# THE DEVELOPMENT CHARACTERIZATION AND DISTRIBUTION OF COAL SEAM IMPLICATION FOR THE QUALITY VARIATION IN PIT PUNTADEWA, MUARA JAWA FIELD, EASTERN KALIMANTAN

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## ABSTRAK

Lapisan batubara di cekungan Kutai memiliki karakteristik yang menarik untuk dikaji, terutama di Formasi Pulaubalang. Endapan sedimen pada masa Eosen Tengah dipengaruhi oleh pola struktur yang berkembang pada masa Paleogen - Neogen serta stratigrafi itu sendiri, yang berimplikasi pada pola distribusi dan kontinuitas yang bervariasi. Kondisi tersebut dapat menimbulkan kendala dalam kegiatan eksplorasi batubara, terutama pada permodelan batubara. Makalah ini akan mengungkapkan bahwa pola distribusi dan kontinuitas lapisan batubara dapat berubah meskipun dalam jarak yang dekat. Data terpadu berupa data penampang stratigrafi terukur, survei topografi, data kualitas terdekat digunakan untuk membangun model geologi berupa karakteristik perkembangan dan sebaran lapisan batubara. Pada wilayah penelitian ini difokuskan pada empat lapisan batubara (seam A1, seam A2, seam A3 dan seam A4). Berdasarkan hasil studi, rangkaian lapisan tersebut diendapkan dalam Satuan Batulempung Formasi Pulaubalang. Fasies sedimen strata lapisan batubara adalah batulempung berlapis selingan dengan batubara. Fasies ini berkembang menjadi endapan rawa yang dipengaruhi oleh dataran banjir. Lapisan tersebut termasuk dalam nilai batubara yang tinggi berkisar antara 5,926 – 6,365 cal/g (adb) dan 7,441 – 7,498 cal/g (daf). Selanjutnya, geometri batubara dikontrol oleh sedimentasi dan struktur geologi. Ketebalan lapisan relatif sama tetapi di beberapa area berkembang sisipan pengotor, pembelahan lapisan serta sesar yang membatasi kemenerusan lapisan batubara. Dengan mengetahui kondisi geologi, metode ini dapat diterapkan dalam membantu strategi pengembangan pertambangan baik pemodelan geologi maupun estimasi sumberdaya dan cadangan.

*Kata kunci: Persebaran, kemenerusan, endapan rawa*

## *ABSTRACT*

*Coal seam in a Kutai basin have an interesting characteristic to be studied, especially in Pulaubalang Formation. Sediments deposit during the middle Eocene are influenced by structural patterns that developed during the Paleogene – Neogene period also the stratigraphic itself, which have implications for varying distribution patterns and continuity. These conditions can cause problems in coal exploration activities, especially in coal modelling. This paper will reveal that the distribution patterns and continuity of coal seam can be change even though at close range. Integrated data in the form of stratigraphic measuring section data, topography survey, proximate quality data is used to build the geological model in the form of development characteristics and distribution of seam. In this research area focused to four coal seams (seam A1, seam A2, seam A3 and seam A4). Our study results, those seam series deposited in claystone unit of Pulaubalang Formation. Sediment facies of coal bearing strata was laminated claystone intercalated with coal. These facies developed in backswamp deposit that influenced by floodplain. Those seams included to high coal value range from 5,926 – 6,365 cal/g (adb) and 7,441 – 7,498 cal/g (daf). Furthermore, the geometry of coal controlled both sedimentation and structural geology. The thickness of seam is relatively equal but, in several area, developed parting, splitting also faulting that constrain the continuity of coal seam. By knowing the geological conditon, this method can be* *applied in assisting mining development strategies both geological modelling, resources, and reserve estimation.*

*Keywords: Distribution, continuity, backswamp*

## A. INTRODUCTION

The process of coal formation both during deposition and after deposition in the form of geological structures, intrusion, etc. affect the quality and content of the elements in coal (Thomas, 2002). Coal seams also have varying distribution patterns and continuit, even at close distances (Kuncoro, 2000). The geological control of its varying distribution and continuity needs to be studied in more depth to obtain economical reserves. The study area administrativelly located around Batuah - Tani Harapan, Muara Jawa, Kutai Kartanegara, East Kalimantan and physiographically located in the lower Kutai Basin (Figure 1).


**Figure 1**. Location map of the research area

This study focused on the development of the characterization and distribution of seams and their implications for the quality of coal in the pit of Puntadewa. The development of each seam can be known by integrating stratigraphic profile measurement data and proximate analysis data. The introduction of facies types also needs to be considered in stratigraphic relationships, both laterally and vertically which can be determined and correlated to the geometry of coal seams generated by borehole data in the study area, whilst proximate quality data is used to determine the trends in term of quality variations of coal seam from the study area.

## B. RESEARCH METHOD

The method consisted of several stages, first is literature study which to learn all things related to the research area. Then, collecting field data in the form of observations of rock outcrops by using measured stratigraphic section to obtain typical lithology changes and sedimentary structure that consist of sedimentary textures, sequence order pattern and variation of rock layer thickness, measurements of strike and dip data, measuremnet of geological structure data, and rock sampling. As well as secondary data analysis using actual topography survey data and borehole data to obtain 3D modelling and distribution section of coal seam generated by minescape with in grid and interpolator fem classified, by this method we can analyzed the distribution patterns and continuity of coal seam that sometimes even change though at close distance. Last, by knowing proximate quality data which used to determine the trends of quality variations of coal seam from the study area.

## C. RESULT AND DISCUSSION

### LITHOFACIES INTERPRETATION

**Measured Stratigraphic Section F-1A**

This section is located inside wall of Pit Puntadewa. This section about 18.5 meters thickness. Based on its appearance in the field, this section arranged by sandstone unit, intercalated with fine sandstone, fine to medium sized, well rounded and well sorted, matrix supported with silica cement, very thinly bedded (20-60mm), include as low strength rock (R3), permeable, it has sedimentary characters such as parallel lamination and tabular cross lamination intercalated with massive sandstone as main deposited. According to Miall, 1977 the characteristic of sandstone deposited included as “ST” means that this deposit has medium to coarse grain and well to medium sorted. This deposit included as channel – braided river facies. Based on depositional environment Horne, 1979 this deposit includes as Fluvial – Upper deltaplain environment **(Figure 4)**.

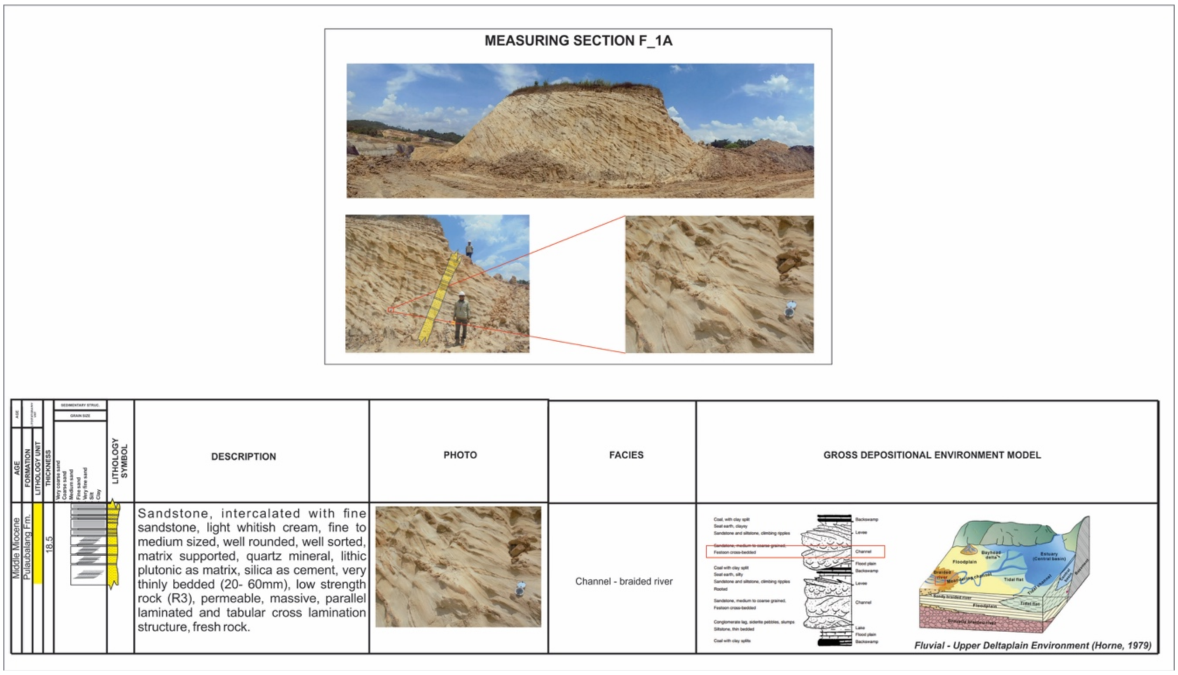


**Figure 4.** Measured Stratigraphic Section F-1A in Pit Puntadewa

**Measured Stratigraphic Section F-1B**

This section is located inside wall of Pit Puntadewa. This section about 34 meters thickness. Based on its appearance in the field, this section arranged by claystone intercalated with coal. It has massive and laminated structure with thickness range from 2 to 17 meters. That claystone as apart between each coal to other called interburden. According to Miall, 1977 the characteristic of this deposit included as “C” means that this deposit indicated as fine grain sedimen wich has organic matter. This deposit included as backswamp deposit to floodplain deposit. Based on depositional environment Horne, 1979 this deposit includes as Fluvial – Upper deltaplain environment **(Figure 5)**.

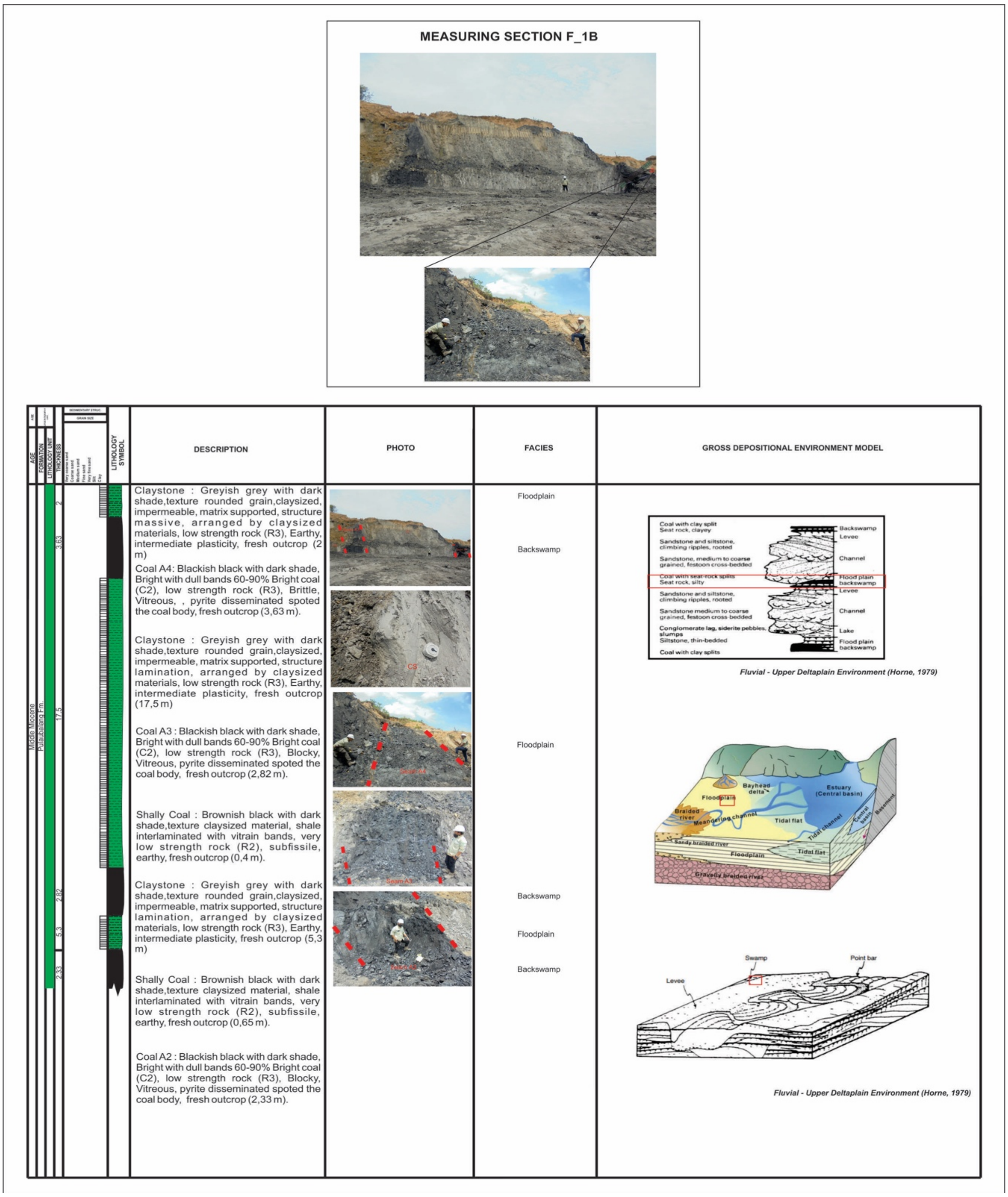


**Figure 5.** Measured Stratigraphic Section F-1B in Pit Puntadewa

**Measured Stratigraphic Section F-2**

This section is located inside wall of Pit Puntadewa. This section about 68 meters thickness. This section is the continuity of section F_1B Based on its appearance in the field, this section arranged by claystone intercalated with coal. It has massive and laminated structure with thickness range from 2 to 17 meters. That claystone as apart between each coal to other called interburden. According to Miall, 1977 the characteristic of this deposit included as "C" means that this deposit indicated as fine grain sedimen wich has organic matter. This deposit included as backswamp deposit to floodplain deposit. Based on depositional environment Horne, 1979 this deposit includes as Fluvial – Upper deltaplain environment **(Figure 6)**.

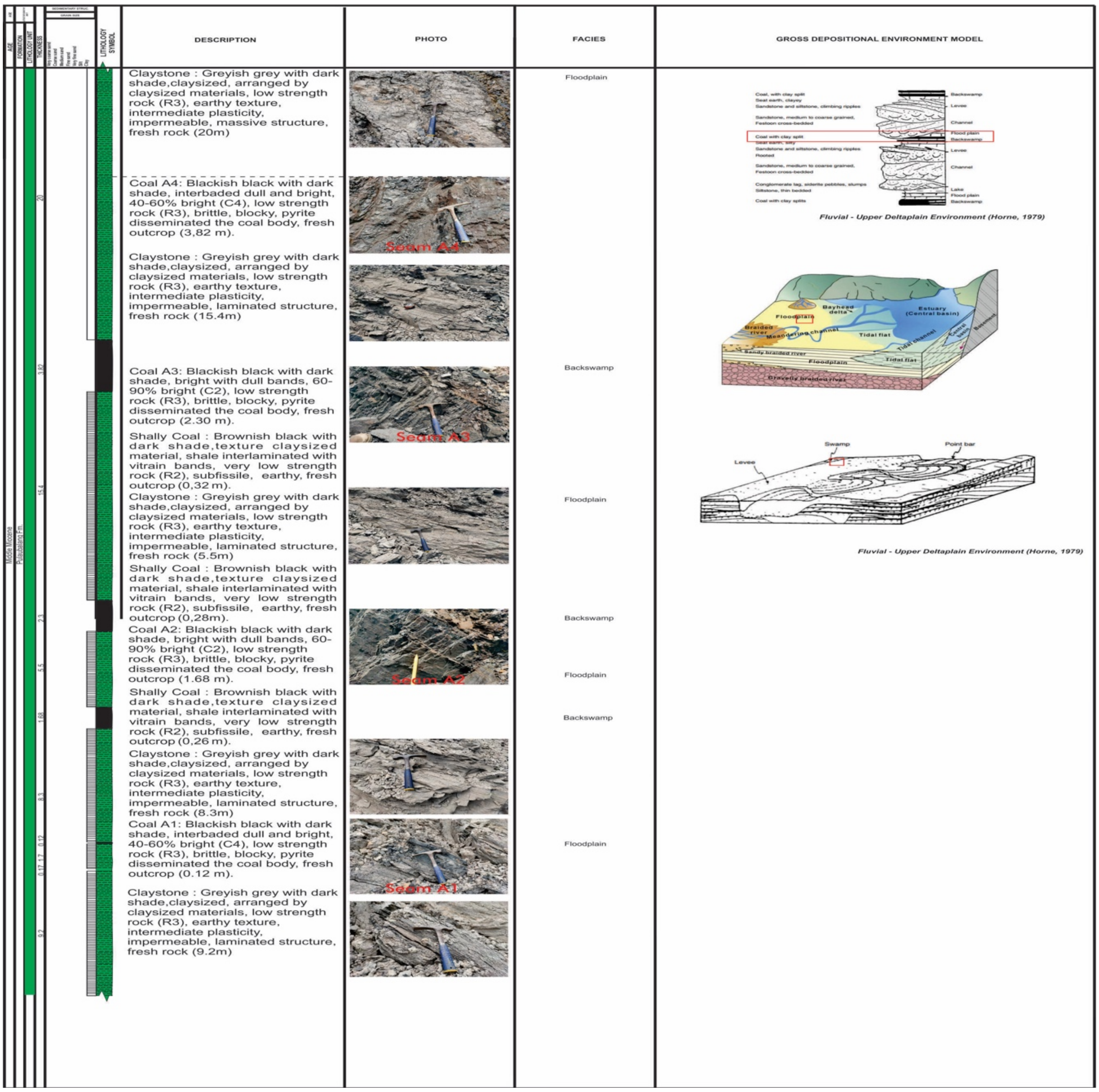


**Figure 6.** Measured Stratigraphic Section F-2 in Pit Puntadewa

## COAL CHARACTERIZATION

### Coal Megascopic

Coal seam outcrops in the research area are found in Pit Puntadewa, Muara Jawa field. Based on coal stratigraphy is in Pulaubalang Formation as a coal bearing formation in the research area. The coal seam deposited in interbedded claystone unit with relatively steep slope about $53^0$ also has interburden between seams consisting of carbonaceous shale, claystone, and fine-grained sandstone with a dark grey to brown color range from 10-18 meter. The physical characteristics of coal seam has different variation from seam A1 through seam A4. The characterization mentions below:

**Seam A1**: Black colour with dark blackish shade, bright to interbedded dull (40-60% bright - C4), low strenght rock, brittle, blocky, pyrite disseminated the coal body are rare, has a thickness range from 1.2 meter to 1 meter. There is parting in coal body about 0.30 meter (Figure 7).

**Seam A2**: Black colour with dark blackish shade, bright dull bands (60-90% bright – C2), low strenght rock, brittle, blocky, pyrite disseminated the coal body are common, has a thickness range from 1.68 meter to 0.8 meter. There is no parting inside the coal body (Figure 7).

**Seam A3**: Black colour with dark blackish shade, bright dull bands (60-90% bright – C2), low strenght rock, brittle, blocky, pyrite disseminated the coal body are rare, has a thickness range from 2.3 meter to 1.52 meter. There is no parting inside the coal body (Figure 7).

**Seam A4**: Black colour with dark blackish shade, bright dull bands (60-90% bright – C2), low strenght rock, brittle, blocky, pyrite disseminated the coal body are common, has a thickness range from 3.82 meter to 3.11 meter. There is no parting inside the coal body (Figure 7).

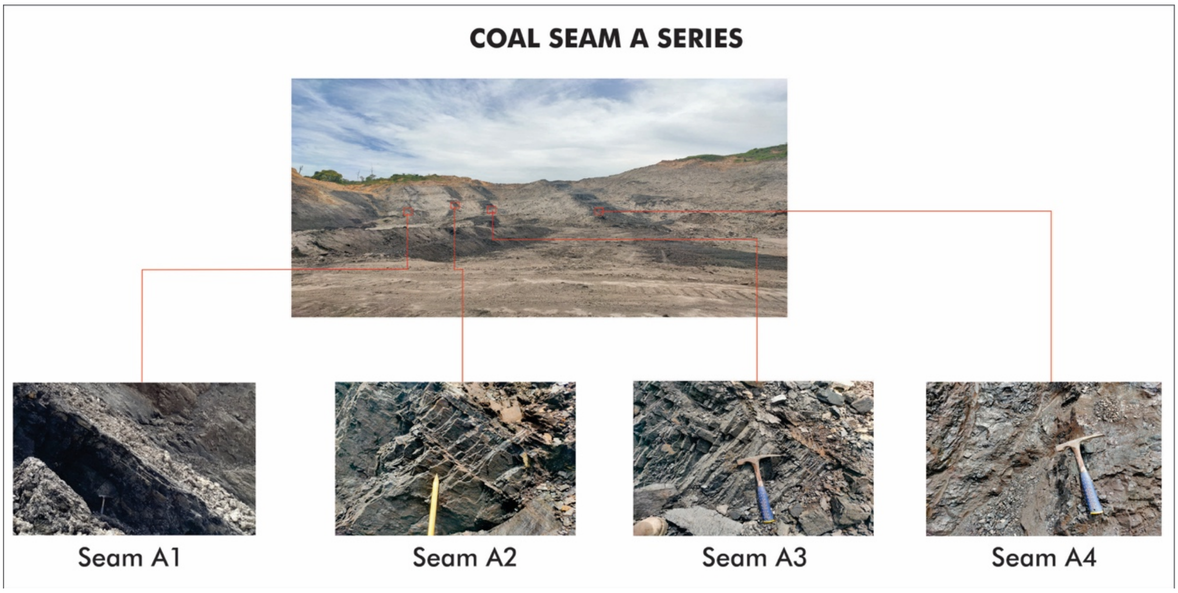


**Figure 7.** Coal seam A series in Pit Puntadewa

## Coal Quality

Relating to the focus of this study, the quality parameters coal is only emphasized in the following parameters: Inherent Moisture, Total Moisture, Ash, Volatile Matter, Fixed Carbon, total sulfur content, and calorific values (Table 1).

**Table 1.** Proximate analysis data

| Seam | LOC | X | Y | Z | THICK | Weight | TM (%) | IM (%) | ASH (%) | VM (%) | FC (%) | TS (%) | GCV adb | GCV ar | GCV daf | GCV Btu/lb | GCV Mj/kg | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1-P1 | N | 514028 | 9917156 | 15 | 0.45 | 8.320 | 17.94 | 9.20 | 19.27 | 37.31 | 34.22 | 0.81 | 5,247 | 4,742 | 7,335 | 13203 | 30.71165 | HvB |
| A1-P2 | N | | | | 0.4 | 9.780 | 15.98 | 12.98 | 7.66 | 37.02 | 42.34 | 1.42 | 5,802 | 5,602 | 7,311 | 13159.8 | 30.61116 | HvB |
| A1-P3 | N | 514028 | 9917156 | 15 | 1.2 | 10.220 | 17.48 | 11.33 | 3.87 | 40.79 | 44.01 | 0.93 | 6,320 | 5,882 | 7,453 | 13415.4 | 31.20571 | HvB |
| A1-P4 | N | 513738 | 9916490 | | 1 | 8.210 | 12.41 | 9.98 | 5.46 | 40.31 | 44.25 | 1.73 | 6,301 | 6,131 | 7,452 | 13413.6 | 31.20152 | HvB |
| A1-P1 | S | 513682 | 9916394 | | 1 | 8.220 | 13.36 | 10.36 | 1.81 | 42.59 | 45.24 | 1.83 | 6,533 | 6,314 | 7,438 | 13388.4 | 31.14291 | HvB |
| A1-P2 | S | 513767 | 9916514 | -48 | unmeasured | 9.040 | 14.25 | 11.13 | 2.25 | 41.65 | 44.97 | | 6,581 | 6,350 | 7,598 | 13676.4 | 31.81283 | HvB |
| A1-P3 | S | 513397 | 9916012 | | 1.2 | 6.32 | 12.88 | 9.19 | 1.3 | 42.85 | 46.66 | 1.64 | 6707 | 6,434 | 7493 | 13487.4 | 31.37319 | HvB |
| A2-P1 | N | 513999 | 9916901 | 15 | 1.68 | 7.710 | 15.05 | 10.03 | 17.09 | 36.33 | 36.55 | 6.40 | 5,291 | 4,996 | 7,260 | 13068 | 30.39762 | HvB |
| A2-P2 | N | 513761 | 9916417 | | unmeasured | 6.670 | 13.20 | 9.67 | 1.52 | 44.32 | 44.49 | 2.54 | 6,568 | 6,311 | 7,396 | 13312.8 | 30.96705 | HvB |
| A2-P3 | N | | | | 0.8 | 7.64 | 12.56 | 9.80 | 4.70 | 42.16 | 43.34 | 2.51 | 6,377 | 6,182 | 7,458 | 13424.4 | 31.22665 | HvB |
| A3-P1 | S | 513982 | 9916940 | 15 | 2.3 | 9.910 | 11.62 | 8.50 | 1.43 | 37.57 | 52.50 | 2.47 | 6,629 | 6,403 | 7,360 | 13248 | 30.81632 | HvB |
| A3-P2 | S | 513829 | 9916521 | | 1.52 | 11.370 | 12.40 | 9.14 | 2.06 | 44.13 | 44.67 | 1.88 | 6,503 | 6,270 | 7,323 | 13181.4 | 30.6614 | HvB |
| A3-P3 | S | | | | unmeasured | 8.04 | 11.49 | 8.49 | 1.36 | 44.31 | 45.84 | 1.75 | 6,736 | 6,515 | 7,472 | 13449.6 | 31.28526 | HvB |
| A4-P1 | S | 514042 | 9916918 | | 3.11 | 8.130 | 16.46 | 11.48 | 5.06 | 39.90 | 43.56 | 0.74 | 6,291 | 5,937 | 7,538 | 13568.4 | 31.56161 | HvB |
| A4-P2 | S | 513862 | 9916644 | 15 | 3.82 | 2.540 | 13.05 | 10.50 | 1.75 | 42.58 | 45.17 | 2.51 | 6386 | 6,204 | 7,277 | 13098.6 | 30.4688 | HvB |
| A4-P3 | S | | | | unmeasured | 10.410 | 11.13 | 9.97 | 0.95 | 43.68 | 45.40 | 1.32 | 6,590 | 6,505 | 7,398 | 13316.4 | 30.97543 | HvB |
| A4-P4 | S | | | | unmeasured | 8.720 | 10.67 | 9.73 | 1.07 | 44.59 | 44.61 | 1.54 | 6,523 | 6,455 | 7,313 | 13163.4 | 30.61953 | HvB |

## Inherent Moisture (IM)

The Inherent Moisture content in coal can be used for measuring high or low rank of coal. Moreover, the lower of Inherent Moisture value, the higher of the rank coal. The Inherent Moisture content is as the following: Seam A1 ranges from 9.19% - 11.33% with an average of 10.40%. Seam A2 ranges from 9.67% - 10.03% with an average of 9.83%. Seam A3 ranges from 8.49% - 9.97% with an average of 9.17%. Seam A4 10.50%.

**Total Moisture (TM)**
The Inherent Moisture content is as the following: Seam A1 ranges from 12.41% - 17.48% with an average of 14.08%., Seam A2 ranges from 12.56% - 15.05% with an average of 13.60%. Seam A3 ranges from 10.67% - 12.40% with an average of 11.46%. Seam A4 ranges from 13.05% - 16.46% with an average of 14.76%.

**Volatile Matter (VM)**
The Volatile Matter content of Volatile Matter on seam A1 ranges from 40.31% - 42.85% with an average of 41.64%. Seam A2 ranges from 36.33% - 44.32% with an average of 40.94%. Seam A3 ranges from 37.57% - 44.59% with an average of 42.86%. seam A4 ranges from 39.90% - 42.58% with an average of 41.24%.

**Fix Carbon (FC)**
In general, the value of Fix Carbon on seam A1 ranges from 44.01% - 46.66% with an average of 45.03%. seam A2 ranges from 36.55% - 44.49% with an average of 41.46%. seam A3 ranges from 44.61% - 45.84% with an average of 46.60%. seam A4 ranges from 45.17% - 43.56% with an average of 44.37 %.

**Total Sulphur (TS)**
The content of total sulfur from the main seams is as follows: seam A1 ranges from 0.93% - 1.83% with an average of 1.53%. seam A2 ranges from 2.51% - 6.40% with an average of 3.82%. seam A3 ranges from 1.32% - 2.47% with an average of 1.79%. seam A4 ranges from 0.74% - 2.51% with an average of 1.63%.

**Ash**
The Content of ash from the main seams is as follows: seam A1 ranges from 1.30% - 5.46% with an average of 2.94%. seam A2 ranges from 1.52% - 17.09% with an average of 7.77%. seam A3 ranges from 0.95% - 2.06% with an average of 1.37%. seam A4 ranges from 1.75% - 5.06% with an average of 3.41%.

**Calorific Value (GCV ar)**
The calorific value of coal seam is as follows: seam A1 ranges from 5882-6434 with an average of 6222 kal/gr. Seam A2 ranges from 4996 - 6311 with an average of 5830 kal/gr. Seam A3 ranges from 6270 - 6515 with an average of 6430 kal/gr. Seam A4 ranges from 5937 - 6204 with an average of 6071 kal/gr. From the table show that the trend of overall seam is stable value, range from 4742 - 6505 average value 6073 kal/gr.

**Coal Rank**
Based on the classification rank of ASTM (Figure 8), all coal seam in the research area (sample from pit Puntadewa) included as High Volatile B Bituminous Coal with Calorific Value as Btu/lb and MJ/kg, range from 13068 – 13415.4 Btu/lb and 30.39 – 31.20 MJ/kg.

LEGEND : SEAM A4, SEAM A3, SEAM A2, SEAM A1

| Class/Group | Fixed carbon limits (dry, mineral-matter-free basis), % | | Volatile matter limits (dry, mineral-matter-free basis), % | | Gross calorific value limits (moist,† mineral-matter-free basis) Btu lb⁻¹ | | Mj kg⁻¹‡ | | Agglomerating character |
|---|---|---|---|---|---|---|---|---|---|
| | Equal or greater than | Less than | Greater than | Equal or less than | Equal or greater than | Less than | Equal or greater than | Less than | |
| Anthracitic: | | | | | | | | | |
| Meta-anthracite | 98 | – | – | 2 | – | – | – | – | |
| Anthracite | 92 | 98 | 2 | 8 | – | – | – | – | Non-agglomerating |
| Semianthracite§ | 86 | 92 | 8 | 14 | – | – | – | – | |
| Bituminous: | | | | | | | | | |
| Low volatile bituminous coal | 78 | 86 | 14 | 22 | – | – | – | – | |
| Medium volatile bituminous coal | 69 | 78 | 22 | 31 | – | – | – | – | |
| High volatile *A* bituminous coal | – | 69 | 31 | – | 14,000¶ | – | 32.6 | – | Commonly |
| High volatile *B* bituminous coal | – | – | – | – | 13,000¶ | 14,000 | 30.2 | 32.6 | agglomerating** |
| High volatile *C* bituminous coal | – | – | – | – | 11,500 | 13,000 | 26.7 | 30.2 | |
| | | | | | 10,500 | 11,500 | 24.4 | 26.7 | Agglomerating |
| Subbituminous: | | | | | | | | | |
| Subbituminous *A* coal | – | – | – | – | 10,500 | 11,500 | 24.4 | 26.7 | |
| Subbituminous *B* coal | – | – | – | – | 9,500 | 10,500 | 22.1 | 24.4 | |
| Subbituminous *C* coal | – | – | – | – | 8,300 | 9,500 | 19.3 | 22.1 | |
| | | | | | | | | | Non-agglomerating |
| Lignitic: | | | | | | | | | |
| Lignite *A* | – | – | – | – | 6,300†† | 8,300 | 14.7 | 19.3 | |
| Lignite *B* | – | – | – | – | – | 6,300 | – | 14.7 | |

*This classification does not apply to certain coals.
†Moist refers to coal containing its natural inherent moisture but not including visible water on the surface of the coal.
‡Megajoules per kilogram. To convert British thermal units per pound to megajoules per kilogram, multiply by 0.002326.
§If agglomerating, classify in low volatile group of the bituminous class.
¶Coals having 69% or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of gross calorific value.
**It is recognized that there may be non-agglomerating varieties in these groups of the bituminous class, and that there are notable exceptions in the high volatile‡ bituminous group.
††Editorially corrected.
Soruce: reprinted with permission from ASTM D388–1999.

**Figure 8.** ASTM classification of coal rank

The rank of each seams is as follows:
Seam A1: Volatile Matter content 40.79%, Fixed Carbon 44.01%, Calorific Value 7453 daf (13415.4 Btu/lb and 31.20 MJ/kg). Included as High Volatile B Bituminous Coal.
Seam A2: Volatile Matter content 36.33%, Fixed Carbon 36.55%, Calorific Value 7260 daf (13068 Btu/lb and 30.39 MJ/kg). Included as High Volatile B Bituminous Coal.
Seam A3: Volatile Matter content 37.57%, Fixed Carbon 52.50%, Calorific Value 7360 daf (13248 Btu/lb and 30/81 MJ/kg). Included as High Volatile B Bituminous Coal.
Seam A4: Volatile Matter content 42.58%, Fixed Carbon 45.17%, Calorific Value 7277 daf (13098 Btu/lb and 30.46 MJ/kg). Included as High Volatile B Bituminous Coal.

## COAL DISTRIBUTION AND CONTINUITY

The coal seam in research area is a part of anticline that divided in two flanks (east flank and west flank). In the research area focused on east flank. The data showed using actual topography survey data and borehole data to obtain distribution section of coal seam and isopach or distribution of thickness generated by minescape with in grid and interpolator fem classified. The coal seam dominantly has north east – south west direction. The coal seam included to A series with high coal value consist of four seams: A1, A2, A3, A4. Those seams parted with interburden with thickness about 36 meters between A1 to A2, interburden about 7.5 meters between A2 to A3, interburden about 18.7 meters between A3 to A4 (Figure 9).

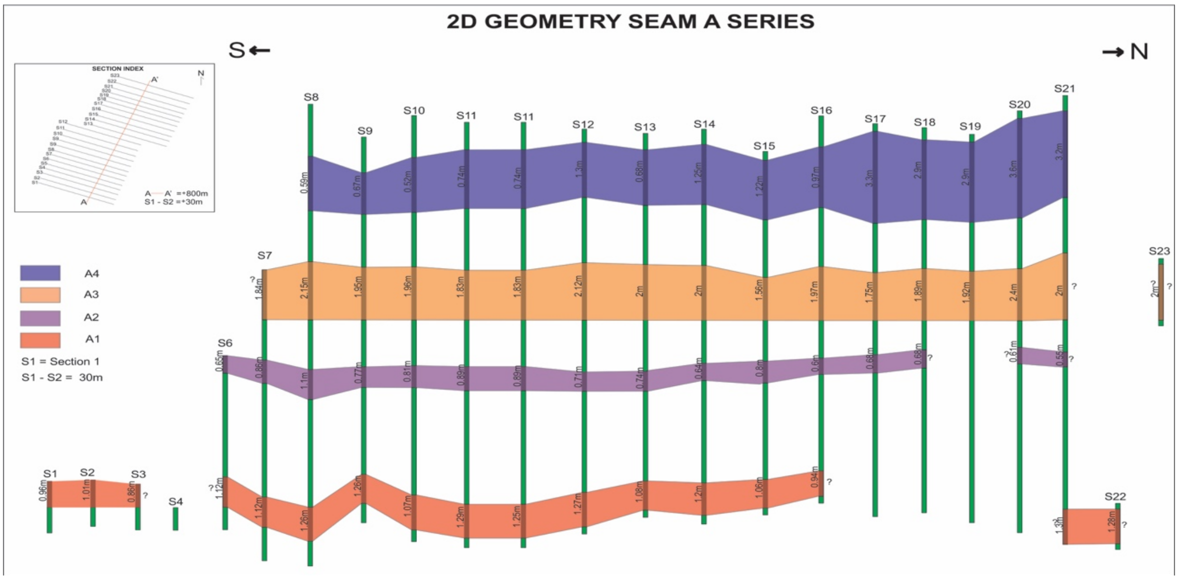


**Figure 9.** Section geometry seam A series

The thickness variation of A1 about 0.96 meter to 1.3 meter. From the picture above show that the linear trend of coal thickness relatively well orders (Figure 9). The distribution pattern of coal following the strike and dip of coal also relatively regular orders and continue to north east – south west direction. There are discontinuity in northern part of the seam. This phenomenon interpreted as leeve or channel that developed and interupted this seam. Roof and floor present as carbonaceous shale. There is no parting in seam A1 (Figure 10).

The thickness variation of A2 about 0.55 meter to 1.1 meter. From the graphic below show that the linear trend of coal thickness relatively well orders (Figure 9). The distribution pattern of coal following the strike and dip of coal and continue to the north east – south west direction. The seam thickness are relatively regular orders and continued. There is no splitting in this seam. Roof present as claystone while floor present as carbonaceous shale. There is no parting in this seam. (Figure 10).

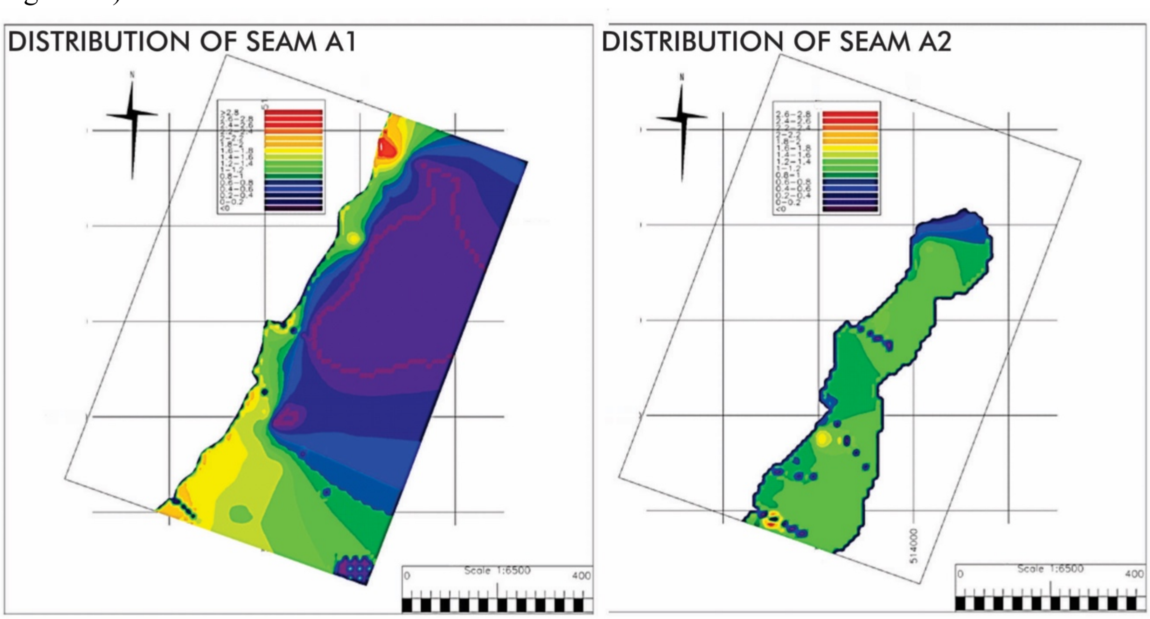


**Figure 10.** Seam thickness distribution of seam A1 and A2

The thickness variation of seam A3 about 1.84 meter to 2.4 meter. From the graphic below show that the trend of coal is thickening to the north (Figure 9). The distribution pattern of coal following the strike and dip of coal also relatively regular orders and continue to the north east – south west direction. There is no splitting in this seam. Roof present as carbonaceous shale while floor present as carbonaceous claystone. There is no parting in this seam. (Figure 11).

The thickness variation of A4 about 0.52 meter up to 7 meter. From the graphic below show that the linear trend of coal thickness relatively thickening to the north (Figure11). The distribution pattern of coal following the strike and dip of coal also relatively regular orders and continue to north east – south west direction.

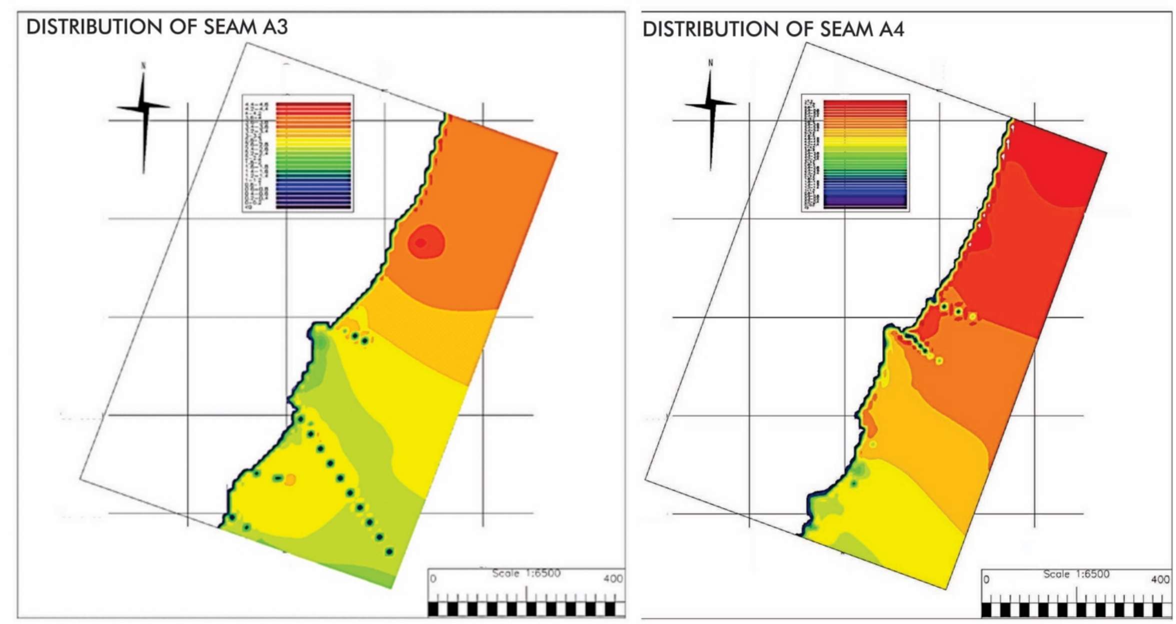


**Figure 11.** Seam thickness distribution of seam A3 and A4

The continuity of all seam disturbs and constrain by several fault, there are left slip fault in northwest-southeast direction as main fault also three antithetic fault relatively east-west direction (Figure 12).

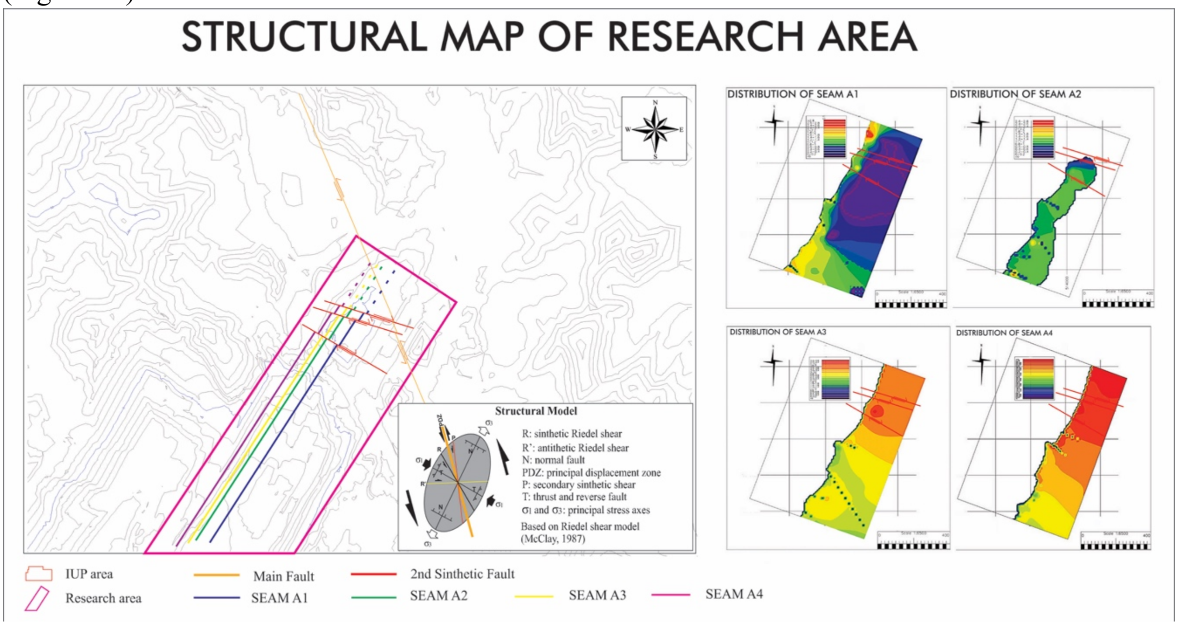


**Figure 12.** Structural map of research area

**IMPLICATION TO COAL QUALITY**

According to Diessel (1992), coal which has a high sulfur value generally comes from the topogenic swamp type which has a high pH value (> 5) and a high water level, generally a swamp that develops in a lower delta plain environment. Coal with a low sulfur value (<1%) generally comes from topogenic peat with high water levels and low pH (<5), generally a swamp that develops in terrestrial environments, such as in the upper delta plain environment.

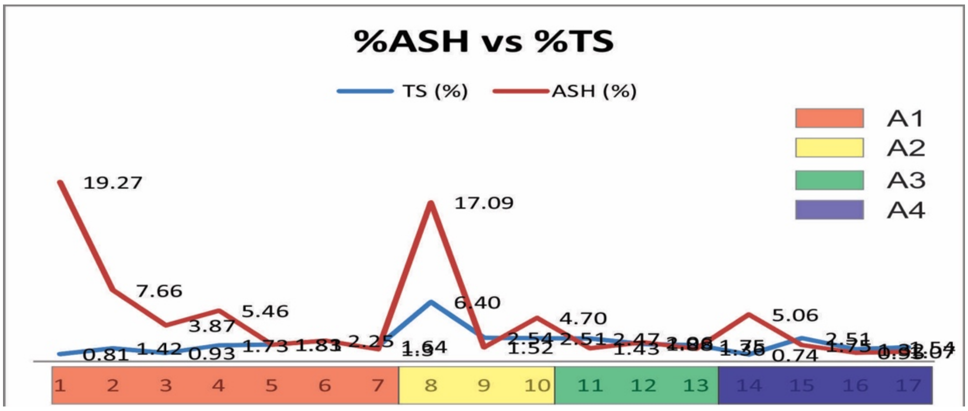


**Figure 13.** Trend of Ash% vs TS%

In general, the graph trend of total sulfur and total ash is directly proportional, but in some parts are different whereas the graph trend of total sulfur (low) inversely proportional to the graph trend of total Ash (high). Coal seam A1 to A4 generally have low to medium ash yield 19.27 to 0.9 (wt.%, db) and low total sulfur content of <1-2 (wt.%, db), except for the sample 1 seam A1, 8 seam A2 and 14 seam A4 which have relatively high ash yield >5 (wt.%,db).

Based on facies analysis in the research area, coal seam developed in the backswamp facies in the fluvial - upper delta plain environment. It means the coal seam A1 – A4 is formed in the topogeneous mire in freshwater peat swamp but there is no invasion or flooding of seawater. The sulfur content contained in coal can be interpreted from an organic material or the parent plant material or sulfur containing mineral authigenetically.

However, the trend of ash values in seam A1, A2 in northern part is relatively high ash yield >5 (wt.%,db). This is may caused by the presence of partings which are generally in the form of clay material. This environment may possible because the sedimentation process in the backswamp facies is controlled by the rising of swamp by long phases of tides that penetrated with marine water may be identified as resultant of high TS value also the rates of sedimentation from overbank or tidal flooding (clastic contamination) that form claystone parting and also supported by the occurrence of syngenetic mineral content (framboidal pyrite) and epigenetic pyrite may increase the ash content.

**D. CONCLUSION**

The following conclusion can be drawn from this case study that, all seam series deposited in claystone unit of Pulaubalang Formation. Sediment facies of coal bearing strata was laminated claystone intercalated with coal. These facies developed in backswamp deposit that influenced by floodplain in fluvial – upper delta plain environment. The distribution and variation of sulfur content are closely related to the coal deposition environment. The coal formed in topogeneous mire in freshwater peat swamp. Invasion or flooding of seawater also minerals matter contained in coal in form of detrital minerals, plant-derived minerals, and authigenic minerals plays important role in which sulfur and ash forming. Those seams included to high coal value range from 5926 – 6365 cal/g (adb) and 7441 – 7498 cal/g (daf). Furthermore, the geometry of coal controlled both sedimentation and structural geology in term of seam distribution and continuity. The thickness of seam is relatively equal but, in several area developed parting, washout also faulting that interrupt the continuity of coal seam. By knowing the geological conditon, this method can be applied in assisting mining development strategies both geological modelling and reserve/resource estimation.

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