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QUALITY OF UPPER EOCENE COAL SEAMS EXPOSED IN THE DATHWEKYAUK AREA, TAMU TOWNSHIP, SAGAING REGION*

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Abstract

The research area is mainly composed of clastic sedimentary rocks and coal seams of Upper Eocene Pondaung and Yaw Formation. The total (6) representative coal samples collected from differences coal seams in the Nyaungpin stream section, near Minthami village, Tamu Township. Six coal samples were used to determine the quality or grade of coals. The coals of the study area constitutes macerals of Vitrinite group (76% to 91%), Liptinite group (0.4 % to 2.8%) and Inertinite group (8% to 17%) respectively. The vitrinite reflectance analysis was carried out on a MPV- Leitz microscope by means of reflected white light using oil immersion objective. The proximate analysis was carried out on the coal analysis instruments, Ollital, Model - JZLR – 9000B. The results of vitrinite reflectance value of coal seam are range from 0.56 and 0.64. The proximate results of coal seams are composed of moisture- 1 % - 9 %, volatile matter – 42% - 45%, Ash – 3% - 11%, fixed carbon – 42% - 51% , calorific value – 10989 - 13261 Btu/lb. Both the vitrinite reflectance values and proximate analysis values were indicate that the coal rank of coal seams fall into “Sub bituminous A and B” rank. The classification based on the German and American Society for Testing Materials (ASTM) coal classification scheme. Subbituminous coals of the study area are economically important because those are used as fuel for electric power generation and industries. Coal samples were analyzed in laboratories at Yamaguchi Univeristy, Japan, Pengujan tek MIRA, Bandung, Indonesia and Georesources Mineral Analyis Laboratory, Yangon, Myanmar.

Keywords: Coals, vitrinite reflectance, proximate analysis and subbituminous.

Introduction

The study area is located about 6 miles east of Minthami village, Tamu township, Sagaing Region. The area is emplaced between the latitudes N 23˚51´ and longitude E 94˚18´and on one inch topographic map of Burma Survey Map and it occupies parts of Map sheet No. 84 I/5. The general structural trend of the study area is nearly NNE - SSW direction. This area is a mountainous and forested region and the ranges are running NE-SW direction. The location map of the study area is shown in Figure (1). Some geologists were studied the Chindwin basin. Aung Khin and Kyaw Win (1968, 1969) published two papers concerning with the geology, paleogeography and hydrocarbon prospects of Burma Tertiary Basins including Chindwin Basin. Bender (1983) briefly described the geology of the Chindwin Basin.

Kyaing Sein et.al (1983) carried out the geological map of Tamu Mawleik- Phaungpin Area, (D.G.S.E, unpublished report). Thawng Lian Mung (2011) carried out the M.Res (Thesis) on sedimentology of the Dathwekyauk coal measures, Upper Chindwin Basin Tamu Township, Sagaing Region.

The aims of this study are to identify the vitrinite reflectance values, proximate analysis values and to determine the grade or quality of coal.

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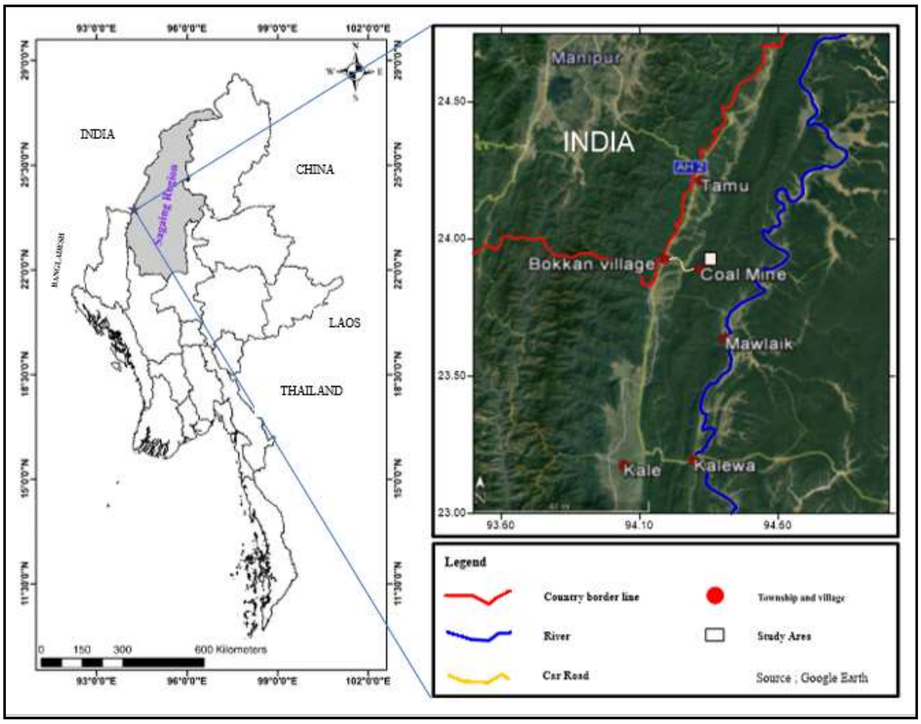

Figure 1. Location map of the study area.

General Geology

Regional Geology of the Study Area

Geomorphologically, as well as tectonically, Myanmar can be subdivided into four major tectonic provinces which are north-south trending linear belts, these are from east to west (1) Shan-Tanintharyi Block (2) Central Cenozoic Belt (3) Western Fold Belt and (4) Rakhine Coastal Belt. In the Early Cretaceous, India Plate started drifting northward and Ceno-Tethys subducting beneath Southeast Asia. Initial "soft" collision between the India Plate and Eurasian Plate occurred during the Paleocene (Wandrey, 2006), and "hard" collision occurred during the Middle Eocene (Metcalfe, 2006). The tectonics of the Central Basin and Western Ranges of Myanmar is determined by the subduction of the Indian Plate beneath the Burma Plate (Brunnschweiler, 1966; Win Swe, 1981). There are at least three basins in the Central Cenozoic belt. The three basins from north to south are the Chindwin Basin, Minbu Basin and Irrawaddy Embayment. The Chindwin basin is fore-arc basin associated with the Tertiary NE directed subduction zone of NW Myanmar. The Chindwin basin is located between the Indo-Burma Ranges in the west and Wuntho Massif mass in the east. The Eocene rocks are exposed in larger linear belts on the western limb of the Chindwin syncline and in two disconnected smaller belts on the eastern limb of the same syncline. They are composed of alternating sequences of sand and shale units. The upper part of the Eocene sequence in the Chindwin basin is made up of non-marine deltaic deposits which locally contain commercial coal seams in Thitchauk area near Kalewa and Dathwekyauk area to the west of Yuwa village. (Win Swe, 2012). Structurally, the Chindwin basin is bounded to the west by Kabaw fault system and to the east by Sagaing strike-slip fault. Towards the East, Chindwin Basin is separate from the Back-Arc basin by the "Igneous Wuntho Massif". (Bender, 1983).

Stratigraphy and Lithology

A thick succession of thin bedded to massive sandstone and shale with minor conglomerate of Eocene age are extensively exposed in a linear north – south trending belt. The Eocene strata of this belt are mainly made up of molasse sedimentary rocks. The present research area is mainly composed of upper Eocene units, Pondaung Formation and Yaw Formation, see Figure 2. These Formations are mainly made up of sandstone, siltstone, shale, mudstone, siderite bands, coaly shale and hard coal seams. In the study area, trough - cross bedding, ripple - cross lamination, parallel lamination and planar - cross beddings are the most common internal structures of the sandstone outcrops. The siderite nodules are common in the carbonaceous mudstone. Twenty coal seams are present in the study area. The thicknesses of coal seams are range from 5 cm to 3 m. (Thawng Lian Mung, 2011).

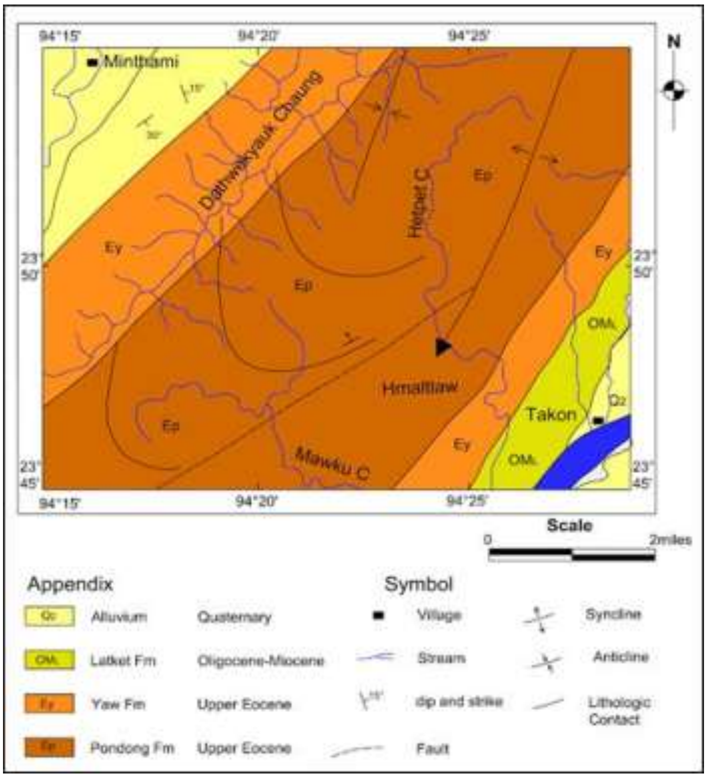

Figure 2. Geological and Location Map of the Study Area. (modified after Kyaing Sein et al.,1983).

Methods of the Present Research

Field Works and Sampling

Coal samples were collected from the coal seams of the Upper Eocene Strata. The samples were collected from the surface exposures in the present investigation area. A total six representative coal and shaly coal samples were obtained from measured stratigraphic section along the Nyaungpin stream sections. The samples were collected from base to top as benches of a channel of the coal beds in order to provide a vertical section of the beds.

Laboratories Works

The samples collected from the field area were analyzed in Laboratories at Section of Geology, Faculty of Education, Yamaguchi University, Japan, Laboratorium Pengujian tekMIRA, Bandung, Indonesia and Laboratory of Georesources Mining Co.ltd, Yangon Region, Myanmar. In laboratory, the briquettes were prepared and used to describe the vitrinite reflectance and maceral analysis. The vitrinite reflectance analysis was carried out on a MPV-Leitz microscope by means of reflected white light, using oil immersion objectives (10x and 50x). Maceral constituents of each coal sample were determined by counting at least 500 points per sample under reflected 'white' light. The reflectance was measured according to Austrilia Standard 2856 and ASTM (2009). See figure (3). The proximate analysis was carried out on the coal analysis instruments, Ollital, Model-JZLR – 9000B. The proximate analysis of coal is an assay of the moisture, ash, volatile matter, and fixed carbon as determined by series of prescribed or standard test methods.

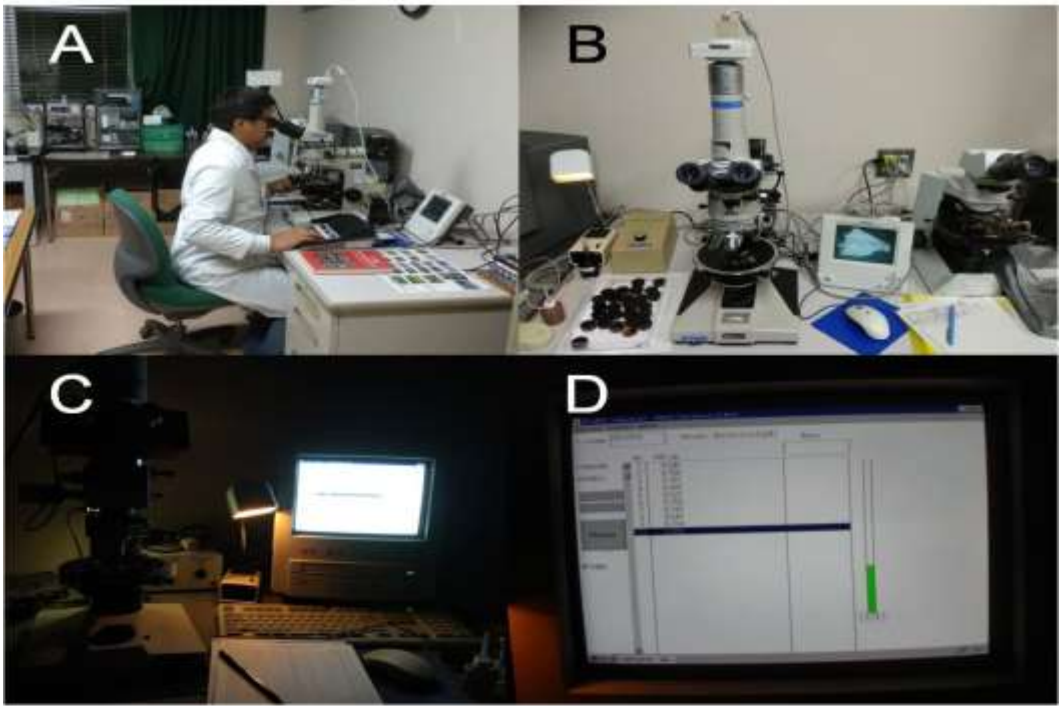

Figure 3. (A, B) showing maceral analysis and (C, D) showing vitrinite reflectance analysis. (At Yamaguchi University, Japan.)

Mode of Occurrences of Coal Seams

There are sixteen coal seams present in the investigated area. But six representative coal seams and samples were used for this research work. The thickness of coal seams ranges between (8) cm to (300) cm. The coal seams are well crop out along the Nyaungpin stream section (N 23º 53´ 03´´, E 94º 16´ 36´´ to N 23º 53´ 50´´, E 94º 17´ 04´´). Megascopically, coals samples are generally dark brown to black colored and appeared brittle. The coal bearing formation is composed of shale with sandstones and siderite bands. The coal seams are underlain by mud, siltstone and overlain by sandstone. The dip amount of coal seams are varies from 38º to 60º and the dip direction showed 110º to 132º (E to SE) direction. See figure 4).

Figure 4. Coal seams of the study area.

Results and Discussion

Maceral Composition (%)

All the three maceral groups (vitrinite, liptinite and inertinite) have been determined in the coal samples. The distribution of various macerals and maceral group is shown as a relative percentage. **The vitrinite group** predominants for all of the coal seams and it percentage varying between (78 to 91 vol.%). The vitrinite maceral subgroup is mainly composed of detrovitrinite/ desmocollinite, telovitrinite/ telocollinite, collinite and telinite. The dominant of collinite and telinite gives a clear indication that the coal is derived from the woody tissues of roots, stems and leaves which composed of cellulose and lignin. (Stach, E., 1982). See figure (5).

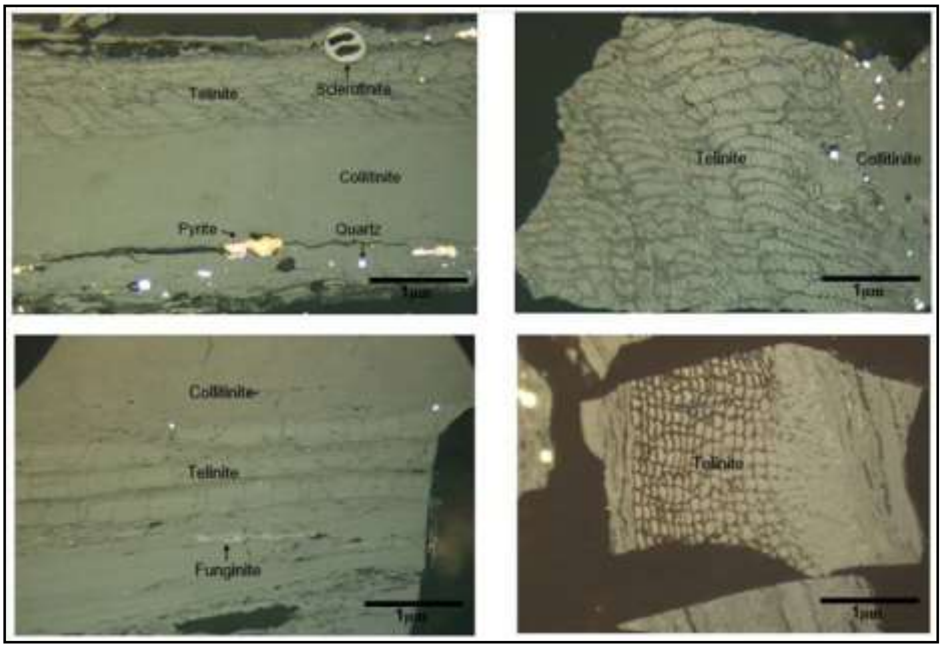

Figure 5. The vitrinite macerals of coal in the study area.

The liptinite group ranges from (0.4 to 2.8 vol.%) in all samples. The sub macerals are mainly represented by sporinite, cutinite and resinite. Cuticles occur not only on leaves and needles but also on shoots, stalks and thin stems. When regarded as a maceral, the resistant cutine layers are termed “cutinite”. See figure (6).

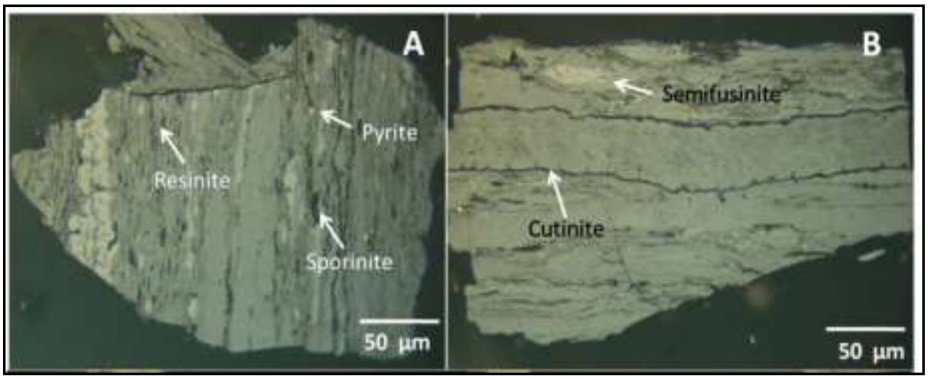

Figure 6. Liptinite macerals in coal. (A). Resinite (small lenses, round to oval or round in shape) and sporinite; (B). Cutinite show that thin to thick wall structures.

The component of **Inertinite group** is (8% to 17 vol%) and sub macerals content are represented by fusinite, semifusinite, sclerotinite and micrinite. Semifusinite always shows lower reflectance than fusinite. The cell structure of semifusinite is mostly less well preserved than that of fusinite. The sclerotinites occur in the form of tabular, cellular or non-cellular hyphae which have grown together in various irregular forms. See figure (7).

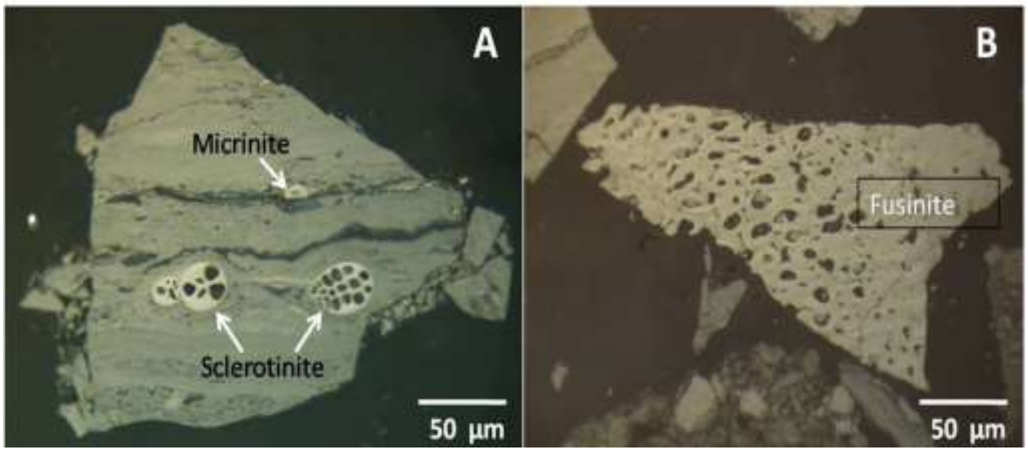

Figure 7. (A, B) showing submacerals of Inertinite Group.

Minerals Matter

The mineral matter is generally composed as (1% to 5 vol%). Clay Minerals may occur in various forms in vitrinite. Pyrite can occur as veins, irregular nodules and filling cell cavities. See Figure (8).

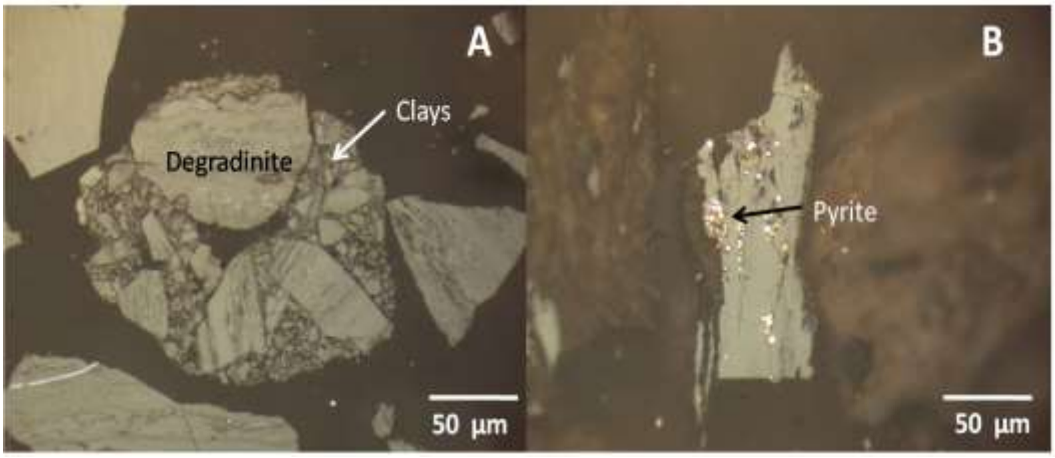

Figure 8. (A). Clays minerals and (B). Pyrite minerals.

Vitrinite Reflectance Analysis

The reflectance was measured according to Austrilia Standard 2856 and ASTM. The details of reflectance analysis results have been summarized in Table 1. The mean vitrinite reflectance value range between 0.56% to 0.64%, placing the coal in the low to medium rank category, based on the American Society for Testing and Material (ASTM) coal classification scheme. (Diessel, C.F.K., 1992).

Table 1. Vitrinite reflectance values (%) of coal in the study area.

Sample No	NC- 1	NC - 4	NC - 9	NC - 15	NC - 16
Maximum value (%)	0.69	0.63	0.64	0.59	0.59
Minimum value (%)	0.60	0.56	0.55	0.54	0.53
Mean Maximum Reflectance value (%)	0.64	0.59	0.59	0.56	0.56

Proximate Analysis

The proximate analysis of coal is an assay of the moisture, ash, volatile matter, fixed carbon and calorific values. The proximate analysis is one of the physical properties of coal. The calorific value is a direct indication of the heat content (energy value) of the coal. The calorific value can be used to evaluate the effectiveness of beneficiation processes. The volatile matter (d.a.f. basis) of the Dathwekyauk coals ranges from 42.11% to 45.97% with a mean of 44.5%. The ash ranges from 3 % to 11.6 % with a mean of 7.5%. The fixed carbon ranges from 42.4 % to 51.4 % with a mean of 48 %. The calorific values range from 10989 Btu/lb to 13261 Btu/lb with a mean of 12073 Btu/lb. The results of the proximate and calorific values are summarized in Table 2.

Table 2. Proximate analysis results (%) of coal in the study area.

Sample No	**Moisture (%)**	**Volatile Matter (%)**	**Ash (%)**	**Fixed Carbon (%)**		**Volatile Matter (%)**	**Ash (%)**	**Fixed Carbon (%)**	**Calorific Value Btu/lb**
Wet Basis						**Dry Basis**			
NC - 1	0.95	45.09	3	50.96		45.52	3.03	51.45	**13261**
NC - 4	2.08	43.77	6.60	47.55		44.7	6.74	48.56	**12593**
NC - 11	9.39	41.65	10.5	38.46		45.97	11.59	42.45	**10989**
NC - 12	6.28	39.46	7.4	46.86		42.11	7.9	50	**11934**
NC - 15	8.48	40.34	7.45	43.73		44.07	8.14	47.79	**11592**

Coal Rank of the Study Area

To classify coal, the vitrinite reflectance values, calorific values and proximate analysis values are needed. The mean vitrinite reflectance value range between 0.56 % to 0.64 %. The volatile matter (d.a.f basis) range between 42.1 % to 45.9 %. The calorific values are 10900 Btu/lb to 13000 Btu/lb. Under the German and American classification schemes, both of the vitrinite reflectance values and proximate analysis values were indicate that the rank of the research area coal seams was fall into “Subbituminous A and B”. See Table 3.

Table 3. The German and North America classifications and their distinction on the basis of different physical and chemical rank parameters. (Stach.E., 1982).

Rank			Reff Rm Oil	Vol. M d.a.f %	Carbon d.a.f %	Bed Moisture
German		USA				
Torf		Peat	0.2	68		
				64		
Weich	Braunkohle	Lignite	0.3	60	ca 60	ca 75
				56		ca 35
Matt				52		
		Sub. Bit C	0.4	48	ca 71	ca 25
Glanz		B	0.5			
		A	0.6	44		
Flam	Steinkohle	High vol Bituminous C	0.7		ca 77	ca 8 -10
			0.8	40		
Gas flamm		B		36		
		A	1.0	32		
Gas			1.2			
		Medium Vol. Bituminous	1.4	28	ca 87	
				24		
Fett		Low Volatile Bituminous	1.6	20		
Ess			1.8	16		
Mager		Semi Anthracite	2.0	12		
Anthrazit		Anthracite	3.0	8	ca 91	
				4		
Meta Anthrazit		Meta Anthracite	4.0			

Conclusion

The research area is mainly composed of Upper Eocene units, Pondaung Formation and Yaw Formation. These Formations are mainly composed of sandstone, siltstone, shale, carbonaceous shale, coaly shale, shaly coal and hard coal seams. Megascopically, coal samples are generally dark brown to black coloured and appear brittle. Petrographically, the maceral Vitrinite group (78% to 91 vol%), liptinite group (1% to 2.8 vol.%) and Inertinite group is (8% to 17 vol%). The mineral matter is generally composed as (2% to 8.6 vol%). Telovitrinite, detrovitrinite, semifusinite, sclerotinite, alginite, fluorinite and cutinite are the common macerals. The mean vitrinite reflectance value range between 0.56 % to 0.64%. The calorific values are 10900 to 13000 Btu/lb. Coals of the research area are Sub-bituminous A and B, based on German and North America coal classification. The Subbituminous coals of the study area are economically important because those are used as fuel for electric power generation and industries.

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