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Occurence of Long-Chain *n*-Alkanes inMuaraWahau Coal, Upper Kutai Basin, Indonesia

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Abstract

MuaraWahau coal belongs to Wahau Formation which was deposited during Early Miocene in terrestrial environments. Organic geochemistry study has been performed to characterize the biomarker composition of the coal. Saturated hydrocarbon fraction comprises n-alkanes with carbon numbers from 14 to 40. Bimodal distribution peaking at n-C_{16} and n-C_{31} are detected. Additionally, unusual peak is also remarkable at n-C_{38}. The long chain n-alkanes peaking at n-C_{31} might be derived from higher plants. The origin of short chain n-alkanes (n-C_{14} to n-C_{21}) are less specific, probably originate from higher plants and/or algae. Other related identified biomarkers which confirm the significant contribution of higher plants are olean-13(18)-ene, olean-18-ene and urs-12-ene. The presence of longer-chain n-alkanes especially unusual high amount of n-C_{38} is interesting to be noted as this compound has been reported only from some Kalimantan coals. Considering the abundance of higher plants biomarkers in MuaraWahau coal, it is hypothesized that the C_{38} n-alkane was likely derived also from higher plants.

1. INTRODUCTION

Indonesia is located in tropical region with dry and wet seasons. The tropical climate contributed greatly to the accumulation of peat as well as the plants type that further determines the geochemical composition of organic matter in coal.MuaraWahau coal is located in Upper Kutai Basin, East Kalimantan and was deposited interrestrial environments. It belongs to Wahau Formation and its rank is lignite.

Organic geochemical composition of coal is commonly dominated by compounds in aromatic fraction. However, saturated hydrocarbon fraction of coal is sometime significant with respect to unravel the coal forming plants as well as the depositional environments. Dominance of odd carbon numbered*n*-alkanes ranging from C_{25} to C_{33} is typical forwaxy and higher plants origin (Douglas and Eglinton 1966; Eglinton and Hamilton, 1967; Kolattukudy, 1969 in Reddy *et al.*, 2000). Organic geochemical studies in particular the distribution of long chain *n*-alkanes for coal and peat in Kalimantan has been done by previous researchers such as Dehmer(1993, 1995),Anggayana(1996) and Widodo(2008).

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Dehmer(1993, 1995)studied the biomarker composition of saturated hydrocarbon fraction in peat deposits in Palangkaraya, Central Kalimantan.She discovered for the first time a series of long chain *n*-alkanes from $C_{36}$to C_{40} with even-numbered carbon predominance over odd carbon peaking atC_{38}.
Anggayana(1996)studied the organic geochemistry of coal from Balikpapan Formation, East Kalimantan andreported that the *n*-alkane distribution ranges from C_{13} through C_{33}, which dominated by odd carbon numbered compounds peaking at C_{27}, C_{29} and C_{31}.
Widodo(2008)researched the organic geochemistry of coal samples from Balikpapan Formation in Embalut area, East Kalimantan.*n*-Alkanes distribution of the coal samples range from C_{14} to C_{40} with a marked predominance of odd over even numbered long chain carbons (C_{25} to C_{31}).Longer chain *n*-alkanes (C_{34} to C_{40}) were also detected.
This study aims to identify the saturated hydrocarbon fraction composition of MuaraWahau coal. Further, the *n*-alkanes distribution will be investigated with respect to their origin.

2. GEOLOGICAL SETTING

Kutai Basin is the most important basin in Indonesia relating to its potential of gas, oil and coal. The study area is located in MuaraWahau area, East Kutai regency, East Kalimantan Province (Figure 1). Geologically, this area is a part of Upper Kutai Basin. MuaraWahau coal belongs to Wahau Formation, deposited in Early Miocene during regression phase along with uplifting (syn-orogenic regressive phase). Coal deposition associated with terrestrial to floodplain deltaic environments. Wahau Formation consists of black claystone containing carbonaceous, tufaceousclaystone, fine sandstones, sandstones and thick coalinterbeds. The thickness of the MuaraWahau coal ranges from 8 to 66 m.

Figure 1.Location map of Muara Wahau coal field in Kutai Basin, East K

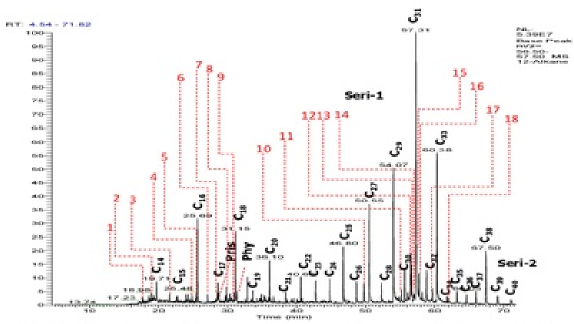

Figure 2.Distribution of long chain *n*-alkanes of Muara Wahau coal.

3. ANALYSIS RESULT

Gas chromatography Mass Spectrometry (GC-MS) analysis of the saturated hydrocarbon fraction shows*n*-alkanes distribution ranging from $C_{14}$to C_{40}. The short and long chain *n*-alkanes (C_{14} to C_{33}) exhibit predominance of odd over even carbon numbers, maximizing at C_{16} and C_{31} (Figure 2). In the longer chain *n*-alkanes (C_{34} to C_{40}), even over odd carbon numbers predominance is detected, with remarkable high concentration at C_{38}.
Saturated non-hopanoidtriterpenoids are present in MuaraWahau coal, which consist of olean-12-ene (12);olean-18-ene (13) and urs-12-ene (14). Hopanoidsidentified in the coal are 22R-17α(H),21β(H)-homohopane (17) and (22R)-17β(H)-homohopane (18); (Table 1).The presence of hopanoid hydrocarbons indicates that bacteria were present during peatification process.

Tabel 1.Identification of compounds from saturated hydrocarbon fraction of Muara Wahau coal.

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

4. DISCUSSION

The presence of two series of long chain *n*-alkanes (C_{25} – C_{33} and C_{34} – C_{40}) explain the changes in peat-forming facies conditions.Oxic condition is characterized by increased proportion of odd-numbered carbons, whereas anoxic condition is characterized by increased proportions of even-numbered carbons (Tissotand Welte, 1984). Oxic and anoxic conditions could alternate by the fluctuation of water level due to seasonal variation (wet and dry). Such conditions probably contributed to generation of the two *n*-alkanes series.
The long chain *n*-alkanes (C_{25} to C_{33}) with predominance of odd over even numbered carbons have been widely reported to originate from higher plants (see e.g. Eglinton and Hamilton, 1967). The short chain n-alkanes are less specific. They could be derived from certain higher plants, algae and/or bacteria. The C_{38}*n*-alkane is interesting, as unusual higher concentration of this compound relative to the other adjacent *n*-alkanes in sedimentary organic matter is rarely studied. Some authors have reported the presence of this unusual compound in peat and coal (Dehmer, 1993; Widodo, 2008). It remains unclear the biological precursor of this compound. However, Widodo (2008)analyzedthe organic geochemical composition ofbark of *Ficuselastica*. He hypothesized that unusual higher concentration of longer chain *n*-alkanes (C_{34} to C_{40}) might be contributed from this plant. In the present case, the occurrence of unusual C_{38}*n*-alkane is likely also related to *Ficuselastica*, because this higher plant is common in tropical region especially in Indonesia. Moreover, other higher plant biomarkers are dominant in the MuaraWahau coal such as olean-12-ene (12);olean-18-ene (13) and urs-12-ene (14).

5. CONCLUSION

n-Alkanes compounds from saturated hydrocarbon fraction of the MuaraWahau coal range from C_{14} to C_{40}. The short chain *n*-alkanes (<C_{21}) were probably derived from higher plants and or algae. The long chain n-alkanes (C_{25} to C_{33}) were likely generated from higher plants. The longer chain n-alkanes (>C_{34}) might originate from higher plants, especially *Ficuselastica*.

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