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RESEARCH ARTICLE

Characterization Coal of The Warukin Formation in Kananai Village, South Barito, Central Kalimantan, Indonesia

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Abstract

This research was conducted to identify geological conditions and the influence of maceral composition on the quality and rank of coal in the study area, which is divided into four rock units. The method used is surface geological mapping to describe the local geological conditions, as well as laboratory analysis which includes maceral analysis, vitrinite reflectance, proximate, and calorific value. The focus of the research is on the unit bedding of mudstone and sandstone with Coal (Warukin Formation) which is a coal-bearing unit. The results of the analysis show that the coal in the study area has the highest rank with an average vitrinite reflectance value (Rv%) of 0.55, the calorific value of 6896 cal/gr, and coal rank is included in the high volatile bituminous C category.

Keywords: Geology**,** Coal, Warukin Formation, Characteristics.

1. Introduction

National Standardization Agency in SNI (1997) Coal is a sediment that contains the accumulation of organic material derived from the remnants of plants that have gone through a lithification process to form coal seams. The material has undergone compression, chemical alteration and metamorphosis processes by increasing heat and pressure during the geological period. Organic materials contained in coal seams have a weight of > 50% by volume of organic materials.

Coal is still one of the main energy sources in Indonesia, one of the largest coal-producing areas in Indonesia is the island of Kalimantan. Kalimantan is one of the regions with the largest coal reserves in Indonesia. The coal found in this region has diverse characteristics, depending on its geological location, formation conditions, and factors in the surrounding environment. Understanding the characteristics of coal is very important in determining the quality, utilization, and environmental impact of coal exploitation

The study area is included in the Barito Basin, administratively in Kananai village, Gunung Bintangawai sub-district, South Barito district, Central Kalimantan . The study area is included in the Barito Basin. The Barito Basin, developed in the region, has long been exploited for its coal content. A well-known coal-bearing formation in the Barito Basin is the Warukin Formation. Based on Sutrisno et al 1994, the Warukin Formation of the Middle Miocene - Upper Miocene age is composed of lithologies such as mudstone, sandstone, and coal.

To analyze the characteristics of the coal in the study area, proximate analysis (moisture, volatile matter, fixed carbon, ash), calorific value, coal maceral, reflectant vitrinite, and reflectant vitrinite were conducted.

2. Regional Geology

Kalimantan Island was formed by tectonic elements consisting of continental plates and oceanic plates Arifullah (2004, in Heryanto 2010). Tectonic activity began in the Jurassic period, which resulted in the mixing of ultramafic rocks and malachite rocks. At the beginning of the Cretaceous period or earlier, there was intrusion of granite and diorite that cut ultramafic and malleable rocks (Sikumbang & Heryanto, 1994). Based on Satyana (2007 in Heryanto, 2010), the Paternospheric Platform from the east moves to infiltrate under the Schwaner Continent, causing ultramafic slabs that are part of the Meratus orogen formed in the Early Cretaceous to Middle Cretaceous Collision. This group is known as the Late Pre-Cretaceous Stratigraphic Group, which underwent upward faulting since the Jurassic to Early Cretaceous periods.

The Meratus Mountains have been uplifted since the Late Cretaceous, resulting in the Tertiary Stratigraphic Group being unconformably overlain on top of the Late Cretaceous Stratigraphic Group. Normal faulting that occurred since the early Paleogene marked the formation of the Barito Basin in the lower block, and this faulting process continued until the Miocene period.

The tectonic setting of Borneo Island by (Nuay, 1985) is divided into 12 units, namely: Sunda Shelf, Mangkalihat Mountains, Paternoster Platform, Kuching Plateau, Meratus Plateau, Sampurna Plateau. Melawi-Ketengau Basin, Tarakan Basin, West Kalimantan-Sea Basin, Barito Basin, Asem-asem Basin and Kutai Basin. (Fig. 1).

The Barito Basin physiographically occupies the western flank of the Meratus Plateau. Heryanto (2010) separates the Barito Basin's stratigraphy into three groups: Pre-Cretaceous, Late Cretaceous, and Tertiary. The Pre-Cretaceous group is composed of ultramafic rocks bordered by rocks of Late Cretaceous age with unit boundaries in the form of faults. (Fig. 2).

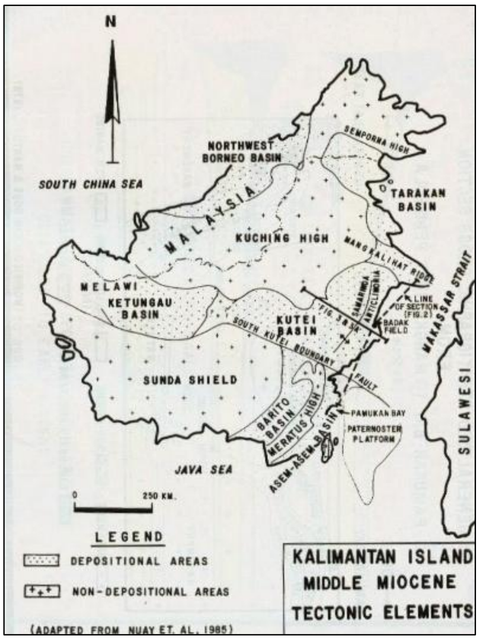


Fig. 1: Tectonic Structure of Kalimantan Island (Nuey, 1985)

The Barito Basin is an asymmetric basin, formed in the eastern foredeep and a platform adjacent to the Schwaner or Shield of West Kalimantan. The Barito Basin began to form in the late Cretaceous, along with the collision between the Paternoster and SW Borneo microcontinent (Satyana, 1999). The study area belongs to the Kucing Plateau tectonic unit, namely the Barito Basin, which began to form in the Late Cretaceous. (Satyana and Silitonga, 1994).

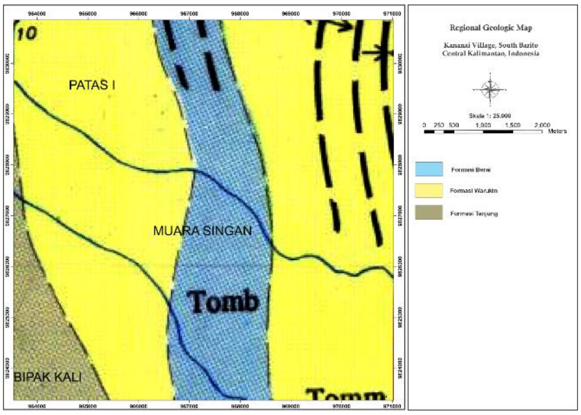


Fig. 2: The research area in the Geological Map of Buntok (Soetrisno, S. et al, 1994)

In general, the tectonic and stratigraphic conditions in the Barito Basin can be described in 4 main phases (Satyana, and Silitonga, 1994). These four tectonic phases are the Pre Rift phase, this phase is a tectonic complex that occurs in the basement at the base of the Basin, the Synrift Phase of the rifting process in the Barito Basin at the Paleocene-Middle Eocene time, the Syn Inversion Phase, at the Middle Miocene time resulting in reactivation and inversion process of old faults in the Barito Basin. The inversion process phase in the Basin at the early Pliocene time of the Meratus Mountains-Proto uplift caused the Barito Basin to be separated by the marine environment so that the sedimentation cycle that was previously transgression turned into a regression cycle.

The Meratus Mountains have been uplifted since the Late Cretaceous, resulting in the Tertiary Stratigraphic Group being unconformably overlain on top of the Late Cretaceous Stratigraphic Group. Normal faulting that occurred since the early Paleogene marked the formation of the Barito Basin in the lower block, and this faulting process continued until the Miocene period.

The research area based on the Geological Map of the research area is included in the Regional Geological Map of Buntok sheet No. 1714, with a scale of 1:250,000 (Soetrisno, S. et al, 1994).

One of the coal-bearing formations in the Barito Basin is the Warukin Formation of Middle Miocene - Upper Miocene age. Regionally, the structure developed in the study area shows an anticline fold structure that is almost north-south oriented (Soetrisno et al., 1994). Warukin Formation with constituent lithology in the form of sandstone alternating claystone with coal inserts (Kusuma and Darin 1989), with Rv max 0.34-0.54, Moisture 8.53-10.26, calorie value 4847-5853 adb, total sulfur 0.13-1.01 adb (Kusnadi, D,. 2015).

The Warukin Formation, composed of Quartz Sandstone, Claystone and Coal, was deposited in a fluviatile to deltaic environment, aged Middle Miocene to Late Miocene. The Warukin Formation can be divided into three parts (Satyana, 1994, and Heriyanto et al., 1996). The lower part of the Warukin Formation is composed of sandstone with melanized claystone, the middle part is composed of sandstone, claystone and coal, the upper part is composed of thick coal beds, thinly layered claystone and sandstone, and lens claystone.

3. Methodology

The research method carried out in the research area consists of several stages, namely literature review, field measurements, and laboratory analysis.

Literature review, some geological reports that have been published about the research area and its surroundings published by several previous researchers. Measuring and collecting surface geological data conducted at the research location in Kananai village. Conducting laboratory tests using 4 (four) coal samples found in the research area. Laboratory tests carried out include coal petrographic analysis, which includes coal maceral analysis, vitrinite reflectance, and calorific value.

Coal petrographic analysis seeks to assess the characteristics of macerals found in coal. This analytical procedure starts with the manual grinding and sieving of coal through 16 mesh and 20 mesh screens. The coal particles that lie between the -16 mesh and +20 mesh sieves are selected for further petrographic study. This coal fraction is blended with resin powder, known as transoptic powder, at an equal weight ratio of 1:1, then placed into a mold and subjected to heating at 200 degrees Celsius. Once the temperature rises to 200 degrees Celsius, the heater is switched off, and pressure is applied to the mold at 2000 psi. The briquette can be extracted once it cools to room temperature. The following step entails polishing the briquette, beginning with cutting it using a grinder-polisher, followed by smoothing with 800 mesh and 1000 mesh silicon carbide on a glass surface. Subsequently, the polishing continues on silk cloth.

Microscopically, coal-forming organic materials are called macerals. This term was originally introduced by Stopes (1935) to indicate the smallest coal-forming material that can only be observed under a microscope.

Macerals are divided into 3 main groups, namely huminite (vitrinite), exinite (liptinite), and inertinite. The three maceral groups can be distinguished from the appearance under the microscope, plant origin, and physical and chemical properties (Stach et al., 1982 Bustin et al., 1983).

The classifications are inertinite, liptinite, and vitrinite. These categories have been established based on their shades of gray when viewed in reflected light through a microscope. Liptinites exhibit a dark gray color, vitrinites range from medium to light gray, while inertinites appear white and can be exceptionally bright..

Various macerals originate from distinct plant components or various remnants of plant parts that have been decomposed by bacterial, chemical, or physical processes. Each group of macerals, along with individual macerals, possesses unique chemical structures that collectively affect the overall chemical makeup of the coal produced (Stach, 1982; Bustin 1983; and Teichmüller, 1989).

Vitrinites consist of wood, bark, and roots that are somewhat "gelatinous," with a lower hydrogen content compared to liptinites. Liptinites originate from spores, pollens, cuticles, and resins found in the parent plant matter. These components are richer in hydrogen than various other macerals. Additionally, they exhibit fluorescence in certain coal grades. Inertinites are primarily the result of the oxidation of various macerals, making them more carbon-dense compared to liptinites or vitrinites, as a significant portion of the oxygen found in the initial plant components or leftovers has been utilized during the oxidation process. The category of inertinite consists of fusinite, which is largely fossilized charcoal, originating from ancient combustion events in the peat that eventually led to coal formation (refer to Scott, 1989 for further details). Other types of inertinite macerals, such as macrinite, arise from the biological breakdown and decomposition of plant materials (Hower and others, 2009). Additionally, some inertinites, like micrinite, are formed through the thermal maturation processes occurring in the peat.

Maceral classification naming standards: German standard, International Committee for Coal Petrology (ICCP) 1975; 1994. Australian standard AS 2856 1986 (Table 1)

Table 1: Coal Maceral Classification (AS 2856, 1986)

Maceral Group	Maceral Subgroup	Maceral
Vitrinite (Huminite)	Telovitrinite (Humotelinite)	Textinite
		Texto-ulminite
		Eu-Ultiminite
		Telocolinite
	Detrovitrinite (Humodetrinite)	Attrinite
		Densinite
		Desmocollinite
	Gelovitrinite (Humocolinite)	Corpogelinite
		Porigelinite
		Desmocollinite
Liptinite (Exinite)		Sporinite
		Cutinite
		Resinite
		Liptodetrinite
		Alginite
		Suberinite
		Fluorinite
		Exsudatinite
		Bituminite
Inertinite	Telo- Inertinite	Fusinite
		Semifusinite
		Sclerotinite
	Detro-Inertinite	Inertodetrinite
		Micrinite
	Gelo-Inertinite	Macrinite

Various macerals emerge from distinct components of plants or from diverse remains of plant parts that have undergone bacterial, chemical, or physical decomposition. Each group of macerals, along with specific macerals, possesses unique chemical structures that collectively influence the overall chemical makeup of the coal produced (Stach and others, 1982; Bustin and others, 1983; Teichmüller, 1989).

Vitrinite reflectance serves as a key metric for assessing the quality or rank of coal. An increase in the vitrinite reflectance value signifies a superior rank of coal, which reflects a greater level of organic maturity. Vitrinite reflection represents a widely accepted technique for measuring the degree of coalification, or maturation, that coal or similar organic materials have experienced. Reflectance measurements contribute to various global coal classification frameworks. Vitrinite reflectance is often utilized to validate rank evaluations obtained from calorific values, volatile material percentages, and fixed carbon levels. The protocols for analyzing vitrinite reflectance in coal samples are outlined in the ASTM method D2798-11 published by the American Society for Testing and Materials in 2013, pages 474-478.

Calorific value refers to the energy generated from the combustion of coal. Coal that has a high calorific value is considered to be a more effective energy source. Coal samples are air-dried to reduce surface moisture. The samples are ground to a specific size (212 µm or 60 mesh sieve). The samples are dried at a specific temperature (usually 105°C – 110°C) to determine the moisture content. The dried coal sample is weighed and placed in a bomb calorimeter. Combustion is carried out in a sealed chamber containing high-pressure oxygen. The resulting data is the calorific value in kcal/kg. Coal rank refers to the degree of maturity of coal formed due to the pressure and temperature experienced during the formation process. Rank is closely related to the carbon and energy content of coal, and is divided into categories such as lignite, sub-bituminous, bituminous, and anthracite. By doing the following stages of analysis, the characteristics of coal in the research area can be known.

4. Geology of the research area

Based on field analysis of the study area, there are 3 (three) geomorphological characteristics showing landforms with plains and hills extending north to south. The hills and plains are fold structures in the form of anticlines and synclines that have experienced flattening due to exogenous processes in the form of intensive erosion or denudation. It is concluded that the research area forms morphology in the form of: (1) Folded hills geomorphology, (2) Intrusion hill geomorphology, (3) Alluvial plain geomorphology.

The rock units found in the research area based on lithostratigraphy are divided into 4 (four) units from old to young, the Limestone Rock Unit inserted Claystone (Berai Formation) deposited in a shallow marine environment (backreef) at the age of early Oligocene - Late Oligocene or Tc-Te4. In the Early Miocene Period, a sandstone rock unit layered with claystone inserted coal (Warukin Formation) was deposited in a transitional environment (Upper Delta Front) then volcanism activity occurred which was not aligned to form the Rhyolite Rock Unit at the age of Pliocene and then above it formed an alluvial sedimentary rock unit bounded by an erosion field. (Fig. 3)

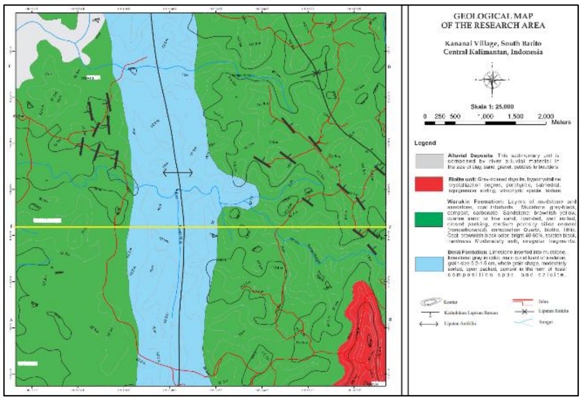


Fig. 3: Geological map of the research area

5. Coal Analysis Of The Research Area

The results of the analysis of coal characteristics in the research area based on 4 (four) coal samples used in laboratory tests in the form of coal petrography and coal calories.

Coal consists of various microscopic elements. To discern certain qualities of coal, a close-up assessment known as petrography may be necessary, which falls under the broader category of petrology. The specialists who analyze coal using a microscope are referred to as coal petrographers. In a specific method of petrography, coal is pulverized into fine dust, mixed with epoxy resin, and poured into molds to create pellets. These pellets are subsequently polished and scrutinized under a microscope utilizing reflected or incident lighting. Additionally, coal can be sliced into fine segments, similar to techniques used in mineral and rock petrography. A thin section represents a sample that has been meticulously cut, then affixed onto a thin glass slide with epoxy. Following this, the surface of the sample is ground down and polished until light can permeate through both the glass and the sample, enabling petrographers to observe intricate details within the specimens.

Petrographic analysis of coal from thin sections or pellets serves various analytical purposes. Vitrinite reflectance: This method assesses the coal's rank and the extent of thermal evolution of hydrocarbon source rocks. Maceral composition: This technique evaluates the relative prevalence of coal's microscopic elements known as macerals. Mineral matter: This approach identifies particular minerals and their forms, alongside assessing the makeup and distribution of mineral matter within coal.

5.1. Coal petrographic analysis

Coal Maceral composition analysis to determine the percentage of Maceral content of a coal sample. In this observation, Carl Zeiss Microscope and Point Counter Model F with 500 times magnification were used. The classification used in the analysis of coal Maceral characteristics in the study area is the Australian standard system AS 2856-1986 Standard Association of Australia.

Sample 1 Coal brownish black, brightness bright scratch brownish black, hardness moderately soft, resistance to crushing strong, uneven fraction, impurity mineral pyrite, coal seam thickness 50 cm. (Fig. 4)

Microscopic analysis of coal organic Maceral composition contains 82.2%vol vitrinite group composed of 52.8%vol Telocollinite Maceral, and 29.4%vol Desmocollinite, 7.4% vol Liptinite group with 7.4%vol resinite Maceral, 7%vol Inertinite group consisting of 7% vol sclerotinite Maceral, and 3.4% vol mineral matter in the form of pyrite. (Fig. 5)

Fig. 4: of Coal sample 1

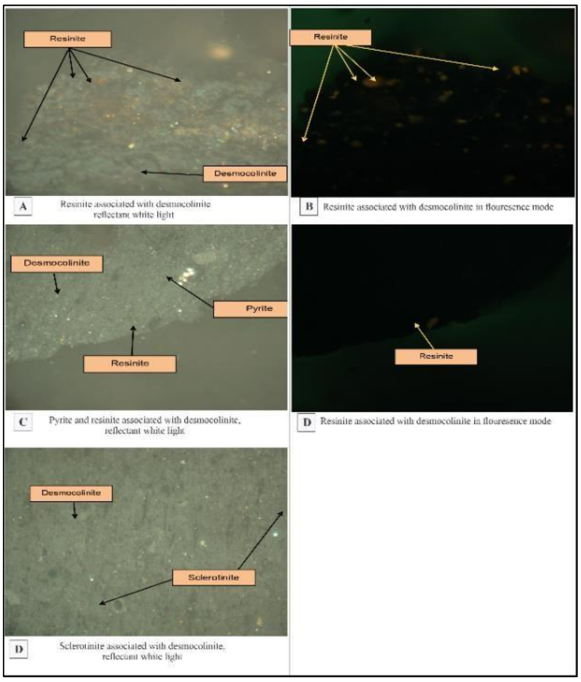


Fig. 5: Microscopic of Coal Macerals in sample 1

Sample 2 Black coal, brightness 60-90%, streaks black, hardness hard, crushing resistance moderately strong, fraction even, mineral matter pyrite, coal seam thickness 2.5m. (Fig. 6)

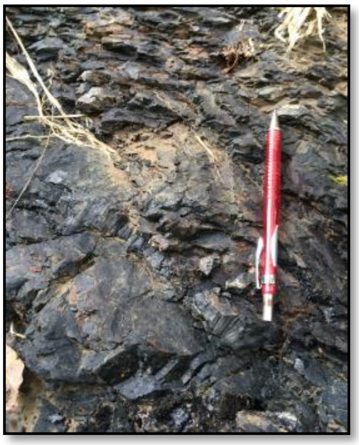
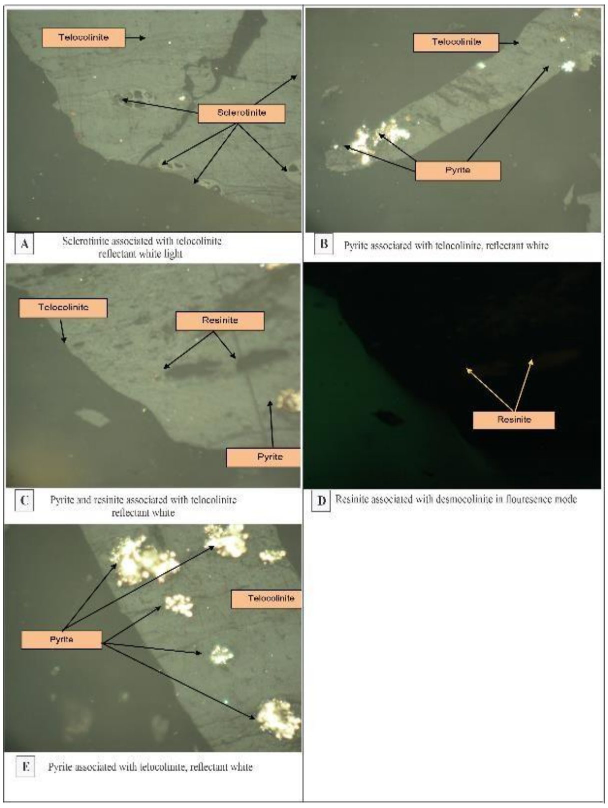


Fig. 6: Coal Sample 2

Microscopic analysis of coal has a vitrinite content of 84.2% vol consisting of Telocollinite 44%vol, and Desmocollinite 40.2% vol, Liptinite group 0.4%vol with resinite 0.4% vol, Inertinite group 14%vol consisting of semifusinite 1.6%vol, sclerotinite 7%vol, micrinite 1%vol and mineral matter 1.4% vol pyrite. (Fig. 7)



A Sclerotinite associated with telocolinite reflectant white light

B Pyrite associated with telocolinite, reflectant white

C Pyrite and resinite associated with telocolinite reflectant white

D Resinite associated with desmocolinite in flouresence mode

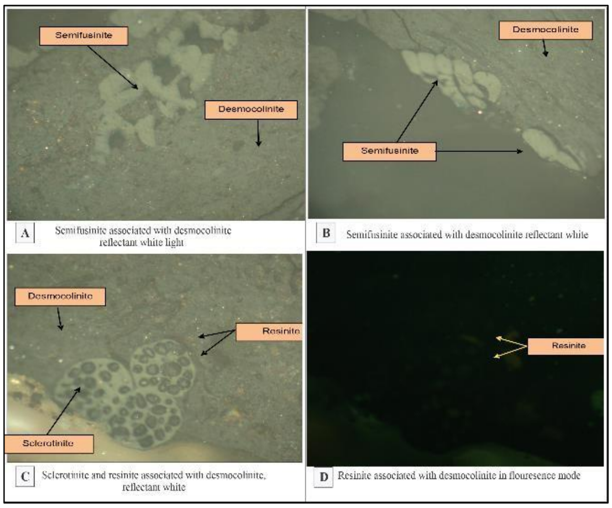
E Pyrite associated with telocolinite, reflectant white

Fig. 7: Microscopic of Coal Macerals in sample 2

Sample 3 Coal brownish black, brightness 40-60%, scratch brownish black, hardness moderately soft, resistance to strike strong, fracture cubical, impurity mineral pyrite, coal seam thickness 3 m. (Fig. 8)

Fig. 8: Coal Sample 3

Microscopic analysis has a vitrinite content of 81%vol consisting of Telocollinite maceral 36.4%vol, and Desmocollinite 40.2%vol, Liptinite group 2.6%vol with resinite maceral 2.6%vol. Inertinite group 14.8%vol consisting of semifusinite maceral 4.6%vol, sclerotinite 10.2%vol, and mineral matter 1.6%vol pyrite. (Fig. 9).



A Semifusinite associated with desmocolinite reflectant white light

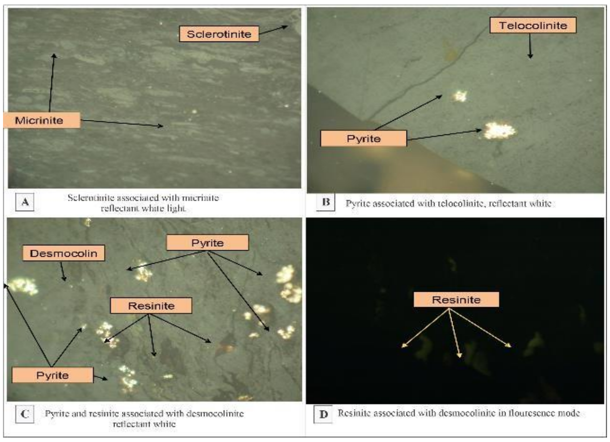
B Semifusinite associated with desmocolinite reflectant white

C Sclerotinite and resinite associated with desmocolinite, reflectant white

D Resinite associated with desmocolinite in flouresence mode

Fig. 9: Microscopic of Coal Macerals in sample 3

Sample 4 Coal is brown in color, dull gloss, brown streak, soft hardness, moderately weak strike resistance, broken sheat, pyrite impurity mineral, 70 cm thick coal. Microscopically, the coal contains 67%vol vitrinite which consists of 35%vol Telocollinite maceral, and 32%vol Desmocollinite, 0.4%vol Liptinite group with 0.4%vol resinite maceral. 31%vol Inertinite group consists of 7%vol semifusinite maceral, 23%vol sclerotinite, 0.6%vol macrinite and 1.6%vol mineral matter in the form of pyrite. (Fig. 10)



A Sclerotinite associated with micrinite reflectant white light.

B Pyrite associated with telocolinite, reflectant white

C Pyrite and resinite associated with desmocolinite reflectant white

D Resinite associated with desmocolinite in flouresence mode

Fig. 10: Microscopic of Coal Macerals in sample 4

The results of petrographic analysis of organic macerals in 4 samples of coal in the study area generally contain a composition of vitrinite macerals 67-84.2%vol, Liptinite 0.4- 7.4%vol, Inertinite 7-31%vol, and metter minerals 1.4-3.4%vol.

Coal sample 1 has a maceral composition of Huminite (Vitrinite) 82.2% vol, Liptinite 7.4% vol, Inertinite 7% vol, and mineral matter 3.4% vol. Coal sample 2 have a maceral composition of Huminite (Vitrinite) 84.2% vol, Liptinite 0.4% vol, Inertinite 14% vol, and mineral matter 1.4%vol. Coal sample 3 has a maceral composition of Huminite (Vitrinite) 81% vol, Liptinite 2.6% vol, Inertinite 14.8% vol, and mineral matter 1.6% vol. Coal sample 4 has a maceral composition of Huminite (Vitrinite) 67% vol, Liptinite 0.4% vol, Inertinite 31% vol, and mineral matter 1.6% vol. (Table 2)

Table 2: Results of coal maceral analysis of the study area.

Sample	Huminit %vol	*Liptinite* %vol	*Inertinite* %vol	Mineral Matter %vol
1	82.2	7.4	7	3.4
2	84.2	0.4	14	1.4
3	81	2.6	14.8	1.6
4	67	0.4	31	1.6

5.2. Vitrinite Reflectance Analysis

Vitrinite reflectance refers to the amount of light that bounces off a smoothed vitrinite surface (Table 3). Vitrinite serves as a maceral, which is an organic constituent found in coal. When vitrinite undergoes heating beneath the surface of the Earth due to burial, its reflective characteristics undergo systematic alterations. This transformation occurs due to an increased density of aromatic carbon-ring structures within the coal matrix (Stach and others, 1992; Bustin and others, 1985; van Krevelen, 1992; Mukhopadhyay and Hatcher, 1993).

Table 3: Coal classification based on vitrinite reflectance, Ward 1984 in Thomas 2013

Rank	Maximum reflectance
Subbituminous	< 0.47
High volatile bituminous C	0.47 - 0.57
High volatile bituminous B	0.57 - 0.71
High volatile bituminous A	0.71 - 1.10
medium volatile bituminous	1.10 - 1.50
Semi- Anthracite	2.05 - 3.00 (approximately)
Anthracite	> 30

Vitrinite reflectance is assessed by pulverizing the coal sample to a fine sand-like texture (-20 mesh indicates particle dimensions below 850 microns) and forming it into pellets for analysis. The upper surface of each pellet is smoothed and treated with a specific oil (immersion method). These pellets are then observed through a petrographic microscope. The initial reflectance readings are taken using a glass standard with a known reflectance value, acting as a baseline for the following measurements. Once this calibration is accomplished, multiple reflectance readings (usually ranging from 50 to 100) are taken from the vitrinite particles within the coal sample. A photomultiplier tube is employed to gauge the amount of light reflected, converting this light intensity into a specific numerical figure. The relative reflectivity (essentially, the gray-scale tint) of the vitrinite materials in the pellets is assessed by visual comparison against established reflectance standards. The values obtained can vary from 0 (indicating low reflection) to 4 (indicating high reflection).

Reflectance analysis was used to determine the intensity of light reflected by the vitrinite maceral. Vitrinite reflectance power will increase in line with the level of coal maturity, so it can be used as a parameter of the maturity level (rank) of a coal seam. vitrinite reflectance analysis results (Table 4).

Table 4: Coal Vitrinite Reflectance Analysis Results

Sample	Mean reflectance vitrinite	Range %vol	standard deviation
1	0.41	0.37-0.47	0.03
2	0.55	0.48-0.59	0.03
3	0.26	0.24-0.29	0.01
4	0.43	0.37-0.47	0.03

The relationship between the results of the mean vitrinite reflectant with the rank classification of ASTM coal in the research area is that the mean vitrinite reflectant ranges from Rv%vol 0.26-0.59. sample 1 Subbituminous rank Mean Rv value 0.41 %vol, sample 2 High Volatile Bituminous C Mean Rv value 0.55 %vol, sample 3 Lignite Mean Rv value 0.26%vol., and sample 4 Subbituminous rank Mean Rv value 0.43 %vol. (Table 5).

Table 5: Rank of coal in the study area based on Rv% vol (ASTM D388-05, 1996)

Sample	Mean Rv %vol	Coal Rank
1	0,41	*Subbituminous*
2	0,55	*High Volatile Bituminous* C
3	0,26	*Lignite*
4	0,43	Sub*bituminous*

5.3. Caloric Value Analysis

Calorific Value serves as a crucial metric. The heating value of coal is assessed using four coal samples taken from the research region. This metric determines how much heat coal can generate and is essential for calculating the quantity of coal required to achieve a specific heat output. Additionally, calorific values assist in classifying coal rank among low- and medium-rank coals that fall under the category of medium-volatile bituminous according to the classification system used in the United States.

Determination of coal rank based on its calorific content in the examined region, following the categorization outlined by ASTM method D5865-12; American Society for Testing and Materials, 2013, p. 648–666, reveals that sample 1 is classified as Subbituminous coal with a calorific content of 5023, sample 2 is identified as High Volatile C bituminous coal with a calorific content of 6896, sample 3 is categorized as Lignite A with a calorific content of 4489, and sample 4 is identified as High Volatile C bituminous coal with a calorific content of 6520. (Table 6)

Table 6: Results of Rank Analysis of coal in the study area based on Calorific Value (ASTM D388-05, 1996)

Sample	Caloric Value	*Coal Rank*
1	5023	*Subbituminous coal*
2	6896	*High Volatile* C *bituminous coal*
3	4489	*Lignite* A
4	6520	*High Volatile* C *bituminous coal*

6. Conclusion

The study area is included in the Barito Basin, administratively in Kananai village, Gunung Bintangawai sub-district, South Barito district, Central Kalimantan. Based on field analysis of the study area there are 3 (three) geomorphological characteristics showing landforms with plains and hills extending north to south. The hills and plains are fold structures in the form of anticlines and synclines that have experienced flattening due to exogenous processes in the form of intensive erosion or denudation. It is concluded that the research area forms morphology in the form of folded hills geomorphology, intrusion hill geomorphology, alluvial plain geomorphology.

Rock units found in the study area based on lithostratigraphy can be divided into 4 (four) units. Limestone and claystone layers deposited in a shallow marine environment (backreef) at the age of early Oligocene - Late Oligocene. The Early Miocene Period, sandstone, claystone and coal layers were deposited in a Transitional environment (Upper Delta Front) and then inconsistently formed rhyolite rocks at the age of Pliocene and alluvial deposits were deposited on top.

The results of the analysis of coal characteristics in the research area based on 4 (four) coal samples used in laboratory tests in the form of coal petrography and coal calories. Coal petrographic analysis is carried out to determine the characteristics based on coal maseral content, coal rank based on vitrinite reflectance and calorific value.

The results of organic maseral petrographic analysis on 4 samples of coal in the study area in general, coal contains vitrinite maseral composition of 67-84.2%vol, Liptinite 0.4-7.4%vol, Inertinite 7-31%vol, and mineral metter 1.4-3.4%vol. The relationship of vitrinite reflectance with rank classification of coal study area with the highest rank of High Volatile Bituminous C in sample 2 with Rv% value of 0.55 and the lowest in sample 3 Lignite with Rv% 0.26. The relationship between Calorific Value and rank of coal in the research area with rank classification from ASTM is the highest calorific value in sample 2 6896 cal/gr rank High Volatile C bituminous coal and the lowest in sample 3 4489 rank Lignite A.

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