

ANALYSIS OF STRATIGRAPHY AND SEDIMENTATION DYNAMICS OF COAL, SAWAHLUNTO FORMATION, OMBILIN BASIN

*Budi Prayitno¹, Muhammad Riva'i¹, Adi Suryadi¹, Husnul Kausarian¹ and Fazrol Rozi²

¹Geology Engineering Department, Universitas Islam Riau, ²Informatic Technology Department, Politeknik Negeri Padang, Indonesia

*Corresponding Author, Received: 28 Feb. 2019, Revised: 26 March 2019, Accepted: 21 April 2019

ABSTRACT: The study area located in Air Dingin Village, Sawahlunto city, West Sumatra at coordinates 0° 40' 30" S - 0° 41' 35" S and 100° 46' 15" E - 100° 47' 50" E. The data has been collected in the field by measuring thickness of layer on outcrops. Lithologies in this study area are dominated by fine to coarse sandstone and layering of claystone, coal and siltstone. However, on the west are dominated by sandstone overlay with siltstone layer and sandstone layer on the east of study area. Suspicion occurs on changes of depositional environment from west to east on study area. Result from cross-sectional analysis of lithology, outcrops show the characteristic of sedimentary structures form such as massive sandstone, graded bedding, parallel lamination, cross lamination, wavy lamination, cross bedding, bedding, cross lamination, gradation, normal gradation and convolute lamination, oxbow lake facies, point bar facies, meander facies, braided river facies and alluvial fan on mid part. While the results of the analysis of the volume of coal maceral deposited on wet swamp forest area, limnic facies is indicated by values TPI 0.7%-1.08% and Gi 3.82%-13.28% low TPI and medium GI. Peatland ecosystems show an Ombrotrophic environment, with prices of GWI 0.00% and VI 0.00% to 015% low GWI and medium VI. The triangle plot shows the telmatic facies of the depositional environment of wet swamp forest, with an average price of T 93.17%, F 6.83%, D 0.25%, with a high percentage value of maceral telocollinite.

Keywords: Stratigraphy, Sedimentation, Petrography, Maceral

1. INTRODUCTION

The Sumatra Island southwest fault which was formed in the Cretaceous, Ombilin Basin was formed due to the fractures of the bedrock complex at the end of the Pre-Tertiary, generated by the horizontal active motion of the Silungkang fault directed northwest-southeast, parallel to the Sumatra fault system. The horizontal active movements then become a place for the settling of the Tertiary sedimentary terrestrial environment. Ombilin Basin is a type of basin located in the mountainous zone, the regionally stratigraphic research area of old age namely Brani Formation, Sawahlunto Formation, Sawah Tambang Formation has two members namely Rasau and Poro Members [1].

Coal is the result of the accumulation of plants under certain depositional conditions, which have changed the type and composition of coal after deposition. Depositional environment of coal carrier formation in Sawahlunto formation is meander river type with oxbow lake sediment and lower point bar [2]. So, it is necessary to conduct field research with a detailed and measurable cross-sectional method focused on a number of coal carrier horizons, while the maceral in coal can be

grouped into 3 main groups, namely the vitrinite, liptin, and inertinite groups. vitrinite comes from wood and leaf tissue which contains lignin and cellulose, Liptinite is a resinous compound such as epidermis, spores, and pollen. Inertinite comes from changes in wood, other tissues biochemically from oxidized compounds. Sclorentinite is an organic component derived from the development of fungi from high-rank coal [3]-[4].

Further research is needed on the type, composition of coal with a measured stratigraphic cross section parameter method in order to determine the stratigraphic sequence, sedimentation pattern and depositional environment of the Sawahlunto Formation of Coal carriers. Maceral analysis of coal petrography used a reflective beam microscope Carl Zeiss Microscope Point Counter Model F with 400x magnification to determine the coal maceral value [5]-[6].

2. LOCATION

The field conditions of the study area as a whole have steep hill morphology, along with the lunto tributaries where measured stratigraphic measurements with river conditions are good enough to do research. Administratively the

research area is located west of Pekanbaru city. To reach the research location from Pekanbaru, it can be done by using land transportation such as a bus to Payakumbuh for - 5hours, and then continued to Sawahlunto city for -3 hours. From the city of Sawahlunto, the study area can be reached by using two wheels motorcycle for -5 minutes. Geographically located at coordinates $0^{\circ} 40' 30''$ LS - $0^{\circ} 41' 35''$ LS and $100^{\circ} 46' 15''$ BT - $100^{\circ} 47' 50''$ BT, Sawahlunto City Fig.1.

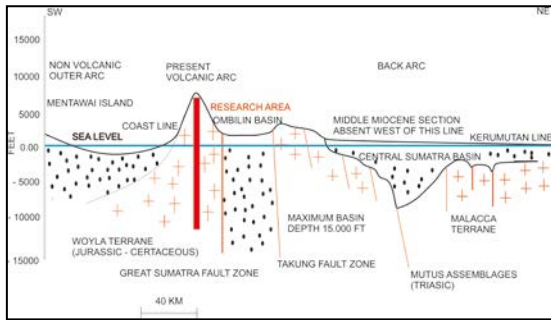


Fig.1 Cross section of the ombilin basin and research area (Heidrick And Aulia, 2000).

3. GEOLOGICAL SETTING

3.1 Structural Setting

Ombilin basins based on tectonic frameworks are almost the same as forming horst and graben, according to [7]-[8], the formation of the Ombilin Basin was influenced by the dextral strike-slip fault to form a symmetrical / pull-apart basin. The results of the micro-tectonic analysis, the Ombilin Basin during the Tertiary experience five tectonic phases consisting of two extensive and three-phase compressive phases [9]-[10] Fig.2.

The first tectonic phase (F3grnt) takes place at the early tertiary together with the formation of a northwest-southeast trending system. Along with opening the basin, the sedimentation process of the Brani Formation alluvium fan consists of breccia, conglomerate, and coarse sandstones that occupy the basic parts of the slope of the basin. Whereas in the center of the basin, swamp sedimentation occurs in the form of carbonaceous clay and sandstone formation of the Sangkarewang Formation.

The second tectonic phase (F4brn) from the Eocene - Oligocene in the form of a compressive phase that produces faults - north-south trending faults; Sundalangit Fault, Talawi Fault, and Sapan Fault. In addition to the compressive phase in several places experiencing extensive phases encouraging the formation of a fault growing and resulting in a decrease in the base of the basin.

The third tectonic phase (F5swl) takes place since the Early Oligocene in the form of a compressive phase that encourages lifting and triggers the formation of river deposits.

The fourth tectonic phase (F6 swtk) in the form of a compressive phase of relative north-south direction. This phase resulted in the reactivation of the fault - the North-South direction (Sundalangit Fault, Talawi Fault, Sapan Fault) Northwest - Southeast (Silungkang Fault, and Takung Fault) to become reverse and strike-slip fault.

The fifth tectonic phase (F7 omben) in the form of an extensive phase of Neogen which triggers the formation of faults - East-West trending faults (Tanjung Gadang Fault, Batubarinding Faults, Paramping Fault, Padanggating Fault) and Northeast - Southwest (Ombilin Fault, Muaro Fault, Fault Kuantan).

Changes in sedimentation from the terrestrial river facies of the Sawahtambang Formation to the sea facies The Ombilin Formation makes the volume of deposition more intensive in the eastern part known as Terban. Sinamar (Neogen) while in the West it is known as Terban Talawi (Paleogene). Tectonic activity immediately after the final phase of the Late Miocene in the form of a compressive phase (F7 ombek) trending west-east and causing a fault reactivity - the previous fault is active again. The strike-slip fault refers to the northwest-trending fault, which is an en-echelon fault from the Sumatran system fault in the form of step over evolution during the Paleocene - the Miopliocene forms several grabbens and successive horsts from the Northwest which shift towards the southeast basin.

3.2 Stratigraphic Setting

Based on the structural map from the compilation of seismic data [11]-[12], the Ombilin Basin is separated into 2 sub-basins, namely; Talawi sub-basin directed NW - SE which has a shallower depth of basin. The Talawi sub-basin based on the geological map consists of the Sangkarewang Formation which lies on the edge of the Ombilin Basin, while the Sawahtambang and Sawahlunto Formations lies on the central part of the Ombilin Basin. The NNW - SSE Sinamar sub-basin is occupied by the Ombilin Formation in the middle of the Ombilin Basin.

In the Geological Map of the Ombilin Basin dividing the formation into two parts, first the Pre-Tertiary section which became the bedrock of the Ombilin Basin then became the Kuantan Formation, Silungkang Formation and Tuhur Formation, while the second part consisted of Tertiary rocks which filled the Ombilin Basin from below above, it is divided into the Brani Formation which is interfingering to the Sangkarewang Formation, the Lower Member of the Ombilin Formation, the Sawahlunto Formation is on overlain by the Sawahtambang Formation, and the Ombilin

Formation [13]. Sawahlunto Formation as one of the important formations in the coal industry.

This formation contains brownish gray shale deposits, silt and is interlocked with brown, compact quartz sandstone, which marks the presence of coal seams. Flake stones are found with fatty/shiny characteristics and act as underclays. Whereas Sandstone shows upward smoothing sequence characteristics, cross-sectional sedimentary structure and wave spurt lamination and erosion of the base point bar. The coal seams occupy the interchanges between gray sandstones and carbonated claystone. Sawahlunto Formation is known to be aligned above the Brani Formation and locally above the Sangkarewang Formation [14]-[16].

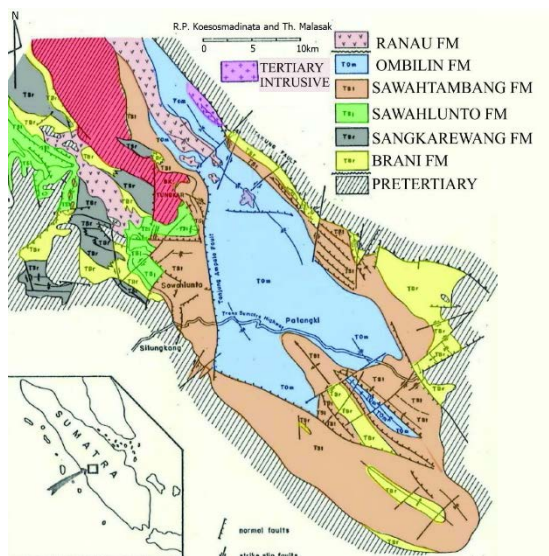


Fig.2 Regional Map of Geological Structure Ombilin Basin (Hendrick and Aulia, 2000).

4. METHODOLOGY

This study uses several approach methods, namely the library approach to microtectonics to comprehensively develop the Ombilin Basin formation [13]. The second approach method is stratigraphic modeling to determine sedimentation dynamics and stratigraphic patterns of coal carrier formations in the research area by trenching along the measurement path. While the third approach method is observing the maceral composition of coal under the reflective microscope Carl Zeiss Microscope and Point Counter Model F with a magnification of 400 times to find out the representation of the main components forming coal in the study area. The fourth approach method is the final approach of the research in the form approach method to find out the facies and carrier peat swamp ecosystem / biochemical coalification in the study area. In the analysis phase, while using

the data obtained from the Ombilin Field, it will also use data obtained from Petai Field from previous research as a comparative study.

5. RESULTS AND DISCUSSION

From the field results can be explained the type of lithology in Lithology stratigraphic cross section dominated by conglomerates with crustacean-sized rock fragments (0.4-7cm) to Shallow (7- 25cm), varied compositions that show the character of basement rocks with mud-sized matrix to sand, angled shape to round the load, uniformity of poorly sorted grain, hard, not showing layers. In the field there is a polyimic rock fragment which is dominated by andesite volcanic rock, and pebble, sharp contact with brittle claystone, fresh light brown color, dark brown weathered color, easily crushed, broken / concoidal form, spread in lithology occupies the western part of the study area, the thickness of this rock is 9.7m.

Alluvial Fan deposited on the environment with the Mid-Fan facies, this sedimentation mechanism is on the hillside which shows a steep slope level that shows the transportation mechanism in close proximity. The deposition mechanism in this lithology will form an alluvial fan dominated by conglomerates with fragments of more than one type of rock. That will continue to be transported until it is deposited in conditions of stable slopes such as braided rivers. And with a deposition environment model approach (Selly, 1978). From the analysis of detailed cross-sectional measurements in the field, this lithology has similarities in lithological features, such as the Brani Formation Aged Paleocene to Eocene.

In stratigraphic cross sections measured, lithology Metasediment thickness of 5m, Metasediment, weathered red color oxidation, the color of weathered gray luster, massive sedimentary structure, responsibilities rounded to rounded, well sorted, compact block. The contact between lithology was firm with silt 5.6 m thickness, fresh brown color, gray weathered parallel thin layer sediment structure, silt loaming rounded round, well sorted, hard. Very fine 4m sandstone thickness, firm contact with coal, black, fractured, concoidal fractions, hard \pm 2m in the body of the Lunto River, black, the presence of cleats filled with water.

Very fine sandstones with laminated bed convoluted sedimentary structures, very thin laminates, past wood debris. Contact between lithologies is firm. Clay, fresh color of brown, weathered gray parallel sedimentary structure laminated, repetition of clay silt there is a fossil trace of wood roots recorded on the layer, also the

contact insert between lithologies is firm. Furthermore, measurement of 2.8m Clay, fresh brown color, gray weathered parallel thin layer sediment structure, and clay silts. The contact between lithology firmly with very fine sandstone.

Deposited on the environment of the former river which is flooded due to the displacement of the path where the river flow is covered with sediment point bar. Oxbow shaped due to the meandering river cutting other parts of the surrounding surface. So it can be concluded that the depositional environment in the study area shows the oxbow lake environment, reinforced by the presence of a laminated parallel sedimentary structure which indicates that at the time it was formed, meandering river currents could not flow quickly to form like a very thin layer of silt, the presence of coal, coal lens indicates that at the time of sedimentation the study area was deposited with materials such as grasses, shrubs, bushes, and deposited dead trees.

Besides that, there is also a convolute bed sediment structure, very thin laminated cross laminated ripple lamination of wood, which indicates that at the time of meander river flow changes, this has resulted in the existing sedimentary structures not developing due to the cessation of suspension currents that regulate the sedimentary structure, with the Meander Faciest Oxbow Lake sedimentation environment model approach. From the analysis of detailed cross-sectional measurements, this lithology has lithology similarities with the Sawahlunto Formation that is Eocene-age which refers to [12].

Sandstone color dull gray weathered, massive fresh gray light color massive structure, normal gradation to smooth upwards, large coarse grains angled to round, with quartz fragments. inter-grain contact, the dominant constituent minerals are hard, compact quartz, the total thickness of this layer is 38.5 m, can be seen in the attachment of stratigraphic crossing measurement table which explains that the normal sedimentary structure of coarse-grained sandstone layer 1.5 m thickness indicates current so that the rough material is deposited due to the gravitational force where the heaviest and largest material will deposit earlier, followed by fine-grained sandstone 1.1 m thickness, indicating a change from the weakening of the suspension current, megascopically dominated by the presence of resistant quartz minerals from the dissolution of the aqueous medium.

Dissolution events are estimated to occur together with the compaction process or at the eogenesis stage can be seen from the dissolution pattern that occurs in the grain outline following the direction of the item. Megascopically cementation

of rock consists of silica, and iron oxide dominated by angular grain shape. The data above shows a low topography and wet climate when the rocks were deposited.

With the deposition environment model approach, it is estimated that rocks are deposited on the lower point bar's meandering river land environment. From the analysis of detailed cross-sectional measurements, this lithology has lithology similarities with the Sawahlunto Formation that is Eocene-age.

Sandstone color weathered dull gray, fresh color gray massive sedimentary structure 8 m thick and color clay weathered dark gray fresh light gray color. There is a parallel laminated sedimentary structure with very fine grain, rounded, firm contact between lithologies. Fine-grained sandstones consist of sandstones, very thin intermittent siltstone and claystone total thickness of 3.5 m.

Megascopically sedimentary rocks have a fresh gray-yellow color and brownish-brownish brownish-yellow color, are well-coated, grain size ranges from moderate sand to very fine sand, with moderate sorting, there is a very thin parallel layer sedimentary structure with inserts very thin coal thickness of 6 cm, at the bottom there is an erosion field. dominated by matrices (supported matrix), It is estimated that rocks in fine-grained sandstone facies are deposited on the environment of the former river which is flooded due to the displacement of oxbow-shaped pathways due to rivers cutting other parts.

It was concluded that the depositional environment in the study area showed oxbow lake depositional environment, reinforced by the existence of very thin parallel layer sedimentary structures which indicated that meandering river currents could not flow fast and form a very thin layer of silt and the presence of coal and coal inserts indicated sedimentation deposited in materials such as plants and groups of dead trees. The result is that sedimentary structures did not develop due to the cessation of the suspension currents governing the sedimentary structure pattern, as shown by the Appendix Figure of the Meander River Deposition Environment Model with the Oxbow Lake depositional environment. From the analysis of detailed cross-sectional measurements, this lithology has lithology similarities with the Sawahlunto Formation that is Eocene-age.

Light brown weathered yellow sandstone, massive fresh color, there is a gray structure of the Silang-Siur Thin Layer 45 m thick layer with varying grain sizes, with dominant quartz fragments. In lithology, there is a hard insert of clay with a 1cm thickness which is not continuous contact between

lithologies firmly. sandy color weathered gray, massive fresh color there is a sedimentary structure of thin and parallel layers of color dull yellow color, fresh color of light gray, lithology changes into thin layers of repetition, sedimentary structure of thin wavy layers with large fine rounded grain, fragments quartz, the contact between lithologies gradually thickens the overall lithology section is 6.8 m.

Deposed on the braided river environment when it overflows to river steps due to the uncontrolled volume of flowing water, sediment material is transported out of the stream so that it repeats a very fine layer of sand sediment to silt. As the sedimentary structure always develops because of the continuation of the suspension flow that regulates the sedimentary structure, it can be concluded that the depositional environment of the study area shows the floodplain facies.

Sandstones with some of the silt lenses, fresh yellow color weathered rounds to very round, massive, bedding sedimentary structures, while silt of the sedimentary structure shows a thin layer with a thick layer of 10.96 m. the color is light gray and the color is dark gray, the sedimentary structure shows the existence of a thin layer parallel, the corrugated film is thin and the lining is crossed, the overall thickness of the layer is 5.3 m, there is a very thin lenses of young coal easily crushed, moist and can be kneaded, associated with silt yellowish white color thick coal layer approximately 2 cm on average Sandstones overlay with thin layer of siltstone, fresh yellow color weathered round to very round, massive, 5.36 m thick bedding sedimentary structure.

Deposed on the environment of the former river which is flooded due to the displacement of the path where the river flow is covered with sediment point bar. Oxbow shaped due to the meandering river cutting other parts of the surrounding surface. So that it can be concluded that the depositional environment in the study area shows the oxbow lake environment, reinforced by the presence of parallel sedimentary structures which indicate that the river flow cannot flow quickly, forming a very thin layer of silt, the very thin lenses of coal associated with gray silt, indicates that at the time of sedimentation the study area was deposited with materials such as dead trees, bush plants. In addition, there is also a thin layer sedimentary structure, wood crushing, which indicates that when the meander river flow changes, the sedimentary structure develops because the suspension current continues to regulate the sedimentary structure, parallel layer sedimentary structures are very thin with the deposition environment model River Meander

Faciest Oxbow Lake. From detailed cross section measurements, this lithology has lithology similarities with the Sawahtambang Formation. Poro members aged Late Oligocene-Early Miocene, see in Fig 3 and 4.

The results of testing of 5 coal samples in the study area, which have been laboratory tests showed an average maceral composition of vitrinite value of 78.92%, higher than the value volume of liptinite, inertinite and mineral matter can be seen in the table below. The results of the percentage of maceral vitrinite in each coal sample can be explained that the average value of the percentage of 5 samples is 78.92%, so the depositional environment of the study area is forest swamp type of hard-trunked plants.

Maceral liptinite in each coal sample explained that the average value of the percentage of 5 samples was 00.00%, interpreted that the study area was not of the origin and characteristics of liptinite groups such as Algae, Spores, pollen, epidermis, leaves, stems and roots, Resins, fats, waxes and oils, Lipids, bitumens that come out in the coal process, Results of destruction of algae, plankton and lipid bacteria, Extinction degradation(mechanic / biochemistry) and bark network are thought to have been destroyed during the process. the average value of the 5 samples is 13.4%, the study area begins to contain the origin and characteristics of the inertinite groups formed in relatively dry conditions causing oxidized tissues such as Wood Tissues, oxidized semi-fincite, and semi-fissile pieces, Humic compounds which oxidize to jelly, the process of decay and fungi.

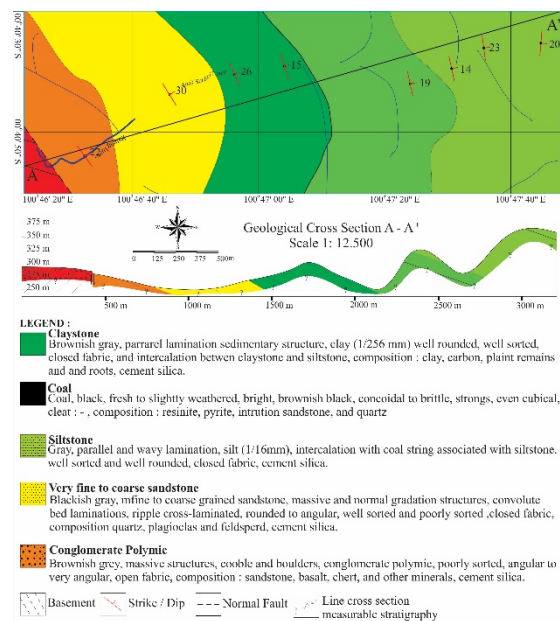


Fig.3. Geology map and stratigraphic of Study Area. (Modified from Koesaemadinata & Matasak, 1981).

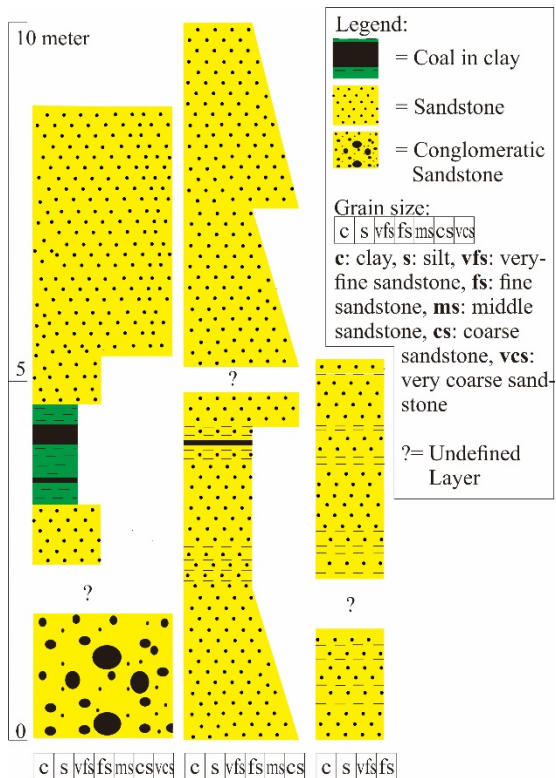


Fig.4. Stratigraphy model of dynamic sedimentation in the research area.

Sample 1 has a mineral matter of pyrite 29.8% with no oxide, clay. Total inertinite total volume of maceral 29.8%. Sample 2 Having 0.6% pyrite mineral matter has no oxide, clay value; the total volume of 0.6% inertinite maceral volume. Sample 3 has a mineral matter of pyrite 1.0% with no oxide, clay value. Total inertinite total volume of macerals is 1.0%. Sample 4 has no value of pyrite, oxide, clay. The amount of total inertinite masal volume is 0.0%. Sample 5 has a mineral matter of pyrite 6.4% with no value of oxide, clay. The total volume of all mineral matter samples is 7.56% Fig.5.

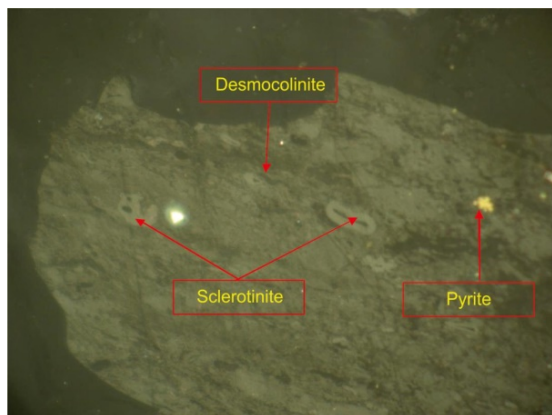


Fig.5. Coal Samples 2 maceral sclerotinite and pyrite are associated with maceral desmocollinite,

reflected light of bright white reflectance, magnification of 500x.

Dominated by mineral pyrite with an average total amount of 7.56%, this means in the study area has characteristics such as Postgenetic mineral matter which means that when coal is formed there is a lift with the formation of meandering river deposits. The formation of coal deposits in flooded areas. There was a reactivation of the formed faults and a minor fault in the form of a rising fault that occurred along with the deposition of the Sawahlunto Formation, marked by the presence of an average mineral matter of 7.56% pyrite.

Ecosystem analysis of peat land used the parameters of Ground Water Influence (GWI) and Vegetation Index (VI). GWI value is an indication of rheotropic conditions against ombrotrophic. In rheotropic conditions, the peat will undergo an intensive gelification process resulting in strongly modified maceral ts (gelocollinit, corpocollinit, desmocollinit) Fig.6.

Fig.6.Result of interpretation facies and ecosystem

peatland in the study area.

The value of VI was obtained by comparing the minerals which showed forest environmental affinity (tellinite, telocollinit, fucinite and semifusinite) with those showing shrub, marginal, and aquatic affinity.

These minerals are desmocollinit, liptodetrinit, inertodetrinit (shrub), sporinite, cutinite, and alginite. Examples of coal with the diagram Calder et al, 1991, in coal samples 1 to coal samples 5 indicate the Ombrotrophic peatland ecosystem with the sample GWI price of 1 to sample 5 is 0.00% and VI between 0.00% to 0.15% (low GWI and medium VI).

6. CONCLUSION

The geotectonic position and the formation of basin architecture has a positive influence on the composition and facies of coal-forming in the study area. There are three different fluvial deposition systems in the study area; The proximal deposit system is associated with the central part of the alluvial fan, The alluvial fan sediment system, and The prodelta sediment system. Observations under the microscope show the main components of coal-forming in the study area show representation of the average vitrinite maceral; 78.92%, liptinite; 0.60%, inertinite; 12.88% and mineral pyrite 9.45%, clay minerals are noted to be absent. Based on Calder's calculations and approaches, 1991 and 1986 Diesel obtained coal depositional facies in the study area in the limnic stadium in rheotropic and mesotrophic conditions.

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