment, the thickness reach 1.250 meters, it occupies a steep karst hills.

Karamuan Formation composed of consists of gray mudstone, partly calcareous and fossilized; quartz sandstones; gray siltstone; light-gray tuffaceous siltstone, there is fossil insert in the limestone, carbonaceous siltstone, shally siltstone overlies the Tanjung Formation conformably, and estimated interfingering with Berai Formation, deposited in shallow marine to outer shelf.

Montalat Formation characterized by white quartz sandstones, cross bedding structures, partly calcareous, deposited overlies the Formasi Tanjung conformably in a marine environment, interfingering with Berai Formation, Oligocene, the sediment about 1.400 meters thick.

Warukin Formation, the character of the sandstone includes beds that are medium grained, well sorted. Contain carbonaceous mudstone, carbonaceous siltstone. Partly conglomeration sandstone, semi-solid, cross and parallel laminations. This formation overlies the Berai Formation, the depositional environment of the Warukin Formation is coastal at Middle Miocene, estimated to be 500 meters in thickness.

Alluvial deposit Consist of gravel, pebbles, sand, mud and plant debris.

### 3. Material and Methods

Sample have been prepared by the standard method using hydrofluoric acid digestion continued by oxidation. The function of each chemical material is; concentrated hydrofluoric acid to remove silica, potassium hydroxide to remove humic acid, hydrogen chloride to remove carbonate, zinc chloride with specific gravity 2.2 to separate palynomorphs from others material. Acetolysis is a process to remove cellulose. Before making slides, palynomorphs colored by safranin. Examination of palynomorphs was using transmission light microscope in different magnification of 100x, 400x, and 1000x.

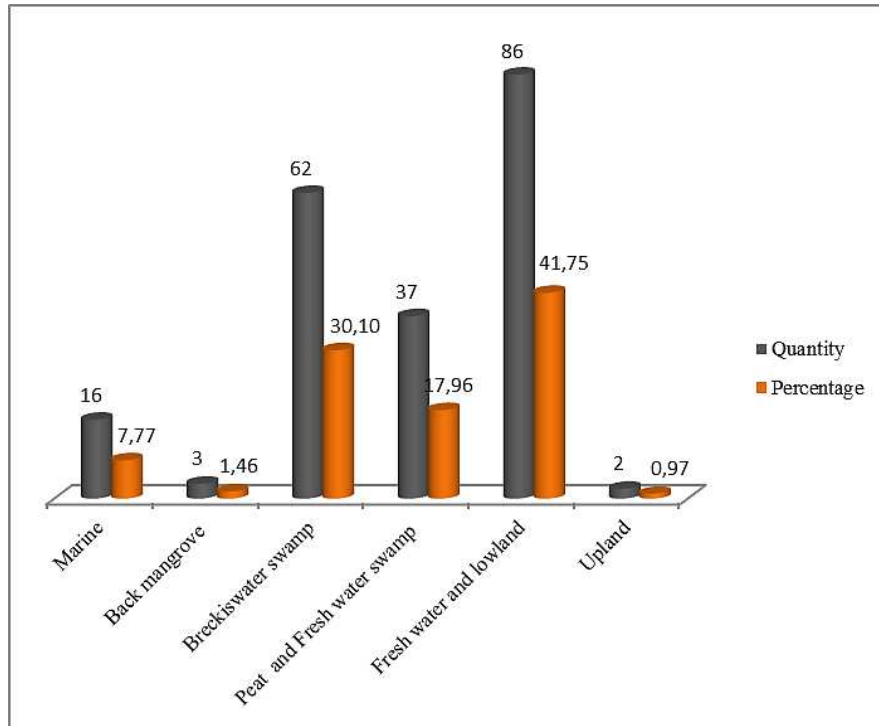
Based on the environment of palynomorphs origin then grouped based on their environmental, in this case grouped into six i.e: marine, back mangrove, brackish water swamp, freshwater swamp, freshwater and upland element. Marine palynomorphs which observed only dinocyst and linning test foraminifera, both of them were found in

the sample. Back mangrove element referred to pollen and spore that produced by vegetation which grows behind mangrove environment. Freshwater swamps elements are pollens and spores that came from around streams or lake which influenced by rain and seasonal flooding so causes water levels to fluctuate swampy condition. Freshwater elements are pollen, spore, and algae which came from the freshwater environment around lowland area. The upland element is pollens and spore which produced by vegetation came from mountain vegetation. Type of vegetation environment have been publish by Haseldonxk (1974).

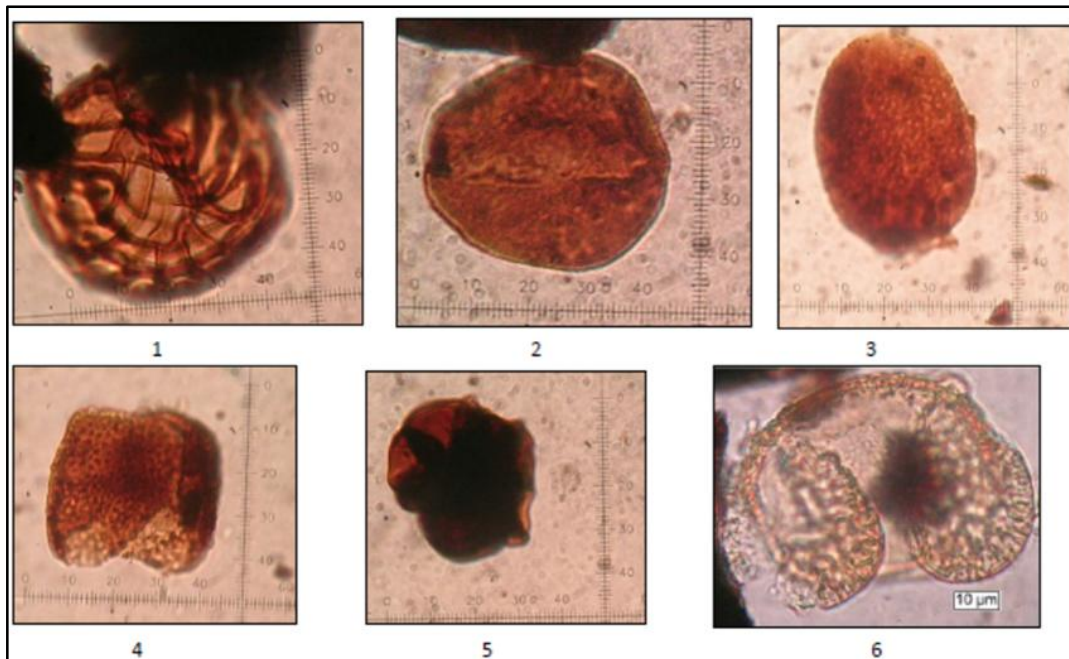
## 4. Result and discussion

### 4.1. Paleoenvironment

Acquired 206-grain palynomorphs that comprising 7.84% of the marine environment, which consists of Dinoflagellate cyst and linning test foraminifera. Brackish water swamp 19.61% consisting of pollen/spore derived from the fact brackish environment is derived from mangrove and back mangrove. Peat and Freshwater swamp 30.39%, those are pollen and spore which produced by plants from peat swamps, freshwater swamps, and riparian. Freshwater and lowland 41.18% consist of pollen which produced by lowland and freshwater plants. Upland pollen 0.98% the result of wind-transported pollen (Fig 3). Overall palmae pollen is the highest pollen that consisting of *Proxapertites cursus*, *Proxapertites operculatus*, *Palmapollenites kuthensis*, *Longapertites* and *Dicolcopollis*. The plants grow in the coastal areas, especially in the brackish marshes that position area is behind the mangrove until around the river. This fact supported by *Acrostichum aureum* spores were found at the site as indicator brackish area. The collision of India and Asia plate in the middle Eocene to propagate plants from India to Southeast Asia region. At that time both the northern region of the Indian plate and the Sunda region experiencing always wet climate, which is reflected in the equatorial climate and common events coal formation in both areas (Morley 1998, 2003). Pollens are considered developing in the Sunda Region follow the collision and found at the study area are *Palmapollenites kutchaensis*, *Retistephonocolpites*, *Magnastriatites grandiosus* / *Magnastriatites howardii*, *Ixonanthes* type / *Spiniulotriporites spinous*, *Lakiapollis ovatus*. Even marine fossils obtained very few, its presence indicates that the sediment deposition occurred in the transitional basin. Dinoflagellate cyst and inner test foraminifera are marine fossils that transported by tidal current through a channel and deposited in a transitional area it's a sign there was a connection between the deposition area and the sea. Based on palynomorphs composition which dominated by pollen and spore from swamp environment that refers to the delta environment, particularly delta plain.



**Fig.3.** Palynomorphs group in quantity and percentage



**Fig. 4.** *Cicatricosisporites eocenicus* (1), *Palmapollenites kutchensis* (2), *Proxapertites cursus* (3) *Dicolcopollis* (4) Inner test foraminifers (5), *Podocarpidites* (6)

Table 1. Ecological group of Palynomorphs

No	Ecological group	Palynomorphs
1	<b>Marine element</b>	<i>Marine dinocyst</i>
		<i>Foraminifera test lining</i>
2	<b>Back mangrove</b>	<i>Acrostichum aureum</i>
3	<b>Brackis water swamp</b>	<i>Proxapertites operculatus</i>
		<i>Proxapertites cursus</i>
		<i>Dicolcopollis</i>
4	<b>Fresh water swamp</b>	<i>Blumeodendron</i>
		<i>Lakiapollis ovatus</i>
		<i>Lanagiapollis emerginatus</i>
		<i>Longapertites</i>
		<i>Palmapollenites kutchaensis</i>
		<i>Polygalacidites sp</i>
		<i>Sapotaceoideaepollenites sp</i>
		<i>Verrucatosporites usmensis</i>
		<i>Anacolosidites lutoides</i>
		<i>Bombacaeae</i>
		<i>Cycadopites</i>
		<i>Gothanipollis</i>
		<i>Gymnospermae</i>
		<i>Ixonantes type</i>
<i>Lycopodium cernuum</i>		
<i>Lycopodium phlegmaria</i>		
5	<b>Fresh water</b>	<i>Magnastriatites howardi</i>
		<i>Margocolporites vanwijhei</i>
		<i>Matonia sp</i>
		<i>Monoporites annulatus</i>
		<i>Osmundacidites</i>
		<i>Palmae undet</i>
		<i>Polygonum</i>
		<i>Protecidites</i>
		<i>Verrucatosporites spp</i>
		<i>Retistephanocolpites wiliamsi</i>
		<i>Laevigatosporites</i>
	<b>Freshwater Algae</b>	
6	<b>Upland element</b>	<i>Cedripites</i>
		<i>Podocarpidites</i>



**Table 2.** Age relative based on pollen and spore marker

TAXON	EOCENE			OLIGOCENE			HOLOCENE
	Early	Middle	Late	Early	Middle	Late	
Proxapertites cursus/P. operculatus (1)	←						
Magnastritaites grandiosus (2)	—						
Palmaepollenites kuthcensis (3)	—						
Verrucatosporites usmensis (4)	—						
Retistephanocolpites williamsi (5)	—						
Ixonanthes type (6)	—						

(1) aplicable Borneo, Morley 1991  
 (2); (5) aplicable for Borneo, Gemmeraad et al., 1968 and Sunda Region Morley 1998  
 (3); (6) aplicable for Sunda Region, Morley 1998  
 (4) aplicable Borneo, Morley 1991

#### 4.2. Relative age

Some importance fossils have been obtained which can be used to determine relative age Tanjung Formation particularly in the research area as follow: *Proxapertites cursus*, *Proxapertites operculatus*, *Palmapollenites kuthensis* (*Iguanurinae*), *Verrucatosporites usmensis*, *Magnastritaites grandiosus/Magnastritaites howardii*, *Retistephanocolpites*. Both *Proxapertites operculatus* and *Proxapertites cursus*, those fossils existed in the Kalimantan until the Late Eocene, although the first appearance was not explicitly described (Morley, 1991). *Magnastritaites howardi* recorded appeared in the border of Late Eocene - Early Oligocene (Morley, 1998), the appearances of *Verrucatosporites usmensis* approaching the middle-late Eocene border. *Palmapollenites kuthensis* existed since Eocene until Oligocene, and *Retistephanocolpites williamsi* appeared in the Middle Eocene and disappeared in the Late Oligocene. Based on those taxa the establishment process of coal in the study area during Late Eocene (Fig 4).

#### 5. Conclusions

The results showed that the Tanjung coal formation in the Barito Basin was formed at Late-Eocene. This is different from previous research that said Tanjung Formation in the Muara Teweh the age relative was early Eocene. The dominance of pollen which derived from swamp habitat indicates that the process of coal sedimentation occurred in the swamp environment with marine influence.

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