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" Exotic Past For Our Future "

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FACULTY OF MINERAL TECHNOLOGY
UNIVERSITAS PEMBANGUNAN NASIONAL "VETERAN'
YOGYAKARTA
2016

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Preface

Bismilahirrahmanirrahim, Assalamu'alaikum wa rahmatulahi wa barokatuh.

Dear distinguished participants and committee.

In this nice opportunity, I appreciate to all of you for your considerable effort that made the Regional Geoheritage Conference 2016 or the 9th Joint Conference Indonesia – Malaysia Geoheritage Conference happened.

I really thankful to your participations for joining and attending the Conference in Yogyakarta. Special Region of Yogyakarta is well known as education and cultural city. Yogyakarta also become a considerable touristic region especially in cultural heritage. Right now geoheritage in Yogyakarta become more attractive.

In this occasion, the conference is very simple. Conference will be held over two days. First day we will held conference and geotrack in the second day.

There is two main speakers for RGC 2016. The first speaker is Mr. Ibrahim Komoo as Vice President Global Geoparks Network (GGN) and Mr. Yunus Kusumahbrata as Expert Staf Ministry of Energy and Mineral Resources of Indonesia Republic. For the next season, we also have speakers from Thailand and two speakers from Gunungsewu UGG and Batur UGG Indonesia. Moreover, we have 30 outstanding papers that will be presented in this conference. The papers are consist in 12 oral papers and 23 posters presentation with the same value.

In geotrack we will discover several geoheritage sites in Gunungsewu UGG, such as Miocene pillow lava of Berbah; ancient volcanic product of Nglanggeran; exciting bioturbation within shallow marine Sambipitu Formation; and Karst Museum of Indonesia at Wonogiri.

I wish this conference will give us inspirations and enhance the cooperation in Southeast Asia countries, especially in the field of geoheritage. Happy sharing for the progress of our region.

Finally, I would like to express my gratitude to Geological Agency – Ministry of Mineral Resources, especially Center of Geological Survey performa a booth concerning the wonderful of geoheritage and geopark of Indonesia.

Wassalamu'alaikum wa rahmatulahi wa barokatuh.

Prof. Dr. Ir.Bambang Prastistho, M.Sc.
Chairman
Regional Geoheritage Conference 2016

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GEOLOGY AND GEOHERITAGE OF MUARA WAHAU COAL FIELD, EAST KALIMANTAN, INDONESIA "CONCERN OF: GEOLOGY, MICROSCOPY, ORGANIC GEOCHEMISTRY AND COALBED METHANE POTENTIAL

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ABSTRACT

Indonesia coal have the coal-forming material (plants) as well as the parameters that are relatively the same deposition conditions (tropical) although it is located in the sprawling region Indonesia with diverse geological conditions, hence Indonesia is one of the significant coal producer in the world. Research site located in Muara Wahau, East Kalimantan, including the Upper Kutai Basin. Coal bearing formation in the area of Muara Wahau is Wahau Formation Late Oligocene - Early Miocene age. Laboratory analyses was conducted using method coal microscopy observations to determine vitrinite reflectance random (Rr) and maceral composition as well as method of Gas Chromatography-Mass Spectrometry (GC-MS) to determine facies, organic compound (biomarker), maturity and precursor of plant MuaraWahau coal. Maceral composition of the Muara Wahau coal is dominated by vitrinite maceral group, ranging from 76% to 82.4.0%. Liptinite maceral group accounts 0.4% – 1.8 %. The composition of inertinite maceral group ranges from 8% to 18.8%. Huminite reflectance of coal samples from Muara Wahau range from 0.44 to 0.45 Rr (%), according to huminite reflectance, all studied samples are low rank sub-bituminous coals. Maceral composition to detect coalbed methane potential. The presence of 2-series long chain *n*-alkane indicates the changes of peat forming facies condition from oxic condition (increasing odd carbon proportion) and anoxic condition (increasing even carbon proportion) Geological Outcrop along the Telen River and Wahau River, is the type locality of Wahau Formations, should become a geology conservation area in Muara Wahau as Geoheritage and it is very interesting to study geology.

Key words: geology, coal; tropical; facies; high plants; long chains; oxic; anoxic; methane

INTRODUCTION

Muara Wahau is an area of Muara Wahau, East Kutai Regency, East Kalimantan province, including in the Upper Kutai Basin. Coal bearing formation in Muara Wahau is Wahau Formation, the age Late Oligocene - Early Miocene.

Regional geology of Muara Wahau is part of the Kutai Basin which economically is one of the sedimentary basins in Indonesia, most importantly, in addition to rich in oil and gas, the area is also rich in coal deposits.

Indonesia is one of the countries producing big enough coal in the world, some of the factors that affect it are the geological environment and climate.
Indonesia as a tropical country with two seasons (wet and dry), greatly contributed to the accumulation of peat formation, especially fluctuations in water level changes in the peat bog, as the primary control in the accumulation of peat (Dehmer et al., 1993). This causes the Indonesian coal generally has the characteristics of microscopic, organic geochemistry, and almost the same quality.
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This study will discuss Geology of Muara Wahau particularly Wahau Formations where the type locality is on the Telen River and the Wahau River, and both rivers are expected to conservation area as Geoheritage of Muara Wahau.

GEOLOGICAL SETTING

Administratively location area of research is in the area of Muara Wahau East Kutai Regency, East Kalimantan Province (Figure 1).

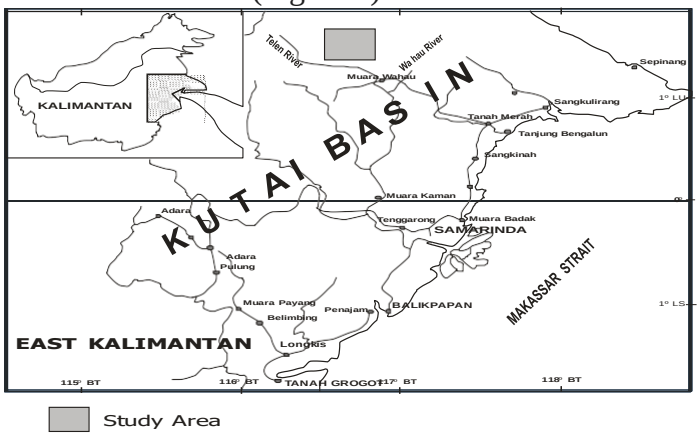

Figure 1. Location map of Muara Wahau coal field in Kutei Basin, East Kalimantan

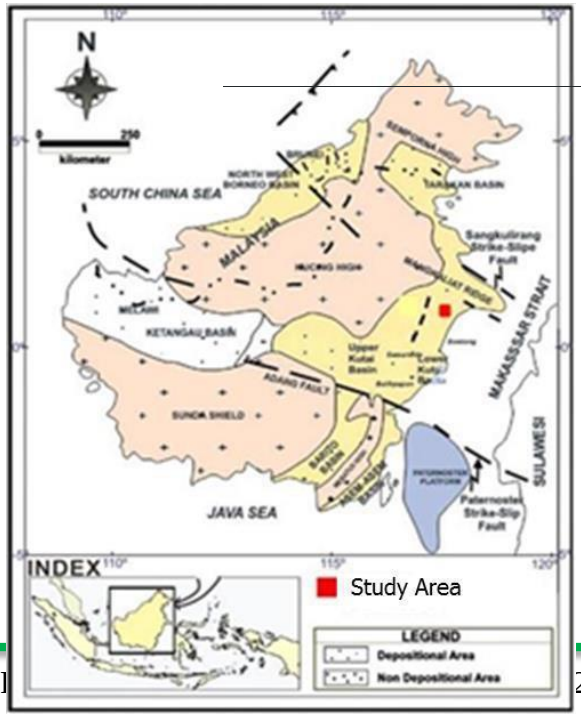

Figure 2. Kutai Basin of the elements of Regional Tectonics (Ott, 1987)

Regionally Muara Wahau is part of the Kutai Basin which economically is one of the sedimentary basins in Indonesia, most importantly, in addition to rich in oil and gas, the area is also rich in coal deposits. According to Ott (1987), the Kutai Basin is restricted by Tinggian Kuching in the west, the north ridge Mangkalihat, Adang Fault to the south and the Makassar Strait to the east (Figure 2). This basin is the largest and deepest of the Tertiary basins in Indonesia with more than 14 km thick fluvial sediments which are accumulated until batial (Allen and Chambers, 1998).

The age of Marah Formation is Late Eocene lithology composed by marl, mudstone, conglomerate and limestone. The age of Marah Formation Late Eocene sequence is an interbedded marl, mudstone, conglomerate and limestone exposed in Muarawahau Sheets and Muara Ancalong, East Kalimantan. The location is the type of formation Angry Angry River at Muara Wahau Sheet (Supriatna and Abidin, 1995). The thickness of this formation is approximately ranging between 400 to 800 meters. Marah Formation cropping in the Marah River is a series of sub-littoral sediment deposited on the foreland basin (Supriatna and Abidin, 1995). The content of the fossil of a layer of marl constituent Marah Formations show Late Eocene age.

Conformly on the top of Marah Formation was deposited Wahau Formation the age is Oligocene - Early Miocene, lithology consists of interbedded claystone, quartz sandstones, silty sandstones and sandy mudstone. Wahau Formation is divided into 2 (two), lower Wahau Formation consists of limestones rich in fossilized algae and corals, while the upper Wahau Formation containing inserts of tuff and lignite.

Unconformly on the top of Wahau Formation deposited Metulang volcanic rocks, the lithology consists of andesite, basalt, lava, lava breccia, tuff, agglomerate and lava breccia. Intrusion Sintang cross cut the Wahau Formation consists of andesite and diorite. Radiometric dating is based on K - Ar, Sintang Intrusion age is 16-21 million years old, Early Miocene (Soeria Atmadja et al., 1999).

Based on the stratigraphic framework and tectonics, the development of the basin coal in the Kutai Basin during the Tertiary related to continental margin, where the basin coal is found in parts of the continental crust that is on the edge of the continent (continental margin) and is passsive margin associated with the system rifting. The age of coal of Wahau Formation is Early Miocene deposition during the regression phase in conjunction with orogenesa process known as Syn-orogenic Regressive Phase Deposition. Deposition coal associated with deltaic floodplain environment of prograding delta during the Miocene. Coal layer tends to be thick, lateral distribution is relatively constant (Koesoemadinata, 2002). Muara Wahau regional stratigraphy based on the correlation of rock units Geological Map Sheet Muara Wahau (Supriatna and Abidin, 1995), ranging from old to young Tertiary shown in Figure 3.

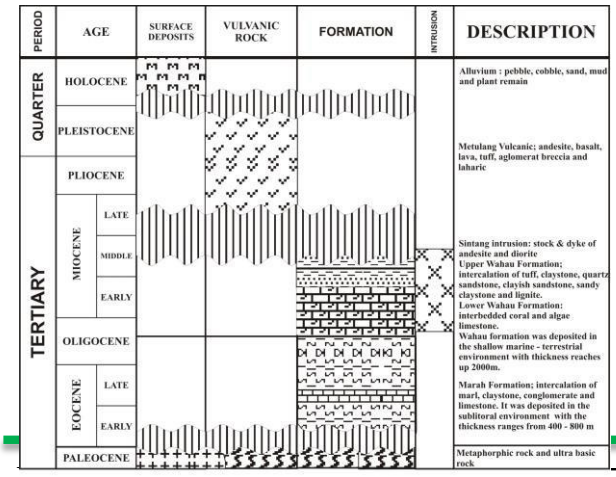

Figure 3. Regional Stratigrapic of Muara Wahau area (Supriatna and Abidin, 1995).

METHOD OF RESEARCH

Stages of the research started from the preparatory phase which includes planning work and literature study, research and collection of field data through geological survey and sample the rocks and the coal is taken directly core drilling, followed by laboratory analysis consists of the preparation and analysis of samples of coal which includes petrographic analysis of rocks and coal, organic geochemistry in the form of Gas Chromatography - Mass Spectrometry (GC - MS) and proximate analysis of coal.

RESULT AND DISCUSSION

GEOLOGY OF MUARA WAHAU

Generally, the condition of morphological research areas undulating low (5 ° - 10 °) almost all areas of research covered in oil palm plantations (Figure 4) so most of the outcrop and coal are already covered by the waste ground at the beginning of the opening of oil palm plantations formerly primary forest.

Figure 4. The Landscape of study area in Muara Wahau

Local Stratigraphy Wahau Formation in the study area consisted of interbedded black carbonaceous claystone, tuffaceous mudstone, fine sandstone, medium sandstone inserts of thick coal and andesite igneous intrusions (Figure 5).

Coal deposition associated with floodplain deltaic environment of the delta during the Miocene progradation. Inclined thick coal layers, spread laterally relative basis (Koesoemadinata, 2002). Wahau Formation lithology in the study area consists of black claystone containing carbonaceous, claystone tufaceous, fine sandstones, sandstones and interbedded thick coal.

The geological map of MuaraWahau area consist of one unit lithology is claystone unit (Figure 6). The pattern of distribution of the geological structure of coal (coal cropline) in the study area is trending north-west of syncline-southeast. Commonly position of the main seam of coal seam and the seam-1-2 is a northwest-southeast with a slope of the coal seam ranges from 8^o to 12^o. In general, the Muara Wahau coal thickness is in the range 8 to 66 meter (Figure 6).

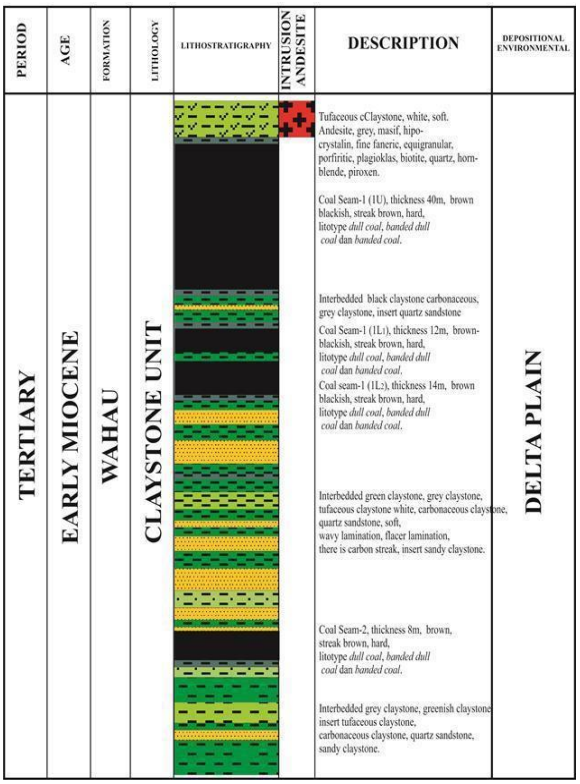

Figure 5. Stratigraphy of Wahau Formation in MuaraWahau area (source: PMB01-08 drill)

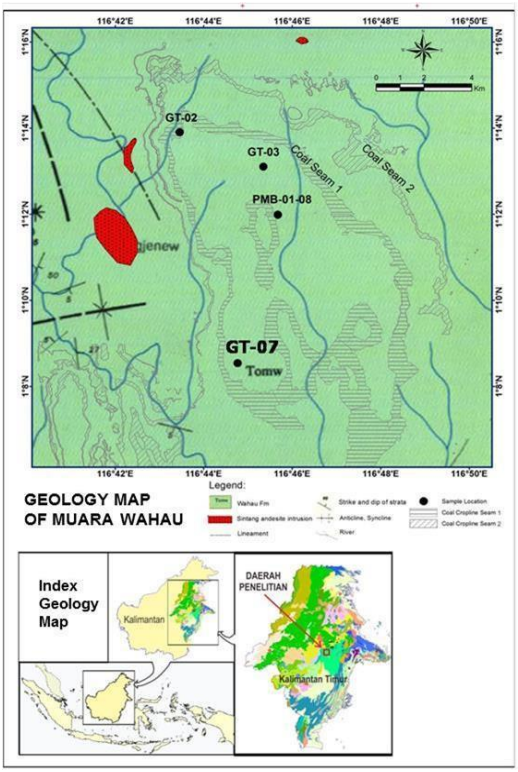

Figure 6. Geological Map of Muara Wahau area

The top of the coal seam seam-1 revealed distributed in Telen River. In general, the physical properties of coal Muara Wahau are: dark brown, hard, dull coal, banded coal and coal banded dull, dull gloss, streak brown color, containing resin. Igneous intrusions as part of the intrusion of andesite Sintang (Supriatna and Abidin, 1995) one of them exposed in Ben Hes residence is the northern part of the study area (Figure 7).

Figure 7. Geological Outcrop type locality Wahau Formation on Wahau River.

a. Coal Seam-1 outcrop
b. Claystone unit
c. Andesite Sintang Intrussion
d. Interbedded Sandstone and claystone

COAL MICROSCOPY (MACERAL) OF MUARA WAHAU

Maceral composition of the Muara Wahau coal is dominated by vitrinite maceral group, ranging from 76% to 82.4.0%. Liptinite maceral group accounts 0.4% - 1.8%. The composition of inertinite maceral group ranges from 8% to 18.8% (Table 1). Huminite reflectance f coal samples from Muara Wahau range from 0.44 to 0.45 Rr (%), According to huminite reflectance, all samples studied are low-rank sub-bituminous coals.

Microscopic analysis shows that the Muara Wahau coals are predominantly consist of vitrinite macerals (Figure 8), with minor liptinite and inertinite. Vitrinite maceral of the coals composed of telocollinite, desmocollinite, densinite, and corpocollinite. Liptinite maceral consist of cutinite, resinite, suberinite, and sporinite. Inertinite maceral is dominated by fusinite, semifusinite, and sclerotinite. Cutinite mainly presents as thin continuous bands in association with vitrinite maceral (Figure 9)

Sclerotinite shows rounded to oval forms and has high reflectance. This maceral is present in all coal samples (Figure 8)

Table 1. Result of Microscopy Analysis (Maceral) coal of Wahau Formation in Muara Wahau area

No. Sampel	Total Vitrinite (% vol)	Total Liptinite (% vol)	Total Inertinite (% vol)	Total Mineral Matter (% vol)	Reflektan Vitrinite (Rv) %
1	79.8	-	18.8	1.4	0.44
2	76.2	1.4	17	5.4	0.44
3	79.4	0.4	17.8	2.4	0.44
4	79.4	1	15.4	4.2	0.45
5	78.8	1.8	17.6	2	0.45
6	82.4	1	8	8.6	0.44
7	79.4	0.4	17.8	2.4	0.45
8	79	1	16.2	3.8	0.45
9	82.4	1	10.8	5.8	0.44
10	79.4	1	15	4.6	0.44
11	80	2	17	1	0.44
12	76	1.2	17.2	5.6	0.45

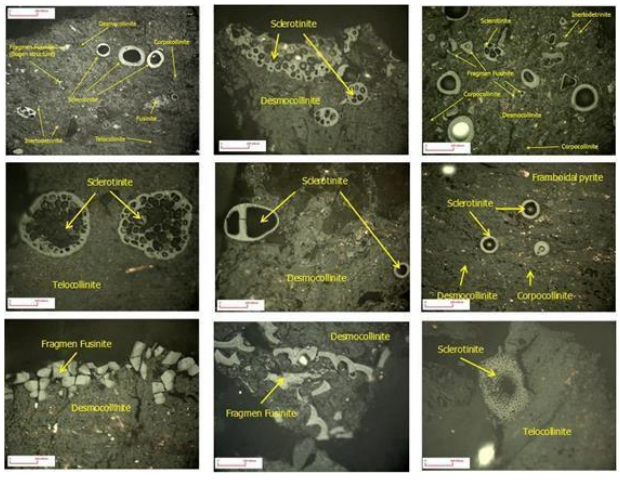

Figure 8. The appearance of microscopic maceral vitrinite and inertinite Muara Wahau coal using white light, a magnification of 200 times

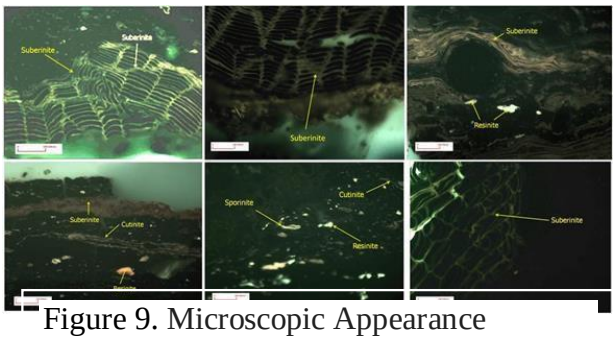

Figure 9. Microscopic Appearance maceral liptinite Wahau Muara coal, using blue light, magnification 200 times

ORGANIC GEOCHEMISTRY OF MUARA WAHAU COAL

Saturated fraction from Muara Wahau coal samples was detected forming long chain series *n*-alkane, the ranging of first series from *n*-C_{21} to *n*-C_{35}, with a high odd over even predominance peaking at *n*-C_{31}, this condition is very specific for higher plant. Additionally, second series long chain n-alkane ranging from *n*-C_{36} to *n*-C_{40} with even over odd predominance peaking at *n*-C_{38}.

High concentration of saturated non-hopanoid triterpenoid dominated saturated hydrocarbon Muara Wahau Coal such as: Olean-13(18)-ene; Olean-18-ene and Urs-12-ene, indicated much input from higher plant (*angiosperm*) which long chain *n*-alkane characteristics.

The presence of long chain *n*-alkane at Muara Wahau Coal are very exclusive especially carbon number *n*-C_{36} to *n*-C_{40}. The long chain in Indonesia was found only in the Kalimantan Coal, beside in Muara Wahau, it was also found in Palangkaraya peat, Central Kalimantan and in Embalut, East Kalimantan (Lower Kutai Basin) at coal of Balikpapan Formation.

The presence of 2-series long chain *n*-alkane indicates the changes of peat forming facies condition from oxic condition (increasing odd carbon proportion) and anoxic condition (increasing even carbon proportion) (Figure 10; Table 2)

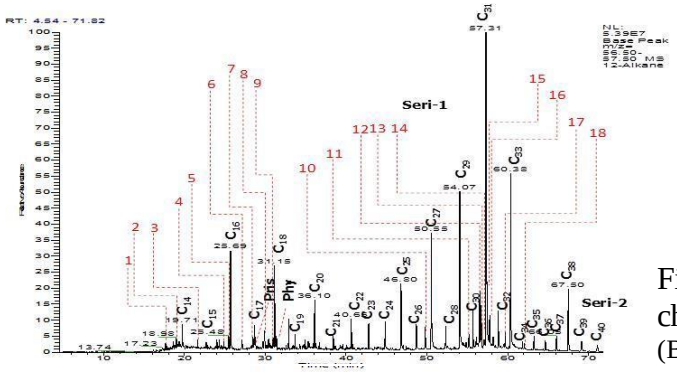

Figure 10. Distribution of long chain *n*- Alkane Muara Wahau coal (Basuki RAHMAD, et al., 2012)

Table 2. Result of identification substance number 1 s/d 18 *n*-alkane fraction Muara Wahau coal sample G2S1C12 (Basuki RAHMAD, et al., 2012)

PEAKS	RET.TIME	COMPOUND (G2S1C12-ALKANE-M/Z 57)	BASE PEAK	M.W.	CONCENT. µg/g TOC
1	17.63	DODECANE (Wiley)	57	170	2.71
2	18.98	TETRADECANE,2,6,10-TRIMETHYL (Wiley)	57	240	3.78
3	21.63	DOTRIACONTANE (Wiley)	57	450	3.42
4	25.38	8-ISOPROPYL-2,5-DIMETHYL-1,2,3,4-TETRAHYDRONAPHTHALENE (Wiley)	187	202	1.18
5	25.48	2-ICOSANETHIOL (Wiley)	57	314	3.42
6	27.08	TETRADECANE,2,610-TRIMETHYTL (Wiley)	57	240	4.89
7	28.48	N-TRICOSANE (Wiley)	57	282	9.64
8	29.87	DOCOSANE (Wiley)	57	310	10.08
9	30.39	TRICOSANE (Wiley)	57	324	3.8
10	49.78	23-NORLUPANE (Haven et al.,1989)	177	398	9.94
11	55.2	ERGOST-22-EN-3-OL, (3β,5α,22E,24R)-(Wiley)	55	400	5.47
12	56.55	OLEAN-13(18)-ENE (Philp, 1985; Dehmer, 1993; Anggayana, 1996; Amijaya, 2006; Widodo, 2008)	218	410	31.37
13	56.66	OLEAN-12-ENE (Philp, 1985; Dehmer, 1993; Anggayana, 1996; Amijaya, 2006; Widodo, 2008)	218	410	13.68
14	56.77	OLEAN-18-ENE (Philp, 1985;Dehmer, 1993; Anggayana, 1996; Amijaya, 2006; Widodo, 2008)	218	410	10.32
15	57.31	URS-12-ENE (Philp, 1985; Anggayana, 1996; Amijaya, 2006; Widodo, 2008)	218	410	32.1
16	57.42	NEOHOP-13(18)-ENE (Wiley)	191	410	4.16
17	58.21	22R-17α(H), 21β(H)-HOMOHOPANE (Philp, 1985; Dehmer, 1993; Anggayana, 1996; Amijaya, 2006; Widodo, 2008)	191	426	5.44
18	59.71	(22R)-17β(H)-HOMOHOPANE (Philp, 1985; Dehmer, 1993; Anggayana, 1996; Amijaya, 2006; Widodo, 2008)	205	426	2.26

COALBED METHANE POTENTIAL

Vitrinite content is relatively high in Muara Wahau coal included in kerogen type III as an identifier of humic organic matter derived from the woody tissue of higher plants (Angiosperm). Vitrinite maceral which is a cellulose-rich network on herbaceous plants forming methane (gas prone) high. The physical properties maceral groups, such as vitrinite has a specific gravity of 1.3 - 1.8 with a high oxygen content and volatile matter content of about 35.75%, it can produce methane (CH_4) or as gas prone.

In essence, the network of cellulose plants more easily hydrolyzed, such as disaccharides, starch, cellulose, hemicellulose, pentosanes, pectins and proteins are decomposed without any difficulty by bacteria and fungi, some produce methane (CH_4) and the solution (carbon dioxide, ammonia, methane/CH_4 and water), which will come out and left to produce a solid material (mainly humic substances), which participated in the formation of coal.

The average quality of coal Muara Wahau Formation: Calorivic Value 4087 kcal/kg (adb), sulfur 0:11% (adb); ash 3.41% (adb); inherent moisture 33.25% (adb); volatile matter 34.48% (adb); fixed carbon 28.86% (adb), Total Moisture 43.51% (Ar); 1:34 relative density. Random vitrinite reflectance from 0.44 to 0.45. Classification rank of coal: sub-bituminuous.

CONCLUSION

- Geological Outcrop along the Telen River and Wahau River, is the type locality of Wahau Formations, should be become a geology conservation area in Muara Wahau as Geoheritage and it is very interesting to study geology.
- Characteristics of Coal Wahau Formation very unique and interesting aspects of microscopic, organic geochemistry and potential for development coalbed methane.

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