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# IDENTIFIKASI PALINOFASIES PADA SAMPEL K4 DAN K5, PROFIL PREMBAN, FORMASI JATEN, DAERAH DONGKO, TRENGGALEK, JAWA TIMUR

## PALYNOFACIES IDENTIFICATION ON SAMPLES K4 AND K5, PREMBAN PROFILE, JATEN FORMATION, DONGKO AREA, TRENGGALEK, EAST JAVA

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***Abstrak***— Wilayah utara Jawa Timur dikenal sebagai salah satu daerah penghasil minyak dan gas bumi terbesar di Indonesia, menjadi lokasi operasi bagi banyak perusahaan migas nasional maupun internasional. Akan tetapi, hingga saat ini kegiatan eksploitasi sebagian besar masih terpusat di bagian utara. Padahal, wilayah selatan Jawa Timur juga menunjukkan berbagai manifestasi potensi sistem petroleum, seperti adanya singkapan serpih yang mengandung hidrokarbon biogenik di Kecamatan Dongko, Kabupaten Trenggalek. Untuk mengeksplorasi potensi hidrokarbon secara lebih terperinci, dilakukan identifikasi palinofasies berdasarkan komposisi kerogen pada batuan sedimen. Analisis komposisi kerogen telah dilakukan pada sampel K4 dan K5 yang berasal dari profil singkapan permukaan Formasi Jaten yang berumur Miosen Tengah. Berdasarkan studi sebelumnya, kedua sampel diendapkan pada lingkungan mangrove. Hasil identifikasi palinofasies menunjukkan bahwa sampel K4, dengan ciri litologi batupasir halus–sangat halus yang bersifat karbonatan, diendapkan pada lingkungan yang lebih jauh dari sumber material organik (lingkungan *lower deltaic plain*). Sebaliknya, sampel K5, dengan ciri litologi serpih hitam berukuran lanau–lempung, diendapkan pada lingkungan yang lebih dekat dengan sumber material organik (lingkungan *upper deltaic plain*). Meskipun memiliki lingkungan pengendapan dan ukuran butir yang berbeda, komposisi material organik pada kedua sampel adalah sama, yaitu terdiri atas inertinit, vitrinit, dan eksinit.

***Kata kunci***: analisis kerogen, Formasi Jaten, minyak dan gas bumi, *palinofasies*

***Abstract***— The northern region of East Java is a significant oil and gas-producing area in Indonesia, attracting numerous national and international companies. However, exploration and exploitation have historically been concentrated in this northern part, while the southern region also shows promising petroleum system indicators. One such indicator is the presence of shale outcrops containing biogenic hydrocarbons in the Dongko District, Trenggalek Regency. This study aims to characterize the hydrocarbon potential of this southern region through palynofacies analysis, which identifies kerogen composition in sedimentary rocks. Two samples, K4 and K5, from a surface outcrop profile of the Miocene-aged Jaten Formation were analyzed. Both samples were previously determined to have been deposited in a mangrove environment. Palynofacies analysis revealed distinct depositional settings. Sample K4, characterized by fine to very fine-grained calcareous sandstone, was deposited in a lower deltaic plain environment, distal to the primary source of organic material. In contrast, Sample K5, a black shale with silt to clay-sized grains, was deposited in an upper deltaic plain environment, proximal to the organic source. Despite the different depositional environments and grain sizes, both samples contain the same types of organic material: **inertinite, vitrinite, and exinite**. This analysis provides a more detailed understanding of the hydrocarbon potential in the underexplored southern region of East Java.

**Keywords**: kerogen analysis, Jaten Formation, oil and gas, palynofacies

# I. INTRODUCTION

The study area is located in the Dongko District, Trenggalek Regency, East Java Province, which lies within the Southern Mountain Range (Figure 1). East Java is a major oil and gas-producing province in Indonesia; however, exploration and exploitation activities have historically been concentrated in the northern region. This focus is partly attributed to the geology of southern East Java, which is characterized by hilly terrain composed of sub-volcanic rocks from past volcanic activity [1]. Nevertheless, the Southern Mountain Range exhibits indicators of a potential petroleum system, such as shale outcrops containing biogenic hydrocarbons in the Dongko District [2]. The rock units in this area are identified as the Jaten Formation, according to the Regional Geological Map of the Pacitan Sheet [1].

Previous research on the Jaten Formation has addressed its geology and sandstone provenance [3], depositional environment [4], palynological stratigraphy [2] pollen and spore diversity [5], and estuarine facies with sandstone characteristics [6]. Despite these studies, a dedicated palynofacies analysis to determine the kerogen composition of its sedimentary rocks has not yet been conducted.

Analyzing the composition of organic material, specifically kerogen, is crucial for reconstructing depositional environments. This analysis helps characterize the organic components and infer the depositional distance from the source material. Therefore, this study aims to conduct a palynofacies analysis to provide a more detailed assessment of the hydrocarbon potential within the Jaten Formation in the study area.

# II. REGIONAL SETTING

According to the regional geological maps of the Pacitan Sheet[1], Blitar Sheet [7], Lumajang Sheet [8], and Tulungagung Sheet [9] the regional stratigraphy is characterized by a repeating sequence of quartz sandstone, claystone, and conglomerate. These layers are intercalated with lignite, tuff, and occasional limestone. The fossil assemblage within the limestone—including corals, algae, echinoid spines, *Lepidocyclina* sp., *Globigerinoides trilobus* (REUSS), *Sphaeroidinellopsis* sp., and *Planorbulina* sp.—indicates a Miocene age.

The Jaten Formation is assigned a **Late Early Miocene age** based on its stratigraphic position overlying Early Miocene carbonate rocks and its correlation with similar units in the Pacitan Sheet. The depositional environment is interpreted as transitional to terrestrial, influenced by reducing conditions, and extending into shallow marine or lagoonal settings [10]. The Jaten Formation conformably overlies the Campurdarat Formation, though it exhibits a laterally intertonguing relationship.

# III. METHOD

Rock samples representing the Jaten Formation were collected from a 2.5-meter-long outcrop profile. Sampling was conducted at six distinct points along this profile, selected based on variations in grain size and distinct lithological boundaries.

Kerogen preparation was performed at the Palynology Laboratory, Bandung Institute of Technology. The process focused on fine-grained, dark-colored sediments and followed standard acid maceration techniques [11] [12]. Prepared kerogen slides were analyzed using a binocular transmission microscope at magnifications ranging from 400x to 1000x [5]. Palynofacies classification followed several established schemes. The relative proportions of Palynomaceral (PM), Amorphous Organic Matter (AOM), and palynomorphs were determined based on the Corelab (unpublished) classification. Kerogen type, constituent macerals, and organic material origin were identified following the methodology of [13]; while quantitative analysis was conducted using the percentage model described by [14]. Age determination and depositional environment interpretations were based on the findings of previous research [2].

# IV. RESULT

## *A. Sedimentological Analysis*

Sedimentological analysis was conducted at six observation points. The Jaten Formation in the study area is composed of lithologies including calcareous siltstone with intercalations of calcareous sandstone, calcareous sandstone, black shale, and gravelly sandstone in the uppermost part (Figure 2). The calcareous siltstone exposed in the study area is characterized by a gray color, silt-sized grains (0.004–0.0625 mm), and carbonate cement. The calcareous sandstone has a dark gray color, very fine to fine sand-sized grains (0.0625–0.25 mm), carbonate cement, and carbonate fragments.

The black shale is black on fresh surfaces, with weathered surfaces turning yellowish-brown. Its grain size ranges from silt to clay (<0.0625 mm), and it exhibits a charcoal-like luster and a fissile texture. The gravelly sandstone is light gray when fresh and weathers to a yellowish-brown. Its grain size ranges

from medium sand to gravel (0.25–4 mm); the grains are sub-rounded to sub-angular, poorly sorted, and have open packing. The fragments consist of plagioclase, quartz, hornblende, and lithic material within a matrix composed of very fine sand to silt. The unit is cemented by silica and contains carbonate lenses and flaser bedding sedimentary structures.

### *B. Age and Depositional Environment*

The age and depositional environment of the study area were previously determined using the palynological method [2] The results indicate that the Jaten Formation is assigned to the Early to Middle Miocene, corresponding to Zone N6–N16 [15] (Figure 2). Deposition occurred in a transitional environment, specifically a back-mangrove to mangrove setting. Based on these data, samples K4 and K5 were deposited during the Middle Miocene in a mangrove environment.

### *C. Palynofacies Analysis Jaten Formation*

The results of the kerogen analysis for samples K4 and K5 are as follows:

1) Sample K4
   Based on maceral observations, there is a low abundance of organic material, with an approximate composition of 5–7% PM1, 3% PM2, 2% PM3, 1–3% PM4, 1% AOM (Amorphous Organic Matter), and 1% sporomorphs. The material size ranges from very small to medium, with sub-angular to sub-rounded shapes and very poor sorting (Figure 3). The percentage of structured maceral components is 7.07%, while non-structured maceral components account for 92.93%. The composition of the organic material includes inertinite, vitrinite, and exinite (Table 1).
2) Sample K5
   Based on maceral observations, there is a high abundance of organic material, with an approximate composition of 5–7% PM1, 20% PM2, 3% PM3, 10% PM4, 1% AOM (Amorphous Organic Matter), and 1% sporomorphs. The material size ranges from small to large, with sub-angular to angular shapes and moderate sorting (Figure 4). The percentage of structured maceral components is 31.31%, while non-structured maceral components account for 68.69%. The composition of the organic material includes inertinite, vitrinite, and exinite (Table 1).


Figure-1. Study of area

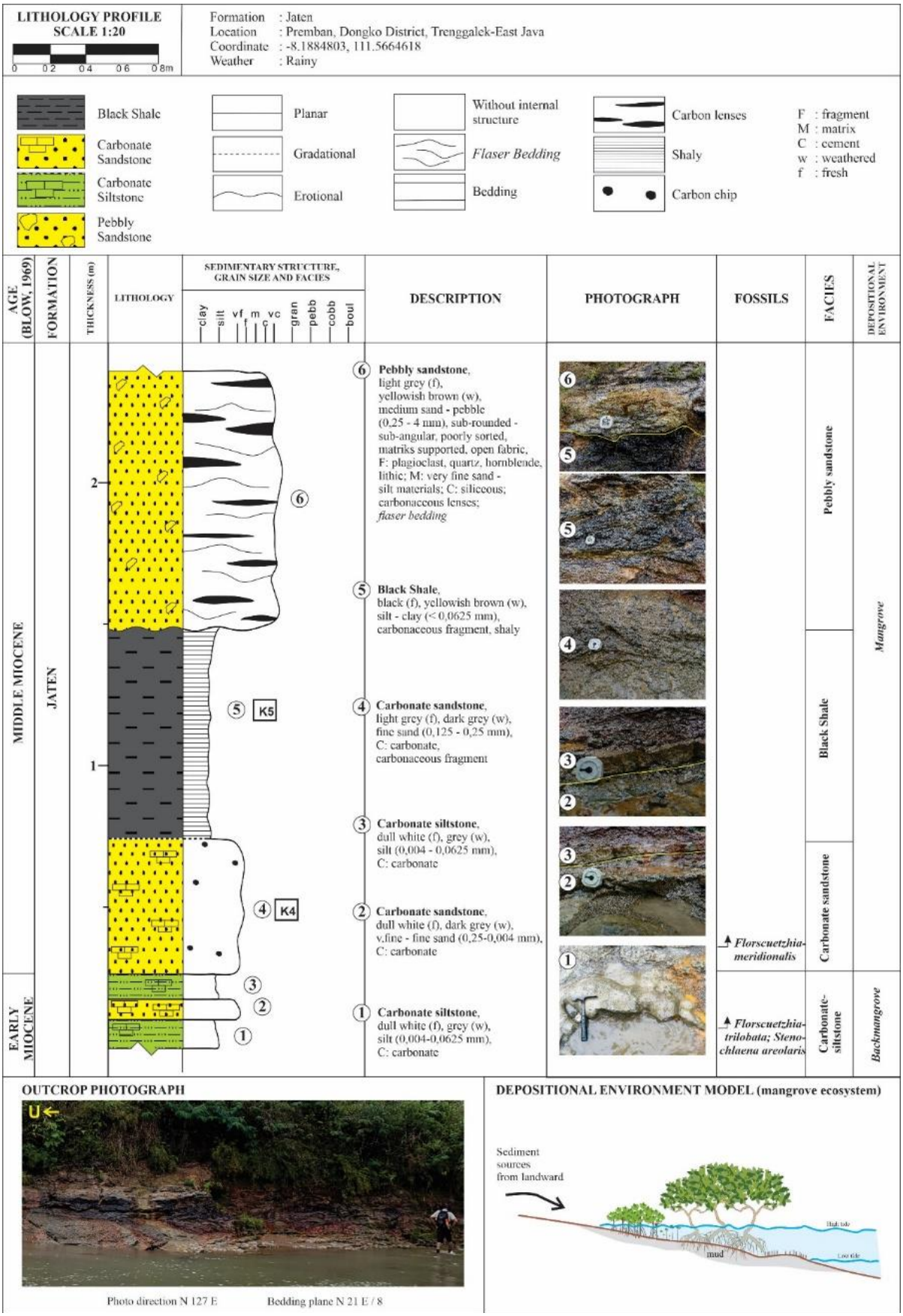


**Figure-2.** Lithological Profile of the Study Area

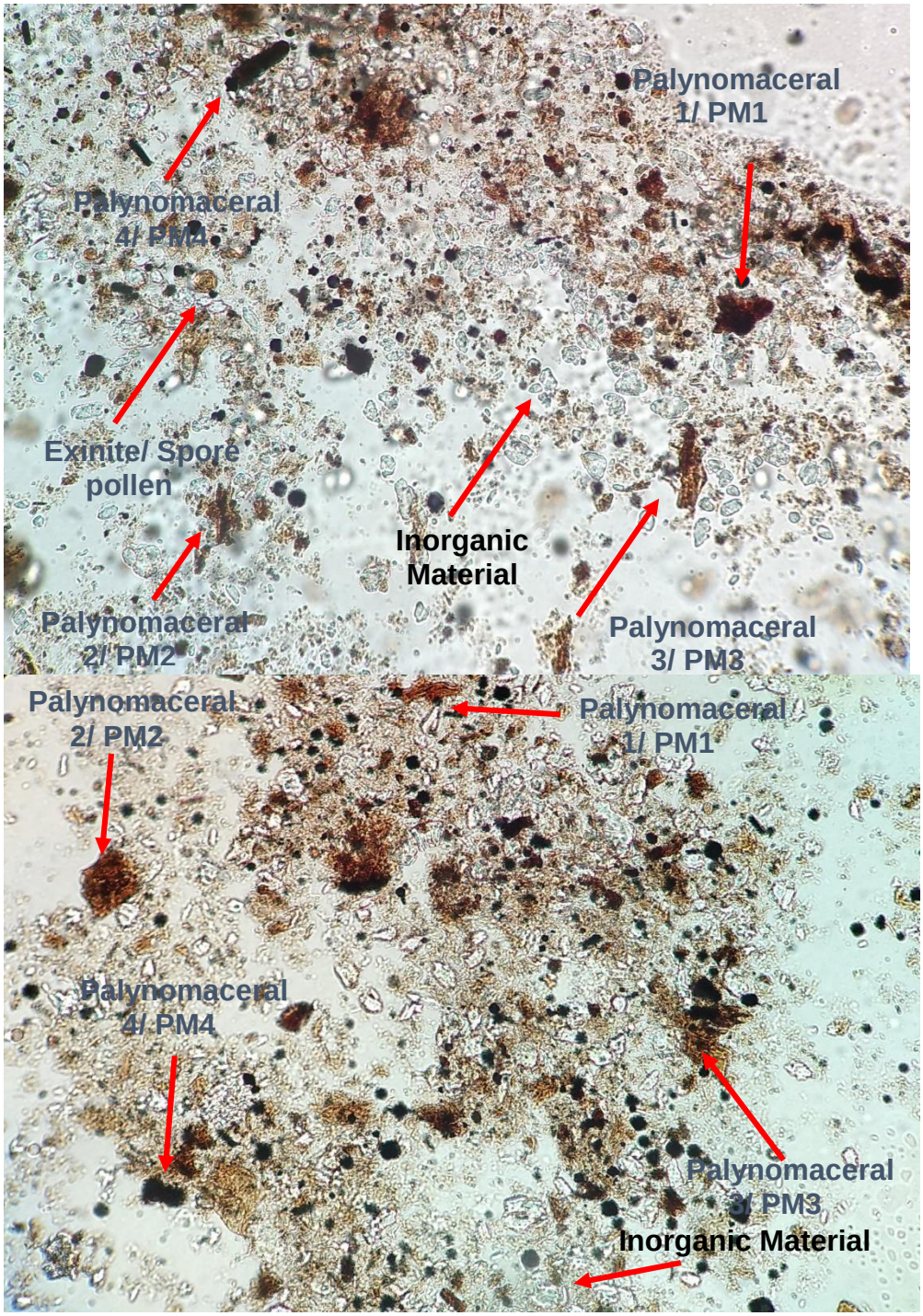


**Figure-3.** Photo of Kerogen Sample K4

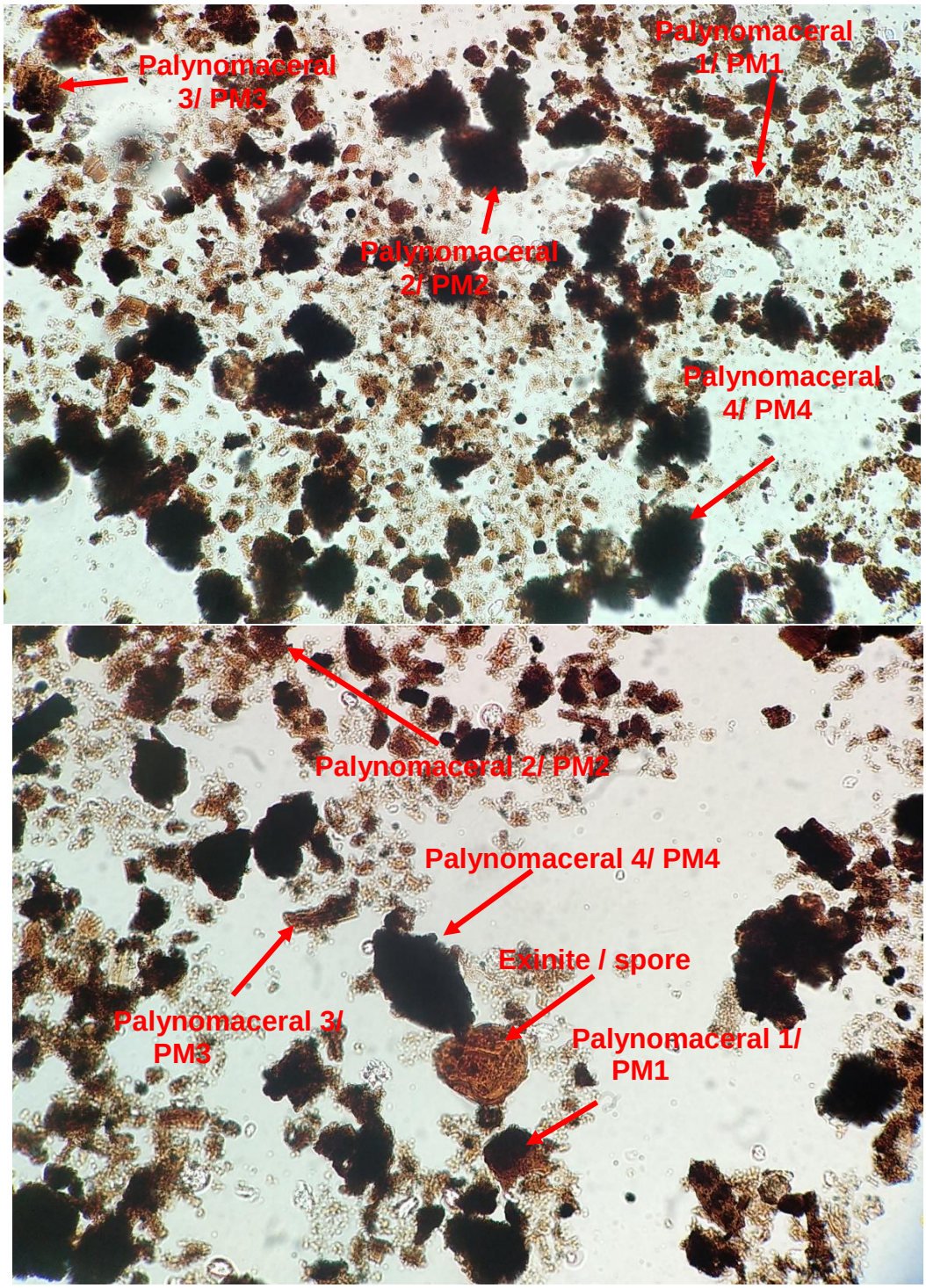


**Figure-4.** Photo of Kerogen Sample K5

The percentage of structured maceral components is 31.31%, while non-structured maceral components account for 68.96%. The composition of the organic material includes inertinite, vitrinite, and exinite (Table 1).

**Table-1**. Kerogen type, constituent macerals, and origin of organic material. [13]

| Maceral | Kerogen Type | Original OM |
|---|---|---|
| Alginite | I | Fresh-water algae |
| Exinite | II | Pollen, spores |
| Cutinite | II | Land-plant cuticle |
| Resinite | II | Land-plant resins |
| Liptinite | II | All land-plant lipids; marine algae |
| Vitrinite | III | Woody and cellulosic material from land plants |
| Inertinite | IV | Charcoal; highly oxidized or reworked material of any origin |

### *D. Discussion*

Lithological data show that sample K4 is characterized by a very fine to fine-grained, dark gray carbonaceous sandstone. Sample K5 is characterized by black shale with silt to clay-sized grains. According to previous research, both samples are of Middle Miocene age and were deposited in a mangrove environment. Palynofacies identification from the kerogen analysis of samples K4 and K5 indicates that sample K4 was deposited in an environment more distal to the source of organic material compared to sample K5.

This is evident from the higher percentage of structured maceral components in sample K5 (31.31%) compared to K4 (7.07%). Conversely, the percentage of non-structured maceral components in sample K4 is higher (92.93%) than in sample K5 (68.69%). Non-structured maceral components are the degraded products of structured macerals, which can result from bacterial activity or physicochemical processes during transportation and sedimentation. Sample K4 reflects a greater transportation distance from the source of organic material and is dominated by a very low abundance of organic matter. Sample K5 represents a depositional environment more proximal to the source of organic material. This is indicated by the organic material size, which ranges from small to large with a dominance of larger particles.

## V. CONCLUSION

This study concludes that sample K4 was deposited in a mangrove environment within the lower deltaic plain, characterized by fine to very fine-grained carbonaceous sandstone. In contrast, sample K5 was deposited in a mangrove environment within the upper deltaic plain, characterized by black shale with silt to clay-sized grains. Both samples K4 and K5 have the same composition of organic material, namely inertinite, vitrinite, and exinite, although their constituent material sizes differ.

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