Available online at: http://proceeding.rsfpress.com/index.php/ess/index
LPPM UPN "Veteran" Yogyakarta Conference Series
Proceeding on Engineering and Science Series (ESS)
Volume 1 Number 1 (2020): 656-668

Sclerotinia Maceral Analysis to Predict Facies Condition on Coal of Muara Enim Formation, Marapi Area, Lahat, South Sumatera.

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Abstract

Sclerotinia as maceral from Group Inertinite is a mycelia mushroom, containing black melanin in the form of black cells. The fungus is rich in melanin to form sclerotinia cells. Sclerotinia is oval or circular consisting of single cells (single sclerotinia) and multiple cells (multiple sclerotinia), which has high reflectivity (Stach et al., 1982). The purpose of this study was to determine the condition of the peat swamp facies or changes in the swamp water level in Seam-B coal in the Marapi area, Lahat, South Sumatra. Changes in the water level of peat swamps in tropical climates affect the growth system of sclerotinia fungi on the peat surface. This condition can be seen from the Gelification Index (GI) values between 0.01 - 0.15 and various Tissue Preservation Index (TPI) between 8.68 - 36.50 (Diessel, 1986). The Seam-B coal facies in the Marapi area of South Sumatra consist of: limnic, limo-telematic, and marsh, these terms are used to determine the depositional environment based on the classification of the hydrological regime according to water level depth (Mitsch and Gosselink, 1986). Based on the results of the coal facies study (Diessel, 1986), there are variations of Seam-B coal facies which are deposited in limnic (wet / very humid) conditions where the sclerotinia fungus develops colony to form multiple sclerotinia in sample B (2), while sample B (1), B (3) and B (4) are deposited in conditions of marsh facies (moist soil) to limbo-telematic (relatively dry) so that some of the sclerotinia fungi develop separately to form a single sclerotinia (in relatively dry conditions) and some live independently colonize.

Keywords: GI, TPI, single sclerotinia, multiple sclerotinia

I. INTRODUCTION

The research location is located in the Marapi area, Lahat, South Sumatra (**Figure** 1) including the Muara Enim Formation as a coal-bearing formation in the research area. The research area belongs to the South

Sumatra Basin, composed of alternating lithologies of sandstone, siltstone, and claystone. coal inserts, early Miocene-Pliocene, deposited in deltaic environments (Ginger & Fielding, 2003).

A coal seam character, either vertically or horizontally, can form in different environments and facies with different forming materials due to several factors such as depositional environment, climate, and changes in water levels. Thus the character of the coal seam is closely related to the genesis of coal (organic material origin, environment, and facies) which is represented by macerals. There is a relationship between fungal spores as one of the organic materials that make up coal and coalification as a carbonization product which can cause an abundance of sclerotinia and produce various organic compounds during coal formation (genes). The inertinite (sclerotinia) content of seam-B coal can provide an overview of the genesis of coal in a series of depositional facies cycles based on the plant originating from coal (maceral); (Stach et al., 1982)

Thus the presence of sclerotinia fungi with various types, both single and triple sclerotinia in the seam-B. coal seam in the research area is expected to predict paleoclimate when the coal of the Muara Enim Formation is deposited in the Miocene-Pliocene.

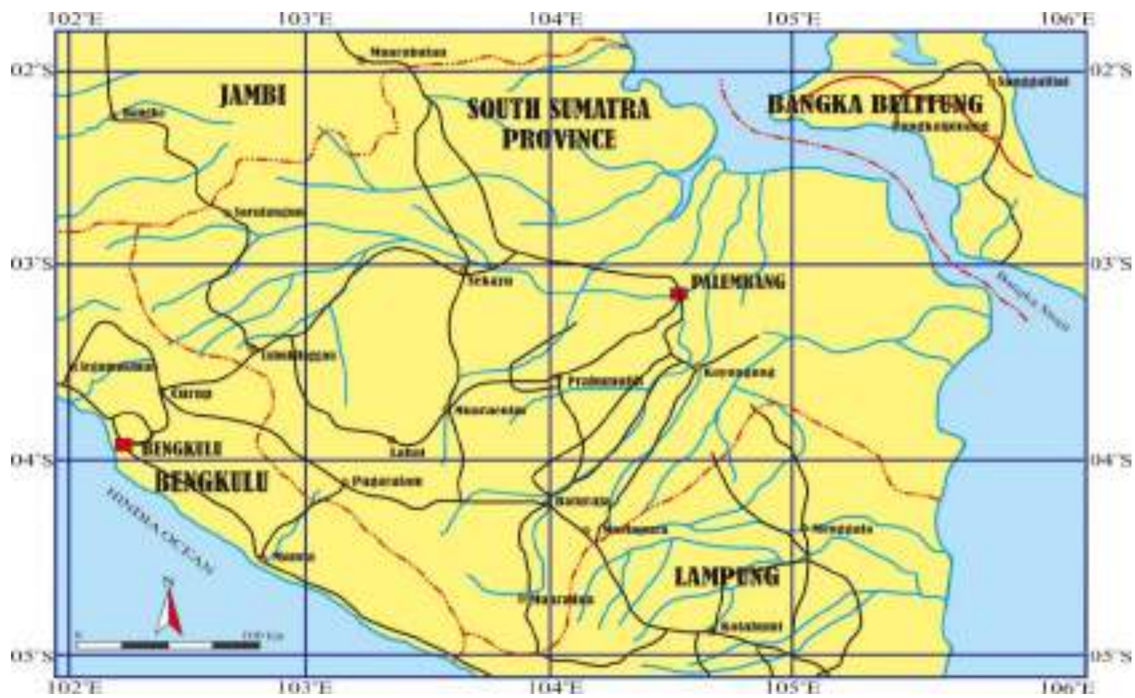


Figure 1. Location of Research, Marapi Area, Lahat Regency, South Sumatera

II. LITERATURE REVIEW

Microscopically the organic materials that form coal are called maceral, analogous to the minerals in the rock. This term was originally introduced by Stopes, 1935 (Stach et al., 1982) to denote the smallest material that makes up coal which can only be observed under a reflected microscope.

The material in coal can be grouped into 3 main groups, namely the vitrinite, liptinite, and inertinite groups. This grouping is based on morphological shape, size, relief, internal structure, chemical composition, the color of reflection, the intensity of reflection, and degree of dissolution (Stach et al., 1982).

Vitrinite group comes from plants that contain woody tissue such as stems, roots, branches, and leaf fibers. Vitrinite is generally the main constituent of coal (> 50%). Through refraction microscopy, the vitrinite group shows a reddish-brown to dark color, depending on the level of coal conversion, the higher the rank of the coal the darker the maceral color, and vice versa. Through the observation of the reflection microscope, the vitrinite group showed brighter reflective colors, ranging from dark gray to light gray depending on the rank of the coal, the higher the rank of the coal the brighter the color of the reflection produced. Based on the morphology, the vitrinite group is divided into 3 maceral subgroups (Table 1).

The liptinite group comes from parts of plant organs such as sap, spores, bark, and algae. Therefore, the chemical element liptinite is rich in Hydrogen which will regenerate oil. Under the microscope, the reflection shows the reflection is gray to dark, has low reflectivity and high fluorescence (Teichmueller, 1989).

Based on the morphology and source of origin, the liptinite group can be distinguished as sporinite, cutinite, suberinite, resinite, liptodetrinite, exsudatinite, fluorine, alginite, and bituminize (Table 1). Inertinite comes from the word "inert" containing basic elements that are not reactive and contribute to coking coal blending such as fusinite, semifusinite, and sclerotinia maceral. Inertinite comes from cellulose and lignin from plant cell walls. These main elements undergo fucicitization during a coalition (Taylor et al., 1998). The inertinite group has the highest reflectance value among other maceral groups. Under a reflection microscope, inertinite shows a gray to greenish-gray color, but in ultraviolet light, it does not show fluorescence.

Based on the internal structure, the level of preservation, and the intensity of combustion, the inertinite group is divided into several macerals, namely fusinite, semifusinite, sclerotinia, microsite, inertodetrinite, and macrinite (Table. 1).

Table 1. Classification of Coal Maseral (AS 2856, 1986)

GROUP MASERAL	SUBGROUP MASERAL	MASERAL
Vitrinite	Telovitrinite	Textinite
		Texto-ulminite
		E-ulminite
		Telocollinite
	Detrovitrinite	Attrinite
		Densinite
		Desmocollinite
	Gelovitrinite	Corpogelinite
		Porigelinite
		Eugelinite
Liptinite		Sporinite Cutinite Resinite Liptodetrinite Alginite Suberinite Flourinite Exsudatinite Bituminite
Inertinite	Telo-inertinite	Fusinite Semifusinite Sclerotinite
	Detroinertinite	Inertodetrinite Micrinite
	Gelo-inertinite	Macrinite

Sclerotinia is a mycelia mushroom, containing black melanin. Melanin-rich mushrooms will form sclerotinia. Sclerotinia is oval or circular, has high reflectivity (Stach et al., 1982) Taylor et al. (1998), explained that the sclerotinia genes could come from different plant origins and environments/facies. Sclerotinia comes from the word sclerotia, which is a form of mycelia fungi residue, which is resistant and can live in unfavorable environments (dry, toxic conditions, waterlogging), but in Tertiary coal, only certain types of sclerotinia are believed to originate from fungi. The high reflectivity of the fungo-sclerotinia (fungo-sclerotinia) has emerged from the moment of origin (such as primary fusinite).

Sclerotinia is produced only from dark fungal spores, dark sclerotia (dark sclerotia), and dark plectenchyme (fungal tissue). Examples of these basic elements are:

1. Black spores, which are now known as smut fungi (Ustilaginales) and seeds with dark yellow / red spots (Puccinia graminis).
2. Black sclerotia (Secure corneum - ergot), including the fungus Claviceps purpurea which is the remains of Gramineae, and black sclerotia (Rhytisma acerinum) which comes from maple leaves
3. Plectenchyme from the remains of mycorrhiza mushrooms.

The appearance of fungal sclerotinia in coal is controlled by:

1. Clumps of plants forming peat
2. Supplies oxygen at the top of the peat layer
3. Concentrated in peat due to selective decomposition.

III. RESEARCH METHODOLOGY

The research methodology carried out begins with investigations and coal sampling in the field, namely on the walls of the coal mine using a systematic stratified channel sampling, starting from the bottom to

the top of the Seam-B coal layer, then the coal samples are prepared for analysis of maceral or microscopic characteristics.

Then, each sample is reduced in size, and a composite is then divided into two for archives and laboratory analysis.

Laboratory analysis work includes:

a. Porosity analysis of coal Porosity measurement is done by cutting the coal sample into a beam shape with a size of 2 cm and a length of 2.5 cm. Next, putting the dry sample into the vacuum desiccator to be expressed for 1 hour and then saturated with kerosene, then the weighing is done.
b. Microscopic analysis of coal to identify maceral, mineral matter, and vitrinite reflectance values. Coal samples were taken from the outcrop of the mining wall then prepared for polishing incisions. In sample preparation, several tools and materials are needed such as:

   1. Coal samples
   2. Resin powder (trans optic powder)
   3. Pounder Tool
   4. Sizes 16, 20, and 65 mesh sizes
   5. Print polished briquette, heaters, thermometers, and presses
   6. Grinder-polisher
   7. Silicon carbide sizes 800 and 1000 mesh and alumina oxide size 0.3; 0.05; and 0.01 microns
   8. Glass preparations and night candles

Coal samples obtained from the drill core are reduced by coning and quartering to obtain the appropriate number of samples for analysis needs. Next, the coal samples were crushed manually and sifted using 16 mesh and 20 mesh sieves, the coal grain size fraction -16 mesh +20 mesh obtained was used for coal petrographic analysis.

The coal fraction size -16 mesh +20 mesh is then mixed with resin powder (trans optic powder) with a ratio of 1: 1. The mixture is then put into the mold and heated to 200oC. After the temperature reaches 200oC, the heater is turned off and the mold is pressured to 2000 psi. Briquette can be removed after the temperature reaches room temperature. The next stage is briquette polishing which starts with cutting using a polishing tool (grinder-polisher) then smoothed with silicon carbide size of 800 mesh and 1,000 mesh above the glass surface. Next, polished using alumina oxide measuring 0.3 microns, 0.05 microns, and finally measuring 0.01 microns on silk or silk cloth. The resulting polishing incision is placed on the preparatory glass with the night candle holder then leveling.

Observation of polishing incisions is done using a reflectance microscope both qualitatively and quantitatively to determine the mineral content and minerals in coal. Microscopic investigation using reflected light with 200 times magnification with the observation of 500 points. The analysis process was carried out at the Coal Petrographic Laboratory R&D Center for Mineral and Coal Technology, Bandung.

Furthermore, in this study, the author will analyze the coal facies of the maceral composition using a modified Diessel (1986) model. Diessel (1986), evaluated the depositional environment of Perm-aged coal in the Hunter and Gunnedah Valleys which are included in the Sydney Basin, Australia. This model has been applied in several coal fields in the world.

Diessel (1986), uses an equation from a comparison of several materials in order to get the GI (Gelification Index) and TPI (Tissue Preservation Index).

The equation is as follows:

$$GI = \frac{\text{Vitrinite + Macrinite}}{\text{Semifusinite + Fusinite + Inertodetrinite}}$$

$$TPI = \frac{\text{Telocollinite + Semifusinite + Fusinitd}}{\text{Desmocollinite + Macrinite + Inertodetrinite}}$$

Furthermore, to determine the coal depositional environment, the GI and TPI values were plotted on the diagram of the depositional environment from Diessel (1986).

The definition of the terms limnic, telematic, marsh and terrestrial is used to determine the depositional environment based on the classification of the hydrological regime according to water level depth (modification of Mitsch and Gosselink, 1986). Limnic is defined as subaqueous, telematic is the condition between the highest water level and the lowest water level, while terrestrial is the condition above the water level, in an environment that is always dry.

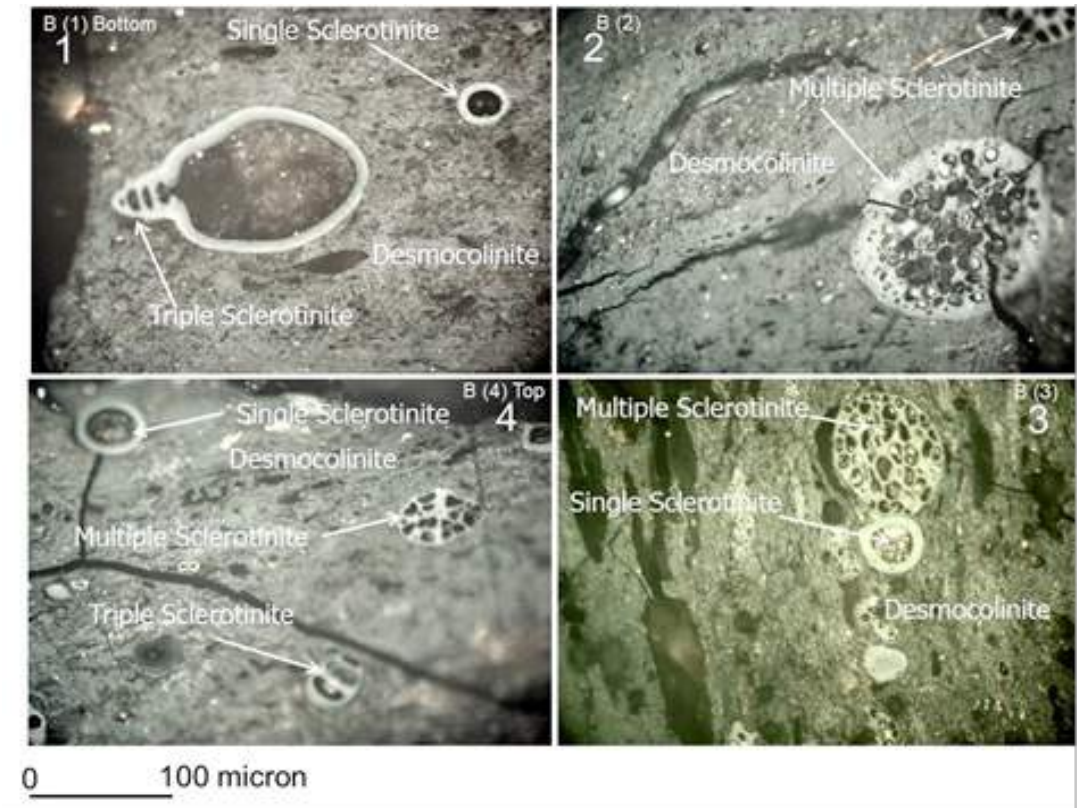
Furthermore, the calculation results of the association facies are plotted into a ternary diagram to determine coal facies.

IV. FINDING AND DISCUSSION

The minerals composition of Seam-B coal in Marapi area from 4 coal samples: B (1) Bottom; B (2); B (3) and B (4) Top (Table 2) is vitrinite between 29.2% - 74.2% Vol .; liptinite 0.0% - 11.6% Vol .; inertinite 0.8% - 8.2% Vol. and mineral matter 9.2% - 68.0% Vol. with reflectant vitrinite value 0.25 - 0.36% (Ro random) and that is lignite coal.

Microscopic characteristics of the maceral group of Vitrinite such as light-dark gray of Telovitrinite, light layers consist of telocollinite which no longer shows the rest of the wood fiber structure; Detrovitrinite in average fragments that trapped in inertinite, liptinite or in mineral matter. The greatest percentage of macerals of subgroup maceral detrovitrinite is dominated by maceral desmocolinite. Maceral densinite appearance under a microscope is like a mixture or collection of vitrinite fractions in fine sized, more tightly and homogeneous than an attribute. Gelovitrinite already homogeneous, round-oval shaped, and generally isolated often inside desmocolinite. Maceral gelovitrinite subgroup only consisted of maceral corpogelinite (Figure 3).

Maceral group of inertinite seam-B is consist of the maceral-sub group: teloinertinite; detroinertinite that only consist of maceral inertodetrinite. Maceral telo-inertinite-sub group is consists of maceral fusinite which shows higher relief than semifusinite, thin cell walls, and the structure is still clearer when compared



with semifusinite. Maceral sclerotinia has oval or circular shaped with high reflectivity, thought to originate from the mycelia fungus that contains black melanin. The average sclerotinia maceral composition of all samples is more than 5% (Figure 3).

Figure 3. Coal Microscopic and Sclerotinite Maceral Appearances of Seam-B

Table 2. Result of Macerals Analysis in Marapi Area, Lahat, South Sumatera

Group Maceral	Sub Group Maceral	Maceral	% (Vol.)			
			B (1) BOTTOM	B (2)	B (3)	B (4) TOP
VITRINITE			**29.2**	**71.2**	**58.4**	**74.2**
	Telovitrinite		**0.0**	**3.6**	**1.4**	**0.0**
		Textinite				
		Texto-ulminite				
		E-ulminite				
		Telocollinite		3.6	1.4	
	Detrovitrinite		**28.6**	**66.0**	**56.4**	**73.8**
		Attrinite				
		Densinite	10.6	1.4	31.4	33.4
		Desmocolinite	18.0	64.6	25.0	40.4
	Gelovitrinite		**0.6**	**1.6**	**0.6**	**0.4**
		Corpogelinite	0.6	1.6	0.6	0.4
		Porigelinite				
		Eugelinite				
LIPTINITE			**2.0**	**11.6**	**0.6**	**0.0**
		Sporinite		0.6		
		Cutinite	1.4	0.4		
		Resinite	0.6	9.6	0.6	
		Liptodetrinite				
		Alginite		0.6		
		Suberinite		0.4		
		Flourinite				
		Exsudatinite				
		Bituminite				
INERTINITE			**0.8**	**8.2**	**3.6**	**3.6**
	Telo-inertinite		**0.4**	**6.8**	**3.2**	**2.6**
		Fusinite				
		Semifusinite		0.4	0.6	
		Sclerotinite	0.4	6.4	2.6	2.6
	Detro-inertinite		**0.4**	**1.4**	**0.4**	**1.0**
		Inertodetrinite	0.4	1.4	0.4	1.0
		Micrinite				
	Gelo-inertinite		**0.0**	**0.0**	**0.0**	**0.0**
		Macrinite				
MINERALS MATTER			**68.0**	**9.0**	**37.4**	**22.2**
		Oksida				
		Pyrite	32.0	4.6	4.0	4.0
		Clay	36.0	4.4	33.4	18.2
TOTAL (%)			100.0	100.0	100.0	100.0
Rv. Min.			0.31	0.31	0.26	0.20
Rv. Max.			0.41	0.39	0.38	0.29
Rv. Mean			0.36	0.35	0.33	0.25
Coal Rank			Sub-Bituminous	Sub-bituminous	Sub-bituminous	Sub-bituminous
Tissue Preservation Index (TPI), Diessel, 1986.			**0.01**	**0.15**	**0.08**	**0.03**
Gelification Index (GI), Diessel, 1986			**36.50**	**8.68**	**16.22**	**20.61**

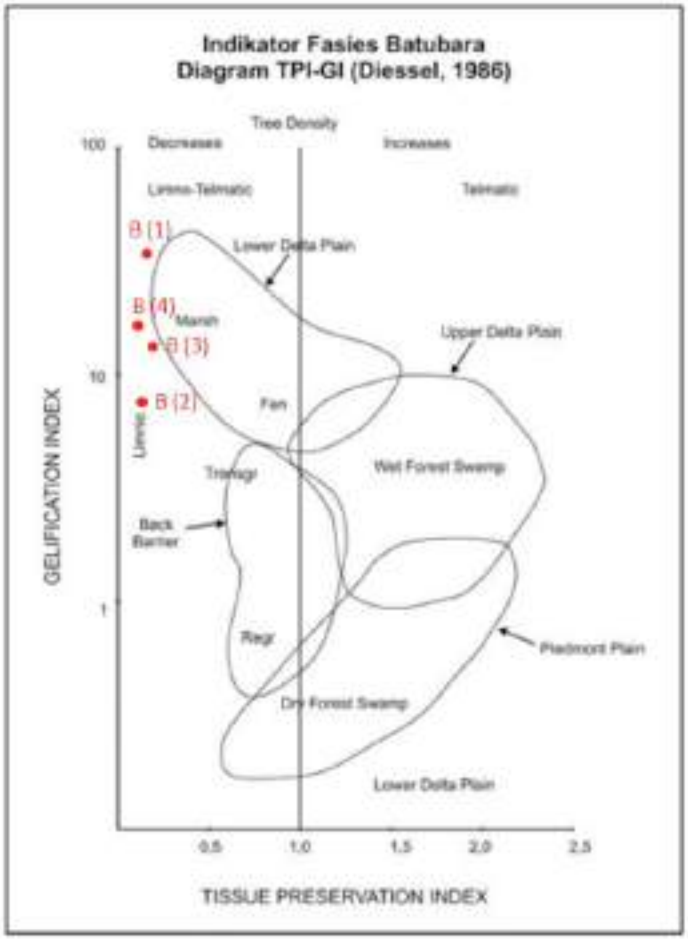


Figure 4. Seam B coal facies on the Diesel diagram, 1986

Seam-B coal from the 4 existing samples, had a GI value between 0.01 - 0.15 and a TPI between 8.68 - 36.50 (Table 2). The plotting results on the facies diagram according to Diesel, 1986 (Figure 4), explains that the coal sample number B (1) Bottom is located in Limno-Telematic, meaning that the conditions are relatively dry (relatively warm) so that the sclerotinia fungus does not develop properly, grows separately. forming a single sclerotinia (single cell). Coal sample number B (2) is located in Limnic, which means that the conditions are relatively wet (very humid) so that the sclerotinia fungi grow in colonies (abundantly) to form multiple sclerotinia (multiple cells). Coal sample numbers B (3) and B (4) tend to be located in Marsh which means the conditions are between wet and dry, meaning that in dry conditions the sclerotinia fungus will grow separately to form a single sclerotinia (single-cell) and in wet conditions, the sclerotinia fungus will grow in a colony to form multiple sclerotinia (multiple cells); (Figure 3 and Table 3).

Table 3. Sclerotinia Composition, condition, and type of sclerotinia of seam B in Marapi area

No	Sample	Sclerotinite % Vol.	Condition	Type of Sclerotinite
1	B (4) Top	2,6	Marsh	Single - Mutiple Sclerotinite
2	B (3)	2,6	Marsh	Single - Multiple Sclerotinite
3	B (2)	6,4	Limnic	Multiple Sclerotinite
4	B (1) Bottom	0,4	Limno-Telmatic	Single Sclerotinite

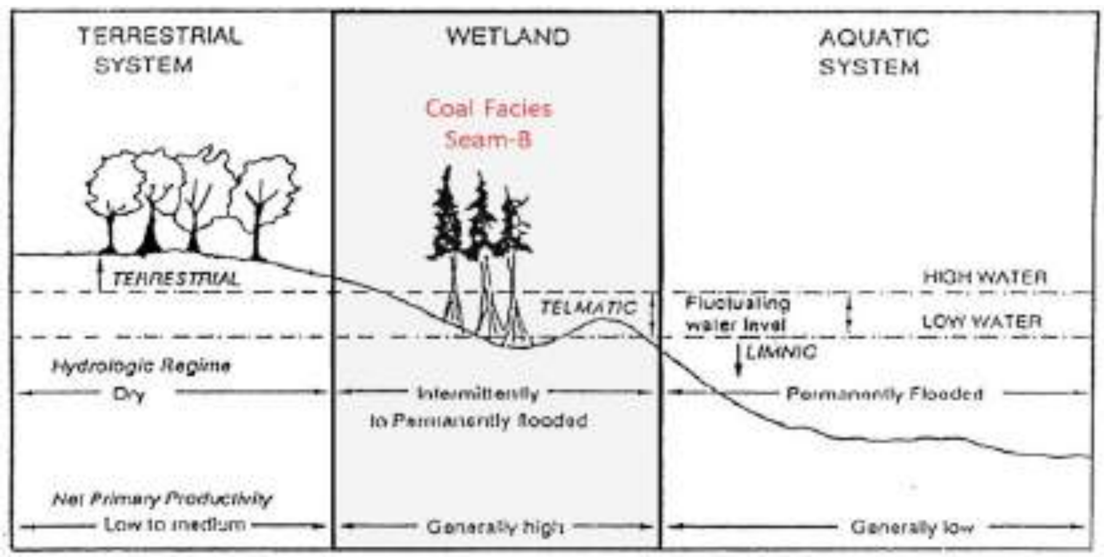


Figure 5. Fasies Batubara Seam B (Mitsch dan Gosselink, 1986)

The seam-B coal facies in the Marapi area of South Sumatra consist of: limnic, limo-telematic, and marsh, these terms are used to determine the depositional environment based on the classification of the hydrological regime according to water level depth (Mitsch and Gosselink, 1986). Limnic is defined as a subaqueous (wet) condition with very humid conditions, while limbo-telematic is a condition between the highest water level to the lowest water level, while marsh is a moist soil condition that is always dry. Thus, in general, the conditions of Seam-B coal facies from the lowest to the top in the Marapi area of South Sumatra from 4 samples are included in changing facies conditions: (limnic, limo-telematic and marsh) namely conditions intermittently to permanently flooded, this condition because the peat swamp is in a tropical climate so that it experiences 2 changes in the seasons (dry and rainy seasons) (raining and summer seasons) so that when the rainy season the peat swamp water level will be flooded, this condition is known as a wet condition. humid) so that the sclerotinia fungus will grow in colonies to form multiple cells, while in the dry season the peat water level recedes, this condition is called dry conditions (warm conditions) so that the sclerotinia fungus will grow separately to form a single cell.

Changes in the water level of the peat swamp from wet to dry conditions or vice versa will affect the growth of sclerotinia fungi in the peat swamp such as the type of plant clumps from which peat is formed, the availability of oxygen at the top of the peat layer and the concentration of sclerotinia fungi in the peat due to selective decomposition that will form to form fungi such as single sclerotinia and multiple sclerotinia (Mitsch and Gosselink, 1986); (Figure 5).

V. CONCLUSION AND FURTHER RESEARCH

Changes in the water level of peat swamps in tropical climates (humid and warm conditions) affect the growth system of sclerotinia fungi on the peat surface, therefore Seam-B coal has variations in changes in the composition of coal maceral and the Gelification Index (GI) with the Tissue Preservation Index (TPI) various.

The limnic facies (wet/humid climate) then sclerotinia fungi develop colony to form multiple sclerotinia, while facies marsh to limbo-telematic (warm climate) then some sclerotinia fungi develop separately to form single cells and some develop colonies to form multiple sclerotinia

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