COMPARATIVE PETROGRAPHY OF OMBILIN AND BAYAH COALS RELATED TO THEIR ORIGIN

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ABSTRACT

Two coalfields have been contrasted and compared on the basis of qualitative and quantitative studies of macerals and minerals. Petrological comparison of the coals indicates that vitrinite and liptinite contents within Ombilin coal are higher than those of the Bayah coal. The inertinite content of both coals is somewhat similar. Mineral matter of Bayah coal is higher than that of Ombilin coal. The vitrinite reflectance and rank of the Ombilin coal is higher and thus, its coal rank (sub-bituminous to anthracite) is better than that of the Bayah coal (sub-bituminous to medium volatile bituminous). A clear distinction between the Ombilin and Bayah coals is not possible with petrographic methods alone, and other geological parameters have to be considered. The maceral compositions of the Ombilin and Bayah coals are slightly different from each other due to intrusion effect. In the thermally affected coals from both areas, liptinite generally cannot be distinguished from vitrinite and therefore it appears to contain high proportion of vitrinite (>90 %). However, thermally unaffected coals from both coalfields contain <90 % of vitrinite. Liptinite maceral is common in coals unaffected by contact alteration with some samples containing up to 10 %. In contrast, thermally affected coals have trace amounts of liptinite. Both thermally affected and affected coals contain rare inertinite with some samples containing up to 7 %. In some cases, coals with high inertinite content have a relatively high amount of mineral matter. The Ombilin and Bayah coals show variable vitrinite reflectances, due to igneous intrusion factor. Coal of lower rank has been metamorphosed to bituminous or anthracitic ranks. The extent of rank increase depends primarily on distance from the intruding igneous rock, but it may also be related to size and temperature of the intrusion. As the vitrinite reflectance (Rvmax) values of the Ombilin coal (0.62-4.69 %) are higher compared to the Bayah coal (0.53-1.23 %), this suggests that the heat source to the thermally affected coals is closer in the Ombilin coal than that of in the Bayah coal.

Keywords: Ombilin, Bayah, comparative petrography, coal

1. INTRODUCTION

Maceral compositions of various Indonesian Tertiary coals are slightly different one to another. Factors that cause these variations include intrusion effects and age. In this study, in thermally affected coals from the Ombilin and Bayah coalfields, liptinite or exinite generally cannot be distinguished from vitrinite. As a result, it appears to contain high proportion of vitrinite, i.e. >90 %. On the other hand, thermally unaffected coals from those coalfields contain <90 % of vitrinite (Santoso and Daulay, 2005; 2007).

The rank of coal is usually considered to be largely controlled by the temperature level under confining pressure, reached by the organic matter and partly by the time during the effects were maintained (Teichmuller and Teichmuller, 1982). Increased burial depth, temperature and pressure over a period of time consequently result in higher rank. Igneous activity can locally increase the heat supply and cause increases in the rank of nearby coal seams.

For these interesting phenomena, the study is aimed to obtain an understanding of the following aspects :

a) to determine the type and rank characteristics of the coals by establishing maceral analyses and reflectance measurements;

b) to examine the effect of igneous intrusion on the type and rank of the coals;

c) to compare of coals petrology.

To achieve the aims, analyses of the Ombilin and Bayah coalfields are included in the present study.

2. ANALYTICAL METHOD

Coal samples for this study were collected from borehole cores and spot samples of Tertiary Ombilin and Bayah coalfields. The procedures, preparation, terminology and techniques used for the study were based on the Standards Association of Australia (1964, 1966, 1975, 1977, 1981a, 1981b, 1983 and 1986).

Thirty-six (36) coal samples from the Ombilin coalfield and twenty-one (21) coal samples from the Bayah coalfield were prepared for petrographic examination according to the techniques developed in the coal laboratory, Research and Development Centre for Mineral and Coal Technology.

Method of preparation of polished particulate coal mounts for microscopic analysis included crushing, embedding, grinding and polishing. Microscopic examination of the polished blocks was undertaken using a reflected light Leitz Orthoplan microscope fitted with a fluorescence mode.

Maceral analysis was based on counting of 500 points using the Swift Automatic Point Counter attached to the microscope. The maceral data were calculated as follows:

- mineral matter counted: % vitrinite + liptinite + inertinite + mineral matter = 100

- mineral matter free basis: % vitrinite + liptinite + inertinite = 100

The measurements on vitrinite reflectance were carried out based on 100 points obtained on each sample from which the mean random reflectance (Rvrnd) and the standard deviation (s) were calculated. In addition, a total of 30 measurements were taken on each sample from which the mean maximum reflectance (Rvmax) and deviation (s) were also calculated.

3. GEOLOGICAL SETTING

3.1 Ombilin

According to De Coster (1974), Harsa (1975) and Koning (1985), the Ombilin coalfield, situated on the northwest margin of the Eocene Ombilin Basin in central west Sumatera, is structurally controlled by wrench faulting related to the Great Sumatera Fault Zone (Figure 1).

Palaeogene cycle of sedimentation in the basin indicates the initial terrestrial phase of Tertiary sequence (Koesoemadinata, 1978; Eubank and Makki, 1981). The Palaeogene sequence was deposited in an intermontane basin that developed at the beginning of the Tertiary when the pre-Tertiary landmass was block-faulted into grabens. The graben-like basin was filled from all sides by alluvial fans, while several lakes existed in the central basin. As the topographic relief decreased, the basin became an alluvial valley with meandering rivers followed by a braided river system prior to be folded and uplifted in the Early Miocene. A number of sub-parallel anticlines and synclines are present in the basin, mostly bounded by major faults, which trend principally east-west, northeast-southwest and northwest-southeast. The coal measures occur in two stratigraphic units: the Sawahlunto Formation and the Poro Member of the Sawahtambang Formation. Three coal seams (A, B and C) occur in the Sawahlunto Formation (Figure 2). Coal seams of the Poro Member of the Sawahtambang Formation are exposed on the southeast part of the basin. The seams are very thin (15 to 18 cm of thickness).

3.2 Bayah

According to Koesoemadinata (1978), Palaeogene and Neogene coals are not well developed in Java. Terrestrial pre-transgressive sedimentation occurred in Banten only Bayah, Cihideung and Cimandiri areas and resulted in coal deposition,

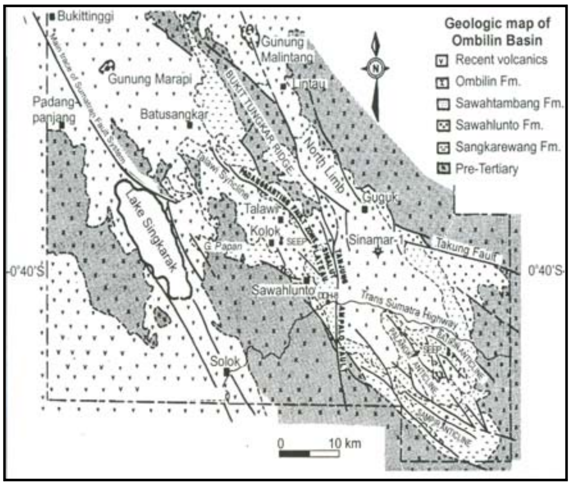

Figure 1. Ombilin intermontane basin (Koning, 1985)

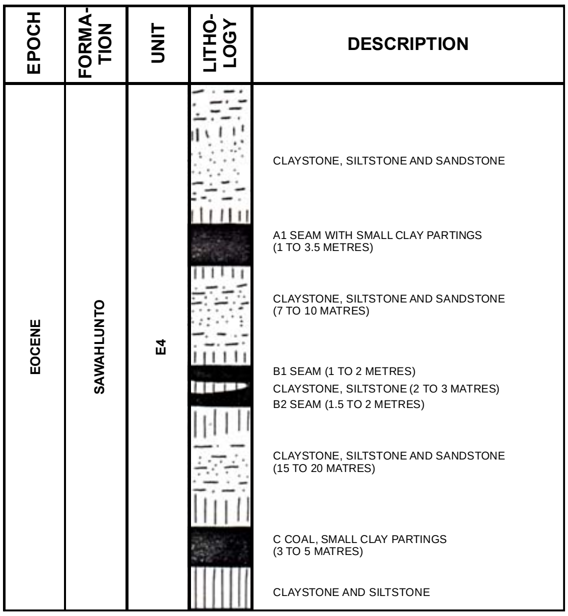

Figure 2. Stratigraphic sequence of the Ombilin coal measures (Marubeni-Kaiser, 1971)

whereas in Central and East Java sedimentation was associated with a marine transgression that occurred over pre-Tertiary basement. The Palaeogene coals include in a monotonous series of quartz-sandstones (partly conglomeratic) and claystones of the Bayah Formation (Figures 3 and 4). The Eocene sediments are strongly folded, particularly in Cimandiri area. In this area, the coal seams reach dips of up to 90º (Koesoemadinata and Matasak, 1981). Some small andesite intrusions occur in Cimandiri. The coal

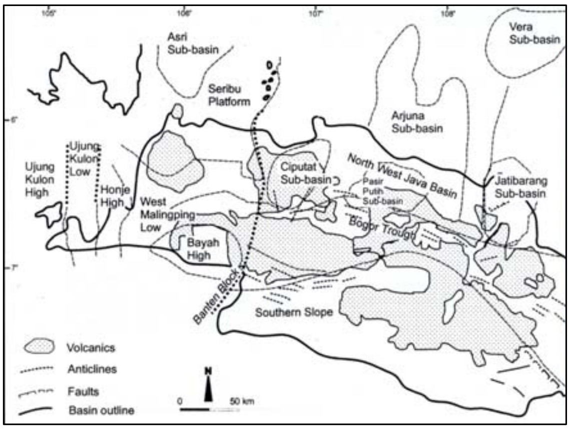

Figure 3. Tectonic map of Banten and West Java

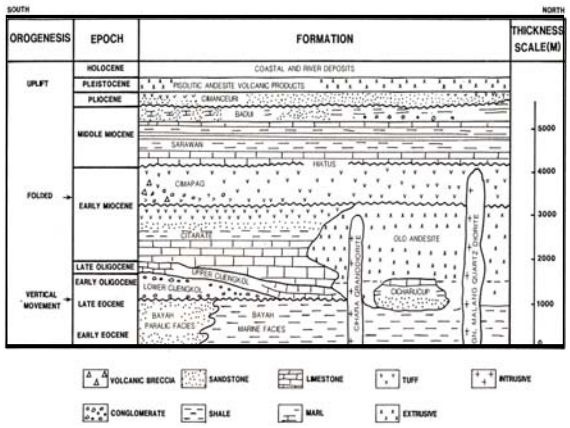

Figure 4. Stratigraphic diagram of Banten area (Katili and Koesoemadinata, 1962)

seams rarely exceed a thickness of one meter unless an exception are two meters of thickness.

Up to nine seams occur in some sections (Koesoemadinata and Matasak, 1981). In some localities, the coals are highly lenticular. No reliable index-strata are available for correlation of the various coal measures. The Neogene coal seams occur in an upper Miocene tuffaceous series that consists of sandstones, mudstones, conglomerates, pumiceous and quartz-bearing tuffs and tuff-breccias.

4. PETROLOGY

4.1 Ombilin

Petrographic studies of 36 coal samples from four coal seams namely A, B1, B2 and C in the Ombilin Coalfield illustrate that all samples are composed mainly of vitrinite and liptinite with inertinite being rare (Table 1). Slightly different maceral compositions exist between the coal seams. For example, vitrinite content increases slightly from seam A to C. Thermally affected coals commonly contain vitrinite and rare inertinite but no recognizable liptinite.

Vitrinite content in the Ombilin coals has a range between 80 and 99 % with average of 90 %. Detrovitrinite forms a matrix for isolated thin bands of telovitrinite and for liptinite (Figure 5). The detrovitrinite matrix comprises >50 % of the total vitrinite in most of the coal samples. Gelovitrinite (mainly corpovitrinite and porigelinite) takes place throughout the coals, which are commonly associated with suberinite.

Liptinite content varies from 1 to 9 %, with average of 6 %. Cutinite, resinite and liptodetrinite are the dominant liptinite macerals, although suberinite and sporinite are dominant in some

Table 1. Maceral composition of the Ombilin coals

Location	Seam	Vitrinite (%)				Inertinite (%)				Liptinite (%)				MM
		Tv	Dv	Gv	Tot	Sf	Scl	Inert	Tot	Res	Cut	Sub	Tot	(%)
Tanah Hitam o/c	A	47	33	5	85	-	tr	tr	tr	-	6	3	9	1
		21	57	10	88	-	-	-	-	-	1	tr	1	tr
		23	51	8	82	tr	tr	tr	tr	1	5	2	8	3
		23	50	13	86	tr	tr	tr	tr	tr	4	4	8	1
Sawah Rasau u/g	A	29	56	10	95	tr	tr	1	1	tr	1	tr	1	tr
		19	58	10	87	-	tr	tr	tr	tr	5	1	6	1
		37	49	10	96	-	1	1	2	tr	1	tr	1	-
		38	48	5	91	tr	2	1	3	1	2	tr	3	1
		24	51	9	84	tr	tr	1	1	1	1	1	3	3
Tanah Hitam o/c	B1	24	49	16	89	1	1	1	3	1	tr	tr	1	2
		19	58	13	90	tr	2	1	3	1	1	tr	2	1
Sawah Rasau u/g	B1	14	65	5	84	tr	1	tr	1	tr	4	tr	4	6
		23	60	9	92	tr	1	1	2	1	2	tr	3	1
Tanah Hitam o/c	B2	19	65	9	93	1	2	1	4	1	tr	tr	1	tr
		28	51	11	90	tr	1	1	2	tr	4	1	5	1
Sawah Rasau u/g	B2	17	68	7	92	1	1	1	3	1	4	tr	5	tr
		66	25	5	96	-	tr	tr	tr	1	1	tr	2	1
		19	61	5	85	tr	1	-	1	tr	3	-	3	3
		41	47	7	95	tr	-	1	1	1	1	1	3	tr
		42	49	1	92	tr	1	1	2	-	3	1	4	tr
		39	42	14	95	-	tr	-	tr	tr	3	tr	3	-
BH7 Parambahan	B	23	57	8	88	1	2	1	4	1	2	-	3	3
		26	54	6	86	1	2	1	4	tr	5	tr	5	3
		40	41	9	90	tr	2	1	3	1	2	1	4	2
		36	36	8	80	2	1	-	3	tr	3	2	5	11
		19	54	13	86	tr	3	3	6	1	1	1	3	1
Tanah Hitam o/c	C	35	53	6	94	-	tr	tr	tr	-	tr	2	2	tr
		33	50	8	91	-	1	2	3	-	1	3	4	-
		99	-	tr	99	1	tr	-	1	-	-	-	-	tr
		99	-	-	99	tr	1	-	1	-	-	-	-	tr
		20	62	6	88	1	1	tr	2	tr	1	tr	1	7
		33	55	5	93	tr	1	tr	1	1	2	1	4	-
Sawah Rasau u/g	C	26	48	18	92	tr	tr	tr	tr	tr	4	2	6	tr
		32	50	12	94	tr	tr	-	tr	1	3	1	5	tr
BH7 Parambahan	C	33	48	8	89	1	2	tr	3	1	3	tr	4	2
		38	45	8	91	tr	1	1	2	1	1	tr	2	4

Notes: Tv : telovitrinite, Dv : detrovitrinite, Gv : gelovitrinite, Sf : semifusinite, Scl : sclerotinite, Inert : inertodetrinite, Res: resinite, Cut : cutinite, Sub : suberinite, MM : mineral matter, Tot : total, o/c : open cut, u/g : underground, tr : trace.

Content

Figure 5. Detrovitrinite (grey), liptinite (black) and pyrite (white) of the Ombilin coal. Rvmax: 0.55 %, field width: 0.28 mm, reflected white light

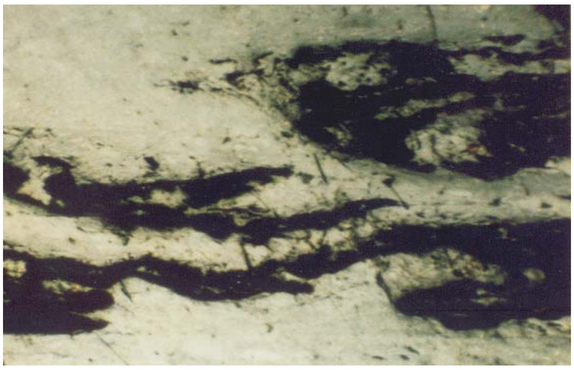

Figure 6. Cutinite (black) in vitrinite (grey) of the Ombilin coal. Rvmax: 0.65 %, field width: 0.28 mm, reflected white light

occurrences. Fluorinite, exsudatinite and alginite occur in a few samples and are rare. Cutinite constitutes over 5 % of some samples and occurs mostly as thin-walled cutinite (tenuicutinite). The cutinite has a weak to moderate intensity orange fluorescence (Figures 6 and 7), and in some cases, it does not fluoresce. Liptodetrinite constitutes up to 6 % of some samples in the Ombilin coals. The liptodetrinite has low reflectance and yellow to orange fluorescence. Resinite is present in most of the samples, although its content is a trace up to 1 %. The resinite occurs as discrete small bodies (<0.06 mm). It has greenish yellow to yellow fluorescence. Suberinite constitutes >2 % of some coal samples. It typically shows a weak orange fluorescence, but in some cases it does not fluoresce. Non-fluorescing suberinite is difficult to distinguish from vitrinite. Sporinite is a dominant liptinite maceral in some samples. It has yellow to orange fluorescence. Fluorinite is rare in the coals. It has greenish yellow fluorescence. Alginite is present in some samples. Its content is variable, ranging from trace to 2 %. It has yellow to orange fluorescence. Significant variation in liptinite fluorescence colours exists in the samples.

Inertinite is a minor constituent in the samples. The inertinite content varies between a trace and 6 %, with average of 2 %. Sclerotinite is the dominant inertinite group maceral consisting of sclerotia, single and twin-celled teleutospores and teleutospores with three and four cells. Semifusinite occurs as thin layers and rarely as isolated lenses in detrovitrinite matrix. Inertodetrinite constitutes 1 % (average) of the Ombilin coals. It occurs as angular and irregular forms disseminated throughout the coals.

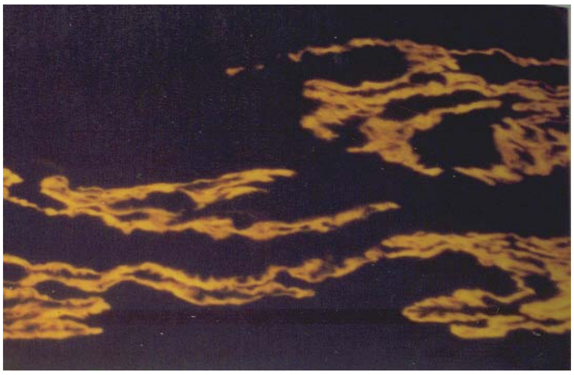

Figure 7. Cutinite (yellow) in vitrinite (black) of the Ombilin coal. Rvmax: 0.65 %, field width: 0.28 mm, fluorescence mode

Mineral matter includes mainly clay and pyrite and it is rare in the Ombilin coals. It generally constitutes a trace to 11 %. Most of the mineral matter occurs as pods disseminated throughout the coals. Framboidal pyrite (Figure 5) is common in the thinner seam.

The liptinite and inertinite contents of the Ombilin coals are systematically related to vitrinite content. The liptinite and inertinite contents decrease with increase in vitrinite content. The liptinite content is not related to the inertinite content.

Mean maximum vitrinite reflectance (Rvmax) values were obtained on thirty-six samples from Sawahlunto Formation of Ombilin Coalfield (Table 2). Most of the samples are high volatile bituminous rank (Rvmax of 0.62-0.77 %), although one sample is sub-bituminous (Rvmax of 0.55 %). The low vitrinite reflectance value of some samples may be due to the presence of alginite (Hutton and

Cook, 1980). The rank of the isolated coals increases sharply into anthracite stage. This change is presumably associated with heating from a local intrusion.

4.2. Bayah

Maceral analyses of twenty-one Bayah coals show that vitrinite is the dominant maceral over liptinite, and inertinite is rare. Mineral matter (mainly clay and pyrite) is significantly high (Table 3).

Vitrinite of the coals varies between 71 and 96 % (average of 88 %). The vitrinite mostly occurs as thick layers with detrovitrinite matrix interbedded with thin layers of telovitrinite (Figure 8). Gelovitrinite including corpovitrinite and porigelinite is present throughout the coals.

Cutinite and resinite are the dominant liptinite macerals. Sporinite, suberinite, liptodetrinite, fluorinite and exsudatinite are present in some samples. Cutinite is the dominant liptinite maceral

Table 2. Rank of Ombilin coals (Australian standard)

Location	Seam	Rv_{max} (%)	Range	Rank
Tanah Hitam o/c	A	0.63 0.64 0.62 0.68	0.57-0.69 0.59-0.70 0.54-0.70 0.62-0.74	High volatile bituminous High volatile bituminous High volatile bituminous High volatile bituminous
Sawah Rasau u/g	A	0.71 0.64 0.67 0.68 0.62	0.60-0.72 0.58-0.70 0.60-0.74 0.60-0.82 0.57-0.69	High volatile bituminous High volatile bituminous High volatile bituminous High volatile bituminous High volatile bituminous
Tanah Hitam o/c	B1	0.64 0.64	0.57-0.69 0.56-0.70	High volatile bituminous High volatile bituminous
Sawah Rasau u/g	B1	0.55 0.65	0.46-0.63 0.59-0.71	Sub-bituminous High volatile bituminous
Tanah Hitam o/c	B2	0.68 0.64 0.71	0.61-0.75 0.59-0.71 0.66-0.80	High volatile bituminous High volatile bituminous High volatile bituminous
Sawah Rasau u/g	B2	0.71 0.62 0.71 0.70 0.72	0.61-0.80 0.54-0.71 0.65-0.78 0.64-0.78 0.67-0.78	High volatile bituminous High volatile bituminous High volatile bituminous High volatile bituminous High volatile bituminous
BH7 Parambahan	B	0.75 0.76 0.77 0.77 0.64 0.63	0.70-0.81 0.72-0.87 0.69-0.83 0.72-0.82 0.56-0.73 0.57-0.67	High volatile bituminous High volatile bituminous High volatile bituminous High volatile bituminous High volatile bituminous High volatile bituminous
Tanah Hitam o/c	C	0.62 **4.69** **3.39** 0.68 0.64	0.57-0.66 4.59-4.77 3.30-3.51 0.60-0.79 0.59-0.75	High volatile bituminous **Anthracite** **Anthracite** High volatile bituminous High volatile bituminous
Sawah Rasau u/g	C	0.70 0.68	0.65-0.77 0.61-0.75	High volatile bituminous High volatile bituminous
BH7 Parambahan	C	0.75 0.77	0.69-0.84 0.73-0.81	High volatile bituminous High volatile bituminous

Notes: o/c-open cut, u/g: underground

Content

Table 3. Maceral composition of the Bayah coals

Location	Vitrinite (%)				Inertinite (%)				Liptinite (%)				MM
	Tv	Dv	Gv	Tot	Sf	Scl	Inert	Tot	Res	Cut	Sub	Tot	(%)
	70	18	5	93	tr	tr	1	1	1	3	-	4	2
	60	22	5	87	1	1	1	3	tr	1	-	1	9
	36	47	5	88	tr	tr	tr	tr	1	2	-	3	8
	37	47	6	90	1	1	1	3	1	1	-	2	4
Bayah	39	48	5	92	1	1	1	3	1	1	-	2	3
	37	40	6	83	tr	tr	tr	tr	2	1	-	3	13
	44	36	8	88	-	tr	tr	tr	-	1	1	2	10
	47	33	8	88	2	1	1	4	1	1	-	2	6
	34	55	5	94	-	1	tr	1	1	3	-	4	2
	54	33	6	93	tr	tr	-	tr	1	1	-	2	4
	35	41	15	91	tr	1	-	1	1	tr	-	1	7
	36	44	13	93	tr	1	-	1	1	1	-	2	3
Cimandiri	44	37	9	90	1	1	2	4	2	1	1	4	1
	45	33	11	89	1	1	1	3	3	1	1	5	2
	48	33	9	90	tr	1	1	2	3	1	1	5	2
	51	26	4	81	3	2	2	7	2	6	tr	8	4
	53	16	2	71	3	2	2	7	2	8	tr	10	10
Cihideung	66	16	3	85	2	2	2	6	tr	7	tr	7	2
	82	9	1	92	1	-	-	1	-	-	tr	tr	7
	96	tr	-	96	-	-	-	-	-	-	-	-	4
	75	16	1	92	1	1	tr	2	-	-	-	-	6

Notes: Tv : telovitrinite, Dv : detrovitrinite, Gv : gelovitrinite, Sf : semifusinite, Scl : sclerotinite, Inert : inertodetrinite, Res : resinite, Cut : cutinite, Sub : suberinite, MM : mineral matter, Tot : total, Tr : trace

(up to 7 %) and mostly occurs as thin cuticles (Figure 9). It has greenish yellow to yellow fluorescence. Resinite, the other dominant liptinite maceral (up to 3 %) occurs as discrete small bodies (<0.06 mm) of various shapes. The resinite has the same fluorescence as the cutinite. Sporinite constitutes a trace to 1 % and it has greenish yellow to yellow fluorescence. Suberinite is rare in the coals and has weak yellow to orange fluorescence, but in some cases it does not fluoresce. Liptodetrinite and fluorinite are rare in the coals having the same fluorescence as greenish yellow. Both are disseminated throughout the coals. Exsudatinite is also rare in the coals occurring mostly infilling joints or bedding-plane cracks. The exsudatinite has strong greenish yellow to yellow fluorescence (Figures 10 and 11).

Inertinite maceral of the coals includes semifusinite, sclerotinite and Inertodetrinite. The semifusinite content is up to 3 %; the sclerotinite and inertodetrinite are up to 2 %. Both sclerotinite and inertodetrinite are scattered throughout the coals. The sclerotinite includes single and twin-celled teleutospores and sclerotia. Some cell lumens are filled by mineral matter. The inertodetrinite occurs as small high reflecting particles (<0.02 mm).

Mineral matter of the coals are mainly clay and pyrite varying between 1 and 6 % (average of 4 %) with few samples containing up to 13 % of mineral matter. The clay and pyrite (consisting of framboidal and massive grain structures) mostly occur as pods disseminated throughout the coals. In some cases, they infill cell lumens.

The vitrinite, liptinite and inertinite contents of the Bayah coals are systematically related to each other. The liptinite and inertinite contents decrease with increases in vitrinite content. The liptinite content tends to increase in inertinite content.

Twenty-one coal samples were examined for vitrinite reflectance and the result is given in Table 4. The coals range from sub-bituminous to high volatile bituminous rank (Rvmax between 0.53 % and 0.83 %). In some areas, vitrinite reflectance of the coals increases locally (ranging from 0.99 % to

Content

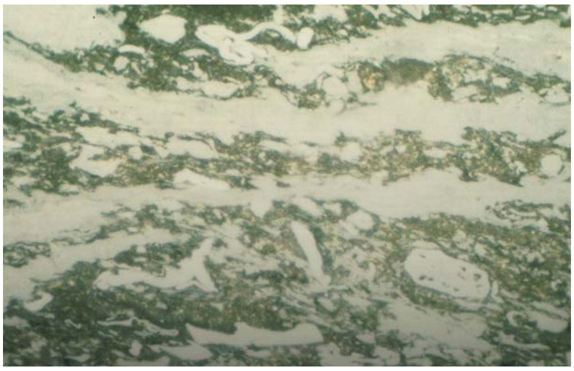

Figure 8. Telovitrinite (grey, long) interbedded with detrovitrinite (grey, short) and clays (black) of the Bayah coal. Rvmax: 0.70 %, field width: 0.28 mm, reflected white light

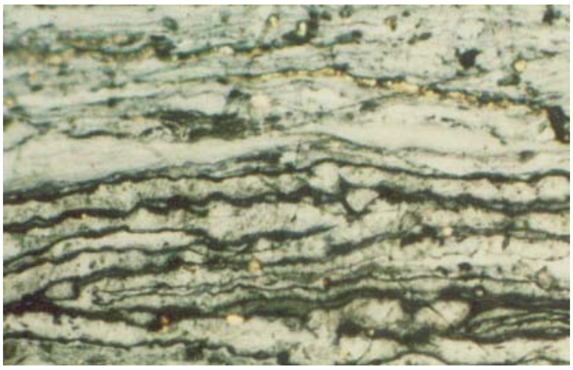

Figure 9. Cutinite (black) and vitrinite (grey) of the Bayah coal. Rvmax: 0.64 %, field width: 0.44 mm, reflected white light

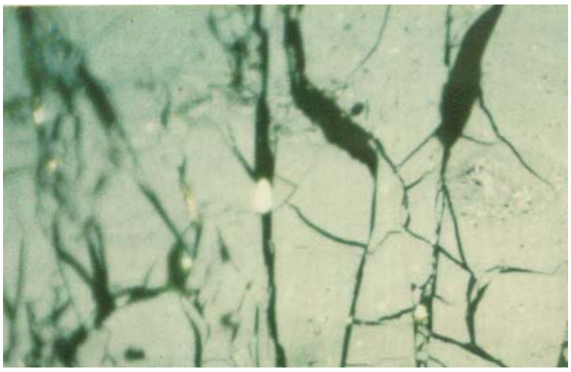

Figure 10. Exsudatinite (black) infilling the fractures of vitrinite (grey). Rvmax: 0.65 %, field width: 0.28 mm, reflected white light

Figure 11. Exsudatinite (yellow) infilling the fractures of vitrinite (black). Rvmax: 0.65 %, field width: 0.28 mm, fluorescence mode

1.33 %). This change is associated with an igneous intrusion.

5. COMPARATIVE PETROGRAPHY

The petrology in terms of the type and the rank of the Ombilin and Bayah coals is compared one with another. Table 5 shows maceral composition and rank of the coals.

The vitrinite content of the Ombilin coal is higher (90.2 %) than that of the Bayah coal. The vitrinite group of these coals is dominated by detrovitrinite, telovitrinite and gelovitrinite. However, the detrovitrinite is somewhat higher in the Ombilin coal. The liptinite content is relatively low in all the coals, which are 3.4 % in the Ombilin and 2.7 % in the Bayah coals. Both of these coals are dominated by cutinite, resinite and suberinite. Like the liptinite content, the inertinite content of all the coals is also relatively low that are 2 % in the Ombilin and 2.5 % in the Bayah coals. Sclerotinite, inertodetrinite and semifusinite are the most common macerals of the inertinite group present in the coals. However, the sclerotinite is more dominant in the Ombilin coal and the semifusinite is more dominant in the Bayah coal. The mineral matter consists of clay and pyrite that is present in the coals and the higher content is in the Bayah coal (5.2 %) compared to the Ombilin coal (1.9%).

Table 4. Rank of the Bayah coals (Australian standard)

Location	Rvmax (%)	Range	Rank
Bayah	0.63	0.57-0.71	High volatile bituminous
	0.65	0.59-0.72	High volatile bituminous
	0.64	0.58-0.72	High volatile bituminous
	0.60	0.53-0.67	High volatile bituminous
	0.61	0.56-0.69	High volatile bituminous
	0.60	0.51-0.65	High volatile bituminous
	0.63	0.58-0.71	High volatile bituminous
	0.79	0.73-0.88	High volatile bituminous
	0.64	0.58-0.73	High volatile bituminous
	0.65	0.58-0.73	High volatile bituminous
Cimandiri	0.83	0.78-0.95	High volatile bituminous
	0.70	0.63-0.76	High volatile bituminous
	0.65	0.58-0.72	High volatile bituminous
	0.65	0.60-0.72	High volatile bituminous
	0.64	0.57-0.71	High volatile bituminous
Cihideung	0.53	0.46-0.62	Sub-bituminous
	0.53	0.49-0.61	Sub-bituminous
	0.53	0.48-0.59	Sub-bituminous
	0.56	0.48-0.62	Sub-bituminous
	1.23	1.18-1.31	Medium volatile bituminous
	0.99	0.90-1.05	High volatile bituminous

Table 5. Maceral composition, mineral matter content, vitrinite reflectance and rank of the Ombilin and Bayah coals

Maceral Group		Ombilin	Bayah
Vitrinite	Mean content (%) Range (%) Common macerals	90.2 80-99 Dv, Tv, Gv	88.8 71-96 Tv, Dv, Gv
Liptinite	Mean content (%) Range (%) Common macerals	3.4 01-Sep Cut, Res, Sub	2.7 tr-10 Cut, Res, Sub
Inertinite	Mean content (%) Range (%) Common macerals	2 tr-6 Scl, Inert, Sf	2.5 tr-7 Sf, Scl, Inert
Mineral Matter	Mean content (%) Range (%) Common minerals	tr-11 1.9 Cl, Py	Jan-13 5.2 Cl, Py
Vitrinite Reflectance	Rvmax (%)	0.55-4.69	0.53-1.23
Rank	Australian Classification ASTM	Sub-bit.-Anthracite Sub-bit.C-Anthracite	Sub-bit.-Med. vol. bit. Sub-bit. C-Med.vol.bit.

Notes: Tv : telovitrinite, Dv : detrovitrinite, Gv : gelovitrinite, Sf : semifusinite, Scl : sclerotinite, Inert : inertodetrinite, Res : resinite, Cut : cutinite, Sub : suberinite, MM : mineral matter, tr : trace, bit. : bituminous, vol. : volatile, Med. : medium

Content

The vitrinite reflectance (Rvmax) values of the Ombilin coal (0.62-4.69 %) are higher compared to the Bayah coal (0.53-1.23 %). The Ombilin coal is sub-bituminous to anthracite according to the Australian classification and sub-bituminous C to anthracite of the ASTM classification. The Bayah coal is sub-bituminous to medium volatile bituminous based on the Australian classification and sub-bituminous C to medium volatile bituminous of the ASTM values.

The maceral compositions of the Ombilin and Bayah coals are slightly different from each other. Two factors can account for these variations, i.e. intrusion effect and age. In the thermally affected coals from both areas, liptinite generally cannot be distinguished from vitrinite and therefore it appears to contain high proportion of vitrinite (>90 %). However, thermally unaffected coals from both coalfields contain <90 % of vitrinite. Liptinite maceral is common in coals unaffected by contact alteration with some samples containing up to 10 %. In contrast, thermally affected coals have trace amounts of liptinite. Both thermally affected and affected coals contain rare inertinite with some samples containing up to 7 %. In some cases, coals with high inertinite content have a relatively high amount of mineral matter. Cook and Johnson (1975) have suggested that this may be the result of peat ablation in relatively oxidising environments giving an unfavourable balance between the rate of accumulation of organic material and mineral matter.

The dominance of vitrinite in the Ombilin and Bayah coals is indicative of forest type vegetation in humid tropical zone, without significant dry events throughout. Vitrinite-rich coal in some cases has a high content of mineral matter. A number of authors including Cook (1975), Shibaoka and Smyth (1975) have noted that many seams deposited in areas of rapid subsidence have both a high vitrinite and mineral content present as discrete dirt bands.

In addition, the maceral and mineral composition of the Ombilin and Bayah coals is somewhat similar one to another, in which the vitrinite content is absolutely dominant in the coals. This suggests that these coals were formed in anaerobic and wet environment. However, the Ombilin coal was deposited in somewhat wetter condition which prevailed during the deposition of the coal.

Despite their short geological history, the Ombilin and Bayah coals exhibit variable vitrinite reflectances, apparently due to variable tectonic and igneous intrusion factors. In these areas, a more rapid and thorough alteration has taken place where bodies of igneous rock have intruded the Tertiary sequence. As a result, coal of lower rank has been metamorphosed to bituminous or anthracitic ranks. The extent of rank increase depends primarily on distance from the intruding igneous rock, but it may also be related to size and temperature of the intrusion. The extent of gas or liquid streaming away from intrusion may also be significant. As the vitrinite reflectance (Rvmax) values of the Ombilin coal (0.62-4.69 %) are higher compared to the Bayah coal (0.53-1.23 %), this suggests that the heat source to the thermally affected coals is closer in the Ombilin coal than that of the Bayah coal.

6. CLOSING REMARKS

The type of Ombilin coal illustrates some similarities with that of Bayah coal. The main difference between the two coalfields is the proportion of mineral matter content. Both the coals have high content of vitrinite with the Ombilin coal is somewhat higher. The coals are low in liptinite and inertinite contents. This suggests that these coals were formed in anaerobic and wet environment, where the Ombilin coal was deposited in somewhat wetter condition which prevailed during the deposition of the coal. The coals with high inertinite content have a relatively high amount of mineral matter. It suggests that this may be the result of peat ablation in relatively oxidising environment giving an unfavourable balance between the rate of accumulation of organic material and mineral matter (Cook and Johnson, 1975).

The Ombilin and Bayah coals have vitrinite reflectances in the range of 0.55-4.69 % and 0.53-1.23 % respectively. The coals consist of thermally unaffected and affected ones. However, vitrinite reflectances for most of the coals (subjected to regional coalification only) are in the range of 0.53-0.77 %. The coals are dominated by sub-bituminous and high volatile bituminous, but some are anthracite. Localised contact metamorphism from igneous intrusions has caused some of the coals reaching rank of the bituminous to anthracite range. The ranks of the coals are generally considered to be largely controlled by the level of temperature under confining pressure. Igneous activity can locally increase the supply of heat and cause increases in the rank of nearby coal seams (Jones *et al,* 1984).

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