

# Age and Depositional Environment of Walat Formation Based on Palynological Analysis in Sukabumi Regency, West Java, Indonesia

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## Abstract:

Walat Formation is equivalent to Bayah Formation. This formation is the beginning of Bogor basin deposition. In this case, age and environment of this formation have been analyzed by previous researchers, but the results of age and environment interpretations have different ranges, especially from its palynological aspect which until now Walat Formation is rarely analyzed using this aspect. This research was conducted to identify the age and depositional environment of Walat Formation in Sukabumi region by using pollen and spores to confirm different interpretations of previous studies. Measure section was carried out in sampling and chemical treatment method was carried out to see palynomorph content in the rock. Furthermore, data analysis was carried out with range of interval zones and pollen grouping based on their environment.

The results show that Walat Formation has Late Eocene age based on the interval zone between first occurrence of *Verrucatosporites usmensis* and *Meyeripollis naharkotensis*, and the last occurrence of *Proxapertites operculatus*, *Proxapertites cursus*, and *Cicatricosisporites eocenicus*. Walat Formation has fluvial depositional environment characterized by the dominance of *Proxapertites operculatus* and *Proxapertites cursus*. The results of this study confirm that the Walat Formation has an Eocene age and a fluvial depositional environment from a palynological aspect.

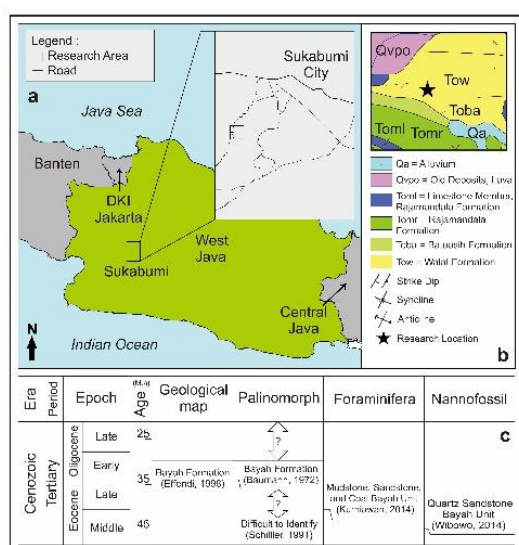
**Keywords:** Palynology, Walat Formation, Age, Environment, and Sukabumi

## 1.0. Introduction:

Palynomorph which is studied in the field of palynology is a material that is resistant to acidic substances. This material can be well preserved because of its resistance to destructive factors [1-4]. The examples of palynomorphs are pollen and spores that can be preserved in terrestrial environment to transition and some species can be preserved in marine environment [1,2]. This material has wide and abundant distribution in sedimentary rocks, therefore, pollen and spores can be used as research objects to identify the age and depositional environment of rock formation in an area [5-7].

Walat Formation is located in the Bogor Basin which is equivalent to Bayah formation. This formation is one of the oldest formations in Bogor Basin and became initial key to the formation of this basin [8-13]. The lithology in this formation is alternation between mudstone and quartz sandstone, which at some points contains coal and quartz conglomerates [13,14]. Several studies have led to various interpretations regarding the age and environment of Bayah formation (Figure 1). This formation has been attributed to Eocene - Oligocene age based on geological maps, Early Oligocene age based on palynomorphs such as *Florschuetzia trilobata*, *Monocalpites medius*, and *Verrumonoletes usmensis* spores, Late Eocene age based on foraminifera *Grobootalia crozulensis*, and Middle Eocene - Late Eocene age based on nannoplankton conformity [10, 14-18].

Depositional environment of this formation is in terrestrial environment from fluvial section based on rock lithology and nannoplankton conformity, but this formation was interpreted to be in transitional environment drawn based on foraminifera *Pyrro sp.* and *Rotalia cocoides* [10,12,14,18]. Overall, identification of age and depositional environment was carried out in the Bayah formation, whereas the Walat Formation had not been yet identified its age and environment, especially from palynological analysis.



**Figure 1:** Condition of Research area; a. Research location in relation to West Java, Indonesia; b. Research location in relation to geological map; c. Previous Research of Walat Formation Age

Coordinates of the study area are 06°56'51.52" South Latitude - 106°51'12.96" East Longitude to 06°56'28.83" South Latitude - 106°50'57.93" East Longitude, Sukadama village, Sukabumi Regency, West Java, Indonesia. These coordinates were used to obtain the Walat Formation rock layer (Figure 1).

Since there are different interpretations of age and depositional environment, this study aims to confirm the age and environment of Walat Formation using Palynomorph.

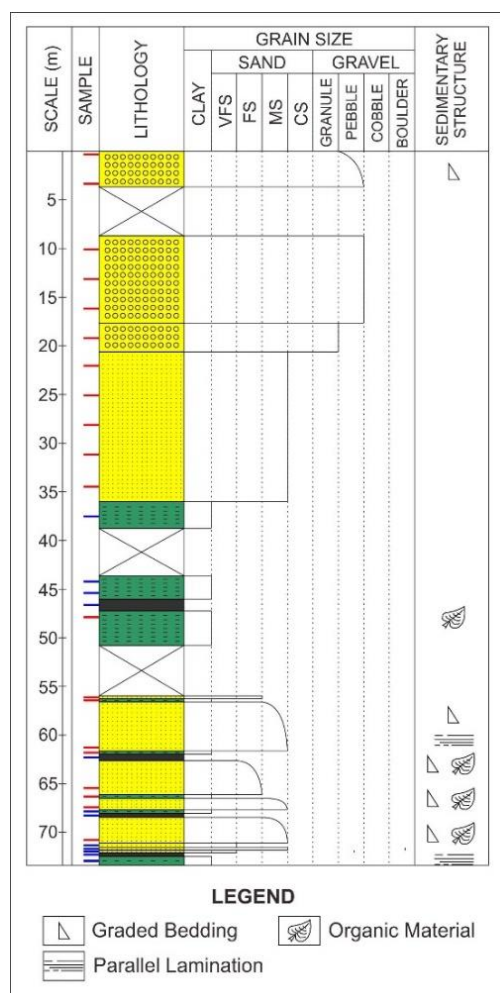
## 2.0. Material and Methods

Field measurements were carried out using measure section method and samples were taken at certain intervals representing the rock layers in study area [19-21]. Furthermore, the samples were prepared using chemical treatment method to separate palynomorphs from other materials [22-25]. This method was done by immersing the sample with various chemicals and neutralizing it with distilled water repeatedly so that the palynomorph material can be seen. The chemical liquids used in this method were HF 40%, HCl 10%, KOH 10%, Alcohol 70%, HCl 10% hot condition, HNO<sub>3</sub> 10% hot conditions, and KOH 10% hot conditions [26-30].

The finished palynomorph slides were analyzed to identify the pollen and spores present on the slide using Olympus CX-22 binocular microscope. Identification and determination of palynomorph material was done by matching characteristics and morphology pollen and spore from some Indonesian palynomorph references and pollen marker [6, 31-33]. Afterwards, the identified palynomorph were analyzed to show how the age and environment of Walat Formation [31, 34-39]. The age analysis was carried out by drawing biostratigraphic zones based on age range of pollen and spores present in the study sample, while the depositional environment was done by looking at the dominance of pollen which showed the characteristics of a depositional environment [40-45].

## 3.0. Results

The results of fieldwork revealed various layers of rock with 70 meters thick that have four main lithologies, namely coal, mudstone, very fine - medium quartz sandstones, and quartz conglomerates. At the bottom (old), alternating between coal, mudstone and quartz sandstone with sedimentary structures in the form of Graded Bedding, Organic Matter, and Parallel Lamination are found, while at the top (young) rocks dominated by quartz sandstones to quartz conglomerates with sedimentary structures in the form of Graded Bedding were found (Figure 2).



**Figure 2:** Stratigraphy of the study area. The blue line indicates the presence of palynomorphs, while the red line indicates the absence of palynomorphs

The results of preparation and identification of palynomorphs were found that each sample contained various palynomorph materials. Many research samples did not contain palynomorphs, influenced by the texture of rocks associated with the preservation of palynomorph material on various types of surface rocks. Coal was the sample with the most abundant palynomorph content in this study. From 32 samples prepared (R.1 - R.32), palynomorphs present in 12 samples including R.1, R.2, R.3, R.4, R.5, R.7, R.8, R.12, R.18, R.19, R. 20 , R.21, whereas for other 20 samples, palynomorph was not found (Figure 2).

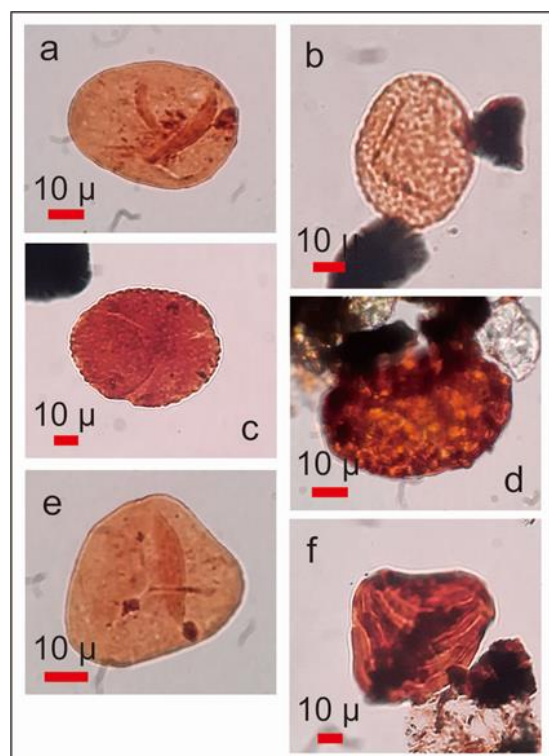
Palynomorphs in the study sample were very diverse, at least 1049 individuals from 24 types of palynomorphs identified in this study sample. The dominant palynomorphs in this study are *Proxapertites operculatus*, *Proxapertites cursus*, *Crassoretitrites vanraadshoveni*, and *Acrosticum* (Table 1).

**Table 1:** Palynomorph content of study area

Fossil Name	Total Fossil (%)
<i>Proxapertites operculatus</i>	69.1
<i>Proxapertites cursus</i>	10.6
<i>Acrosticum</i>	7.6
<i>Crassoretitriletes vanraadshoveni</i>	4.5
<i>Laevigatosporites</i>	2.1
<i>Dicolpopollis sp</i>	1.1
<i>Verrucatosporites usmensis</i>	0.8
<i>Pandaniidites</i>	0.7
<i>Palmaepollenites kutchensis</i>	0.5
<i>Spinizonocolpites echinatus</i>	0.5
<i>Florschuetzia trilobata</i>	0.4
<i>Bacculatusporites</i>	0.4
<i>Lanagiopollis nanggulaensis</i>	0.4
<i>Dipterocarpus intricatus</i>	0.3
<i>Spinizonocolpites prominatus</i>	0.2
<i>Cicatricosisporites eocenicus</i>	0.2
<i>Haloragacidites harrisii</i>	0.1
<i>Myrtaceidites</i>	0.1
<i>Podocarpidiites</i>	0.1
<i>Gothanipollis</i>	0.1
<i>Retistephanocolpites williamsi</i>	0.1
<i>Meyeripollis naharkotensis</i>	0.1
<i>Lycopodium cernuum type</i>	0.1
<i>Apocynaceae type</i>	0.1
<b>Total</b>	<b>100.0</b>

#### 4.0. Discussion

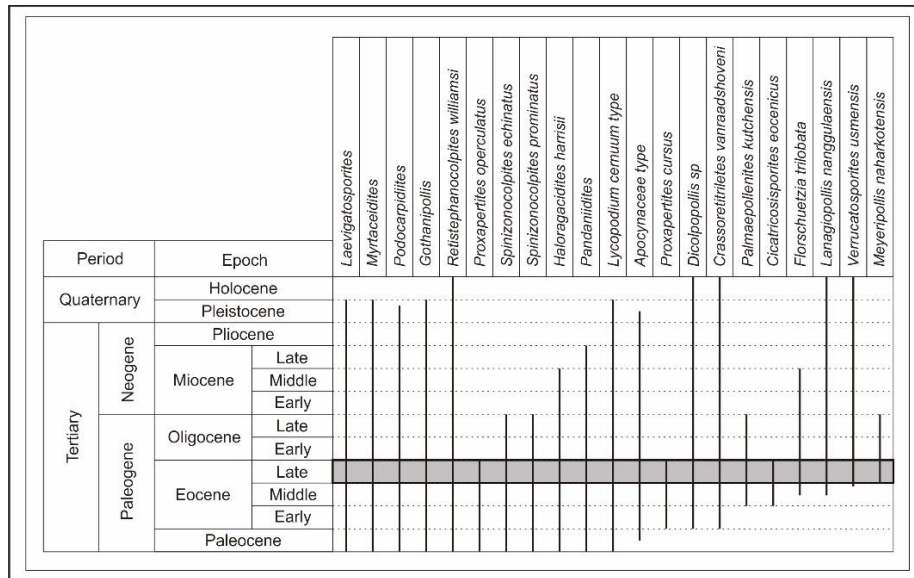
The research samples show many pollens from Eocene and Oligocene age (Figure 3). Important pollen marker in this formation was characterized by the presence of *Proxapertites Operculatus*, *Proxapertites cursus*, *Cicatricosisporites eocenicus*, *Verrucatosporites usmensis*, and *Meyeripollis naharkotensis*.



**Figure 3:** Identified pollen and spores; Pollen (a. *Proxapertites operculatus*, b. *Proxapertites cursus*, c. *Dipterocarpus intricatus*); Spores (d. *Crassoretitriletes vanraadshoveni*; e. *Acrosticum*, f. *Cicatricosisporites eocenicus*)

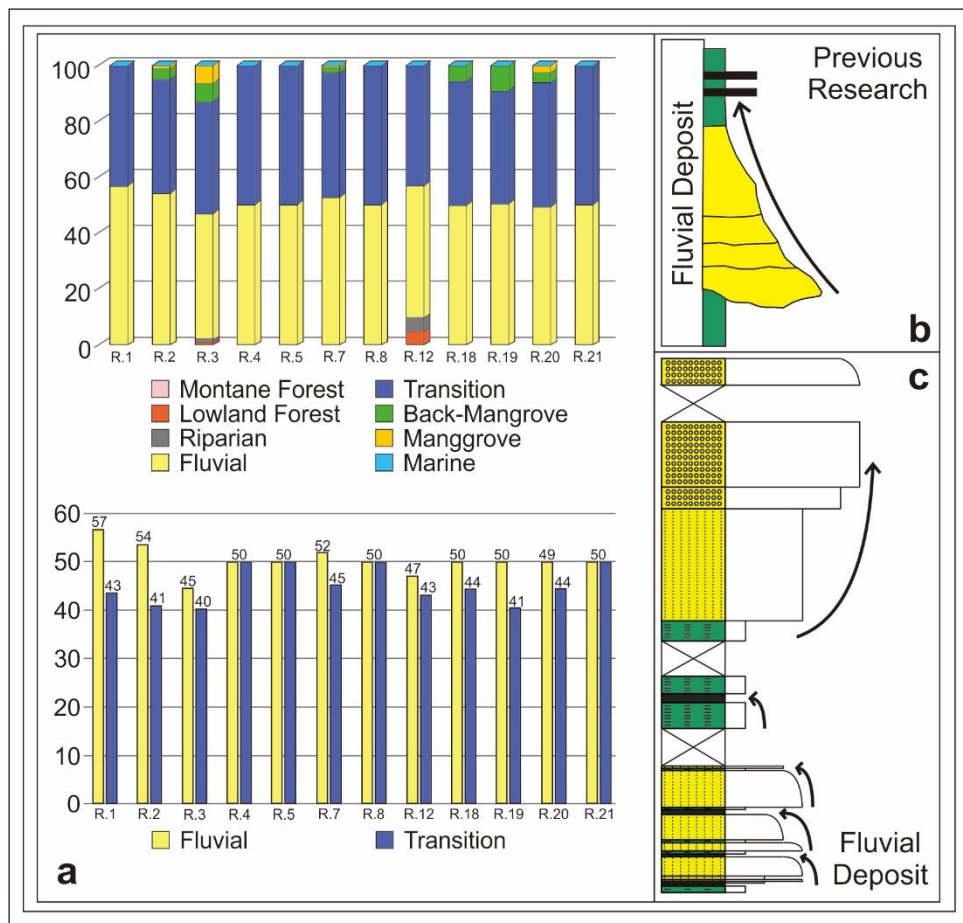
Basically, age of Walat Formation was identified deposited at Late Eocene age. It was drawn based on interval zone between the first occurrence of *Verrucatosporites usmensis* and *Meyeripollis naharkotensis* and the last occurrence of *Proxapertites operculatus*, *Proxapertites cursus*, and *Cicatricosisporites*

*eocenicus* (figure 4). Then, study sample had a dominance of genus *Proxapertites* which had appeared in Indonesia at the beginning of Tertiary and became extinct in Late Eocene both species *Proxapertites operculatus* and *Proxapertites cursus*.



**Figure 4:** Age of Walat Formation, Late Eocene through the interval zone between the genus *Proxapertites*, *Verrucatosporites usmensis* and *Meyeripollis naharkotensis* [34,35].

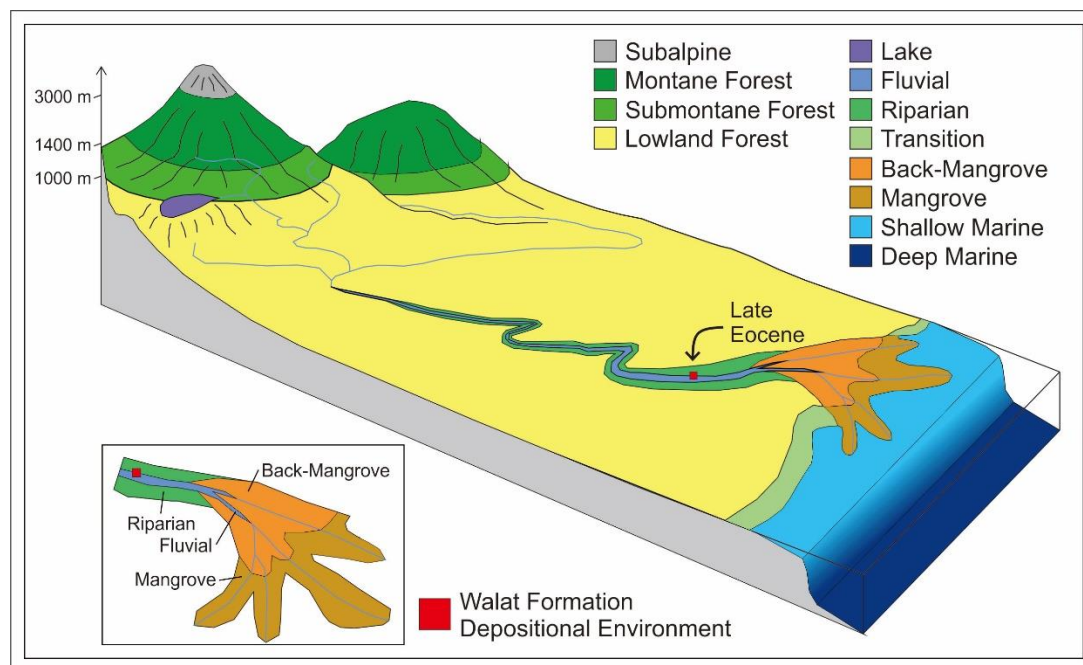
From previous studies which stated that the age of the Walat Formation was up to the Early Oligocene, the absence of dominant *Proxapertites* was identified so that interpretations of Walat Formation continued up to the initial Oligocene [10, 15-17]. Meanwhile, *Proxapertites* were very important palynomorph for Eocene age rocks, because they were extinct at the end of Eocene age. Then, some other studies mentioned this Formation began in the Middle Eocene, whereas, the discovery of pollen *Verrucatosporites usmensis* and *Meyeripollis naharkotensis* showed that Walat Formation began to be deposited not far from late Eocene because these two pollens only appeared at Eocene-Oligocene boundary age [14]. Therefore, this study confirms that the walat formation has a tendency to form in late Eocene age when viewed from palinological perspective which is slightly different from previous studies.



**Figure 5:** Deposition Environment of Walat Formation; a. Distribution of environment indicative palinomorphs in the study sample [35,46]; b. Lithological characteristics of fluvial deposit from previous research [13, 47]; c. Lithological characteristics of Walat Formation can be compared to previous research



The depositional environment of particular formation can be seen from the palynomorph content present in a research sample. Walat Formation was deposited in terrestrial areas as indicated by the absence of marine palynomorphs such as dinocysts or foraminifera lining tests with high pollen and spores from terrestrial areas. From Palynomorph analysis, the graph shows that Walat Formation has tendency of terrestrial depositional environment in fluvial which is characterized by the dominance of *Proxapertites operculatus*, and *Proxapertites cursus*, but several samples show that Walat Formation still has influenced pollen from the transitional environment marked by the genus *Spinizonocolpites*. Whereas in other samples, pollen showed the same amount of transition pollen and fluvial pollen in the study sample (Figure 5). When viewed from characteristics of rocks, Walat Formation has similarity to fluvial deposits from previous research, where lithological characteristics tend to alternating between sandstones, mudstones, and coal [13, 47]. In addition, the presence of graded bedding and parallel lamination sedimentary structures increasingly shows the formation of sediment in the fluvial environment. Therefore, it can be seen that Walat Formation has terrestrial depositional environment region precisely in fluvial environment which is slightly affected by the transition region or close to the transition conditions (Figure 5).



**Figure 6:** Walat Formation depositional environment model [48]

Some studies suggested that Walat Formation is deposited in a fluvial and transition environment [10,12, 14, 18]. From the results of palynomorph analysis and lithological characteristics, Walat Formation has primary depositional environment at fluvial which is affected by the presence of transition environment or is near the transition environment. Thus, the transition pollen was also found in smaller amounts compared to the pollen originating from the fluvial environment. Therefore, the interpretation of walat formation depositional environment is interpreted to be fluvial which is similar to the results of previous studies using other types of analysis. The location of the depositional environment and age of Walat Formation can be seen in the model (Figure 6).

## 5.0. Conclusion

Walat Formation has rock lithology in the form of alternation between coal, mudstone and quartz sandstone at the bottom, and turned into quartz sandstone and quartz conglomerate at the top with graded bedding, organic matter, and parallel lamination sedimentary structures. Palynomorph analysis shows that Walat Formation is deposited in fluvial environment that is affected by the transition or close to the transition, with Late Eocene age.

## 6.0. Acknowledgement

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