HYDROCARBONDS IN COAL DEPOSIT FROM LONG TUTOH, BARAM AND MERIT PILLA, KAPIT OF SARAWAK

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HYDROCARBONS IN COAL DEPOSIT FROM LONG TUTOH, BARAM AND MERIT PILLA, KAPIT OF SARAWAK

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16963

This report is submitted in partial fulfilment of the requirements for degree of Bachelor of Science with Honours in Resource Chemistry

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UNIVERSITI MALAYSIA SARAWAK

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DECLARATION

No portion of the work referred in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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Program of Resource Chemistry (2006-2009)
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ABSTRACT

The coal samples obtained from Long Tutoh coalfield, Baram and Merit Pilla coalfield, Kapit, Sarawak were studied to determine their hydrocarbon composition. The objectives of this study are (1) to characterize the organic components in two Sarawakian coal samples, (2) to predict the source of organic matters and (3) to evaluate maturity degree of coal samples through biomarker evaluation. The geolipid from the coal sample was extracted using Soxhlet extractor and subsequently being separated into aliphatic fraction and polyaromatic fraction on activated silica gel chromatography. The analysis of organic components in the coal samples were performed using capillary gas chromatography/flame ionization detector (GC/FID). Biomarker indices such as ratio of pristane to phytane (Pr/Ph), pristane to heptadecane (Pr/C17), phytane to octadecane (Ph/C18), C25/C15, C27/C17, and CPI125-311 are used to evaluate the source of origin of organic matter and maturity of both coal samples. The CPI125-311 values from both coal samples showed that they are thermally immature. Other biomarker indices which are Pr/Ph, Pr/C17 and Ph/C18 indicated that both coal samples were deposited under anoxic and open water condition.

Keywords: Coal, biomarkers, aliphatic hydrocarbon, gas chromatography/flame ionization detector
HIDROKARBON DALAM ENDAPAN ARANG BATU DARI LONG TUTOH, BARAM DAN MERIT PILLA, KAPIT SARAWAK

ABSTRAK


Kata kunci: Arang batu, penanda biologi, hidrokarbon alifatik, kromatografi gas/pengesan pengionan nyalaan (GC/FID).
CHAPTER ONE
INTRODUCTION

1.1 General Introduction

Coal is a solid, brittle, combustible, carbonaceous rock formed by the decomposition and alteration of vegetation by compaction, temperature, and pressure. It is made of humic organic matter, which experienced several steps of devolatilization with increasing rank (Stach et al., 1982). The coals are mostly consisting of carbon with lesser amount of water, nitrogen and sulfur (Arms, 1990). The color of coal is ranging from brown to black and usually it is stratified. Each coal has different composition. The properties of coal depend on the nature of various components in the original organic accumulation, including both the forms of vegetation represented and the degree of degradation that they have suffered prior to burial.

Coal is formed from the accumulation and alteration of plant debris in swamp area or in the moist environment. When the plant was decomposed, it will formed peat layers which subsequently lead to formation of coal. Peat which is formed when the plant debris accumulated under appropriate condition during the initial steps of coalification is not considered as coal (Speight, 1994). There are two types of coal which are humic or woody coal and sapropelic coal. The humic or woody coal is derived from plant while sapropelic coal is derived from algae, spores and finely divided plant material.

Coal is found on every continent, and world coal reserves exceed 1 trillion tons. In Malaysia, the coal resource is estimated at about 1050 million tones of various qualities ranging from lignite to anthracite; bituminous to sub-bituminous coal, however forms the bulk
of this amount. From the total amount mentioned above, 69% is found in Sarawak, 29% in Sabah and 2% in Peninsular Malaysia (Thaddeus, 2001).

Coal is used widely as fuels to generate electricity and also in industry such as steel industry. Coal also can be used in manufacture such as nylon, styrene, fertilizers, activated carbon, drugs and medicine (Speight, 1994). Different coal from different coalfield has different characteristic which gives different properties for each coal samples. The characteristics of coal are influenced by many different factors, such as vegetation type, climate, facies variation during peat accumulation and the extent of organic matter degradation during diagenesis.

In the past, coal petrological and palaeobotanical data were the primary source of information about the coal forming environment and the ecology of the peat formation. In more recent times, biomarker analysis of the soluble organic matter of coal has increasingly contributed to the understanding of the paleoenvironment in the mires and has provided clues to the botanical input involved in their formation (Pütmann et al., 1985; Dehmer, 1989, 1995; Kalkreuth et al., 1998; Otto and Wilde, 2001). Organic geochemistry has a vital role in determining the characteristic of fossil fuels. It involves identifying organic compounds such as hydrocarbons which is related to biological molecules present in the tissues of living organism. It is called biomarkers and these biomarkers will provide us with the information on the inputs of organic matter, palaeodepositional environment on which they were deposited and the thermal maturity of the sedimentary rocks (Olivella et al., 2006).
1.2 Objectives of the Project

The objectives of this study are:

a) To extract and fractionate the geolipid of coal samples from Long Tutoh coalfield, Baram and Merit Pila coalfield, Kapit, Sarawak.

b) To determine the organic compounds in aliphatic fraction using gas chromatography/flame ionization detector (GC/FID), and

c) To predict origin of the coal samples and its degree of maturity by biomarker evaluation.
CHAPTER TWO
LITERATURE REVIEW

2.1 Coal

Coal is an organoclastic sedimentary rock, composed essentially of lithified plant debris. The initial sediment formed by this process is a moist, spongy material called ‘peat’, but this becomes compressed, dried and modified in both texture and composition due to diagenesis association with burial and tectonic activity. It also can be considered as heterogenous mixture of organic compounds, together with a certain amount of inorganic material in the form of moisture and mineral impurities (Barnsley et al., 1984). It is formed from the fossilized plant remain in the swamps. It is a non-renewable resource which is a fossil fuel formed in ecosystems where plant remains were preserved by water and mud from oxidation and biodegradation. Coal is a readily combustible rock which is usually black or brownish-black rock. It is composed primarily of carbon and hydrogen along with small quantities of other elements such as sulfur.

The coal type can be explained by determining the maceral composition of coal. The coal maceral composition can be determined by petrographic analysis. According to the Stopes-Heerlen system, coal macerals can be classified into three groups which are virtinite group, inertinite group and liptinite group (Barnsley et al., 1984). Previous study on coal samples from Lafia-Obi, Nigeria showed that there were three groups of maceral were considered in the studied coal samples. The first group is liptinite group, comprised of sporinite, resinite, alginate and cutinite which are hydrogen rich with potential to generate liquid hydrocarbons. The second group is virtinite group, comprised of textinite, ulminite,
humodetrinite and gelinite, which has lower hydrogen content and is likely to generate hydrocarbon gas. The third group is inertinite group, consisting of fusinite, semifusinite, macrinite and micrinite, which is hydrogen poor and has little potential for hydrocarbon potential (Ehinola et al., 2002).

### 2.2 Coal in Malaysia

Until 1998, Malaysia's mineral resources is included antimony, barite, bauxite, clays, coal, copper, gold, titanium, iron ore, lead, limestone, natural gas, crude petroleum, rare earths, silica, silver, thorium, tin, tungsten, and zinc. Over the past three decades, most identified resources of barite, bauxite, copper, gold, iron ore, kaolin, limestone, silica, and tin had been exploited, but resources of coal, lead, and zinc remained largely undeveloped (Wu, 1998). In 1980, Malaysia has decided to move away from huge dependency on oil as their fuel energy. As a results from this energy diversification, Malaysia has developed its hydro power and natural gas resources and increase the demand of coals, gas, hydro, and oil which has turned Malaysia into an energy trader in the region. Malaysia has decreased the usage of oil in fuel mix in energy consumption from 87.8% dependence on oil in 1980 to 49.2% in 2000. Natural gas and coal in year 2000 accounted 42.4% and 5.2% respectively of total energy mix (Thaddeus, 2001).

Distribution of coal resources in Malaysia is presented in Table 2.1. As shown in this Table 2.1, Sarawak has the major reserves of coal in Malaysia, with total coal resources equal to 725.37 million tonnes, while Sabah with 307.7 million tonnes and Peninsular Malaysia with 17.00 million tonnes. It is estimated that 231.85 million tonnes of the total amount of coal
reserved in Malaysia is measured reserve, 171.38 million tonnes is indicated reserve while another 646.84 million tonnes is inferred reserve.

Table 2.1: Coal Resources in Malaysia (In Million Tonnes) (Thaddeus, 2001)

<table>
<thead>
<tr>
<th>Location</th>
<th>Measured</th>
<th>Indicated</th>
<th>Inferred</th>
<th>Coal Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarawak</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Silantek</td>
<td>7.25</td>
<td>10.60</td>
<td>32.40</td>
<td>Coking-coal, semi-anthracite, anthracite</td>
</tr>
<tr>
<td>2. Merit Pila</td>
<td>176.20</td>
<td>107.08</td>
<td>121.84</td>
<td>Sub-bituminous</td>
</tr>
<tr>
<td>3. Bintulu</td>
<td>-</td>
<td>-</td>
<td>120.00</td>
<td></td>
</tr>
<tr>
<td>4. Mukah-Balingian</td>
<td>43.60</td>
<td>8.30</td>
<td>98.10</td>
<td></td>
</tr>
<tr>
<td>Sub-total</td>
<td>227.05</td>
<td>125.98</td>
<td>372.34</td>
<td></td>
</tr>
<tr>
<td>Sabah</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Silimpohon</td>
<td>4.80</td>
<td>1.50</td>
<td>7.70</td>
<td>Sub-bituminous</td>
</tr>
<tr>
<td>2. Labuan</td>
<td>-</td>
<td>-</td>
<td>8.90</td>
<td>Sub-bituminous</td>
</tr>
<tr>
<td>3. Maliau</td>
<td>-</td>
<td>-</td>
<td>215.90</td>
<td>Bituminous</td>
</tr>
<tr>
<td>4. Malibau</td>
<td>-</td>
<td>17.90</td>
<td>25.00</td>
<td></td>
</tr>
<tr>
<td>5. SW Malibau</td>
<td>-</td>
<td>26.00</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Sub-total</td>
<td>4.80</td>
<td>45.40</td>
<td>257.5</td>
<td></td>
</tr>
<tr>
<td>Peninsular Malaysia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Batu Arang</td>
<td>-</td>
<td>-</td>
<td>17.00</td>
<td>Sub-bituminous</td>
</tr>
<tr>
<td>Sub-total</td>
<td>-</td>
<td>-</td>
<td>17.00</td>
<td></td>
</tr>
<tr>
<td>Grand total</td>
<td>231.85</td>
<td>171.38</td>
<td>646.84</td>
<td></td>
</tr>
</tbody>
</table>

*15 mt already mined out

Malaysia’s total coal consumption in 1998 was 3 million tonnes, which 1.7 million tonnes were for power stations while another 1.3 million tonnes were for cement industry. Coal utilization as fuel for power plants has estimated to be increased from 4.2 million tonnes in 2000 to 13 million tonnes in 2005. Coal for cement industry is also estimated to be increased from 1.8 million tonnes in 2000 to 2 million tonnes in 2005 (Thaddeus, 2001). In 2004, total coal production is estimated to be 0.3 million short tons while coal consumption is 7.3 million short tons. Total energy consumption during that year is estimated to be 72.7 billion kilowatt
hours. It is also stated that from total consumption of energy, 49% is from natural gas, 41% is from oil, 8% from coal and 2% from hydro (EIA, 2007).

2.3 Organic Compounds in Coal

2.3.1 Hydrocarbons

Hydrocarbon compounds that are commonly found in coal are such as aliphatic hydrocarbon and polyaromatic hydrocarbon. The concentration of total extractable hydrocarbon (TEH) is varied in different rank coal, which is increased among lignites and sub-bituminous coals and reached a maximum within the high volatile bituminous coals, before rapidly decreasing in higher rank coals. The molecular character of extractable hydrocarbon in coal reflects the collective effects of both coal rank and coal types (Stout and Emsbo-Mattingly, 2008). The progressive increase and decrease of TEH yield with increasing rank is due to process of coalification in which smaller and soluble molecules are generated before condensation reaction result in formation of a highly condensed aromatic network (Van Krevelen, 1993).

Hydrocarbon in coals can be derived from restricted range of organism and thus provide a highly selective means of isolating material of specific origin (Pancost and Boot, 2004). The predominance of C_{29} in coals is consistent with the dominant origin of organic matter from land and plants (Betchel et al., 2004). Meanwhile, the dominance of C_{31} n-alkane suggests as characteristic of either grasses or of warm climate plant waxes (Cranwell, 1973). The strong odd predominance of C_{25}-C_{35} n-alkanes is the characteristic for terrestrial plant origin (Rieley et al., 1991) while aquatic plant is characterized by C_{23} and C_{25} n-alkanes.
(Ficken et al., 2000). In the other hand, algae and cyanobacteria is characterized by short chain n-alkanes which are C_{15}, C_{17} and C_{19} (Gelpi et al., 1970).

### 2.3.2 Other Organic components

Other organic components which present in coal sample are sulphur compound. Coal with high sulphur content will cause numerous problems on utilization. In combustion application, the high content of sulphur content will give rise to corrosion problems with the boiler and also cause problems with atmospheric pollution as large amounts of SO_{2} will be released (Barnsley et al., 1984). Moderate content of sulphur is needed for industrial utilization such as for production of solid fuel for metallurgical processing (Ehinola et al., 2002). Organic sulphur in the coal is the sulphur component incorporated into the hydrocarbon compounds of the coal substance.
2.4 Biomarkers in Coal

Biological marker (biomarker) analysis can give us information about environmental conditions and botanical and bacterial input to the paleomire and has been applied to many coal deposits from different ages and location (Dehmer, 1993, 1995; Jiarno et al., 1990 and Bechtel et al., 2003). Beside that, the biomarker distribution also allows us to recognize different inputs, assess their depositional palaeoenvironment and determine their degree of maturity (Olivella et al., 2006).

One of the most important biomarker indices is pristane/phytane (Pr/Ph) ratio. The Pr/Ph ratio is one of the most commonly used geochemical parameters and has been widely used as an indicator of the redox conditions in the depositional environment (Powell and McKirdy, 1973 and Didyk et al., 1978). Pristane and phytane is the most common isoprenoid hydrocarbon found in coal (White et al., 1977). Pristane is originated from the oxidation and subsequent decarboxylation of phytol side of chlorophyll while phytane in the other hand is from the reduction of it. Most recently, archaeabacteria has been proposed as source of phytane (Brassel et al., 1981) while pristane can be also derived from tocopherols (ten Haven et al., 1987). The Pr/Ph ratio is decreasing with increasing maturity of coal samples (Dzou et al., 1995). The value of Pr/Ph ratio lower than 1 indicate reducing or anoxic depositional environment while the value of Pr/Ph ratio more than 1 indicate the oxic condition (Powell and McKirdy, 1973).

The ratio of pristane to phytane also can be used to predict the origin of organic matter in coals either it is origin from terrestrial or aquatic (Nes and McKeans, 1977). The Pr/Ph ratio
ranging from 5 to 11 indicated that coals are originated high wax oils and non-marine sources environment. The high Pr/Ph ratio also indicated that the coal samples can be classified as humic coals and originated from terrestrial plants. In the other hand, Pr/Ph ratio range from 1 to 3 indicated that the coal is originated from low wax oils and marine source environment. According to Claus (1992), coal with Pr/Ph ratio ranging from 4 to 10 showed that it is high volatile bituminous coals.

However, in coal basin with highly sulphate-reducing palaeoenvironment, the ratio of pristane to phytane is not acceptable as oxidity index (Olivella et al., 2006). This character of the paleoenvironment is indicated by the significant present of pyritic sulphur (Querol et al., 1991). This condition, together with high organic-matter content and anoxic conditions is associated with an abundance of organosulphur component at the bottom of the lake (Sinninghe Damsté et al., 1992).

The isoprenoid/n-alkane ratio also has been widely used as biomarker indices to predict the origin and maturity of coal samples. The most common isoprenoid/n-alkane ratios are Pri/C_{17} and Phy/C_{18}. A high Pri/C_{17} ratio might indicate enhanced biodegradation in coal (Betchel et al., 2001) while the value of Ph/C_{18} decreasing below 0.48 marked the boundaries between diagenesis and catagenetic regimes (Chandra et al., 1994). Another important biomarker is Carbon Preference Index (CPI). The CPI can be defined as the ratio of the sum of odd numbered carbon n-alkanes to even numbered carbon n-alkanes in a hydrocarbon distribution. It is a useful parameter for deriving information on the origin of organic matter (Olivella et al., 2006).
CHAPTER THREE
MATERIAL AND METHODS

3.1 Coal Samples

Sample was collected at two areas, which are Long Tutoh, Baram and Merit Pila, Kapit, Sarawak. The coal samples were homogenized and further grounded in a mortar to a fine powder. Aliquots of between 50 and 100g of air dried and ground samples were kept in a jar with Teflon cap liner in a cold area.

3.2 Extraction and Fractionation

The extraction and fractionation method was modified from method by Dzou et al. (1995). Briefly 5g of finely ground sample was extracted in Soxhlet extractor for 24 hours using dichloromethane as the solvent. Prior to extraction, the sample was spiked with 50 μL of 50 ppm of o-terphenyl which serve as internal standards for PAHs and 50μL of 50 ppm solution of octadecene which serve as internal standards for alkanes. The elemental sulfur was removed by activated copper column chromatography. The solvent was removed using vacuum rotary evaporator. Then it was separated into 2 different fractions by eluting using 2 different solvent system on column chromatography packed with activated silica gel. But for this study, only Fraction 1 (F1) was analyzed. The fractions are shown in Table 3.1:

| Table 3.1: The fractions obtained on silica gel chromatography using different solvent system |
|---------------------------------|---------------------------------|
| Fraction                        | Eluent                          |
| F1: Saturated Hydrocarbon       | n-hexane                        |
| F2: Aromatic Hydrocarbon        | n-hexane/CH₂Cl₂ (1:3, v:v)      |
3.3 Instrumental Analysis

3.3.1 Gas chromatography/flame ionization detector (GC/FID)

The methods were modified from study by Amijaya et al. (2006) and Ehinola et al. (2002). The gas chromatography (GC) was performed on a Hewlett-Packard model 5990 series equipped with flame ionization detector (FID). The conditions for GC were: the oven temperature was programmed from 50°C for 5 minutes and then ramped to 310°C at a rate of 6.5°C/min, with a 15 minutes isothermal period at 310°C. Nitrogen gas was used as the carrier gas. The GC was also being equipped with 25m x 0.32mm i.d fused silica capillary column with 0.25μm film thickness. The sample was injected in a splitless mode. The temperature of injector and detector was programmed at 270°C and 300°C respectively.
3.4 Data Analysis

3.4.1 Qualitative and Quantitative Analysis

The data obtained from gas chromatography was used to determine the concentration of aliphatic compound in the coal samples. The calculations were using the formula by Peters and Moldowan (1993).

Relative Response Factor, \( RRF = \frac{C_{std}}{A_{std}} \times \frac{A_{IS}}{C_{IS}} \)

\( C_x = \frac{C_{IS}}{A_{IS}} \times A_x \times RRF \)

Where, \( C_{std} = \) Concentration of standard
\( C_{IS} = \) Concentration of internal standard
\( A_{std} = \) Chromatogram peak area of standard
\( A_{IS} = \) Chromatogram peak area of internal standard
\( C_x = \) Concentration of component X
\( A_x = \) Chromatogram peak area of component X

The Carbon Preference Index \( (CPI_{25-31}) \) value was calculated using equation which is mass ratio of odd to even number carbon molecules in the range (Bray and Evans, 1961).

\[
CPI = \frac{[(C_{25} + C_{27} + C_{29}) + (C_{27} + C_{29} + C_{31})]}{2(C_{26} + C_{28} + C_{30})}
\]
CHAPTER FOUR
RESULT AND DISCUSSION

4.1 Retention Times

Figure 4.1 shows the gas chromatogram obtained from GC/FID analysis on the mixture of n-alkanes standard spiked with octadecene. The retention time for individual n-alkanes are presented in Table 4.1. The retention times for odd numbered n-alkanes were determined based on the average of retention times for two adjacent even numbered carbon alkanes. In the other hand, the retention time for pristane and phytane is determined based on average value of retention times of $C_{17}$ and $C_{18}$ and average value of retention times of $C_{18}$ and $C_{19}$ respectively. The retention times for n-alkanes ($C_{12}$-$C_{32}$) in the coal samples were determined by comparing it with the standard containing mixture of n-alkanes and internal standard (octadecene).

![Gas Chromatogram](image)

**Figure 4.1**: Gas Chromatogram obtained from GC/FID analysis on mixture of even-numbered carbon n-alkanes standard
Table 4.1: Retention times for n-alkane standards and isoprenoid hydrocarbon (pristane and phytane) separated on GC/FID

<table>
<thead>
<tr>
<th>Compound</th>
<th>Molecular formula</th>
<th>Retention Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dodecane</td>
<td>( \text{C}<em>{12}\text{H}</em>{36} )</td>
<td>15.686</td>
</tr>
<tr>
<td>Tridecane</td>
<td>( \text{C}<em>{13}\text{H}</em>{38} )</td>
<td>18.045</td>
</tr>
<tr>
<td>Tetradecane</td>
<td>( \text{C}<em>{14}\text{H}</em>{30} )</td>
<td>20.404</td>
</tr>
<tr>
<td>Pentadecane</td>
<td>( \text{C}<em>{15}\text{H}</em>{32} )</td>
<td>22.276</td>
</tr>
<tr>
<td>Hexadecane</td>
<td>( \text{C}<em>{16}\text{H}</em>{34} )</td>
<td>24.548</td>
</tr>
<tr>
<td>Heptadecane</td>
<td>( \text{C}<em>{17}\text{H}</em>{36} )</td>
<td>26.430</td>
</tr>
<tr>
<td>Pristane</td>
<td>( \text{C}<em>{19}\text{H}</em>{40} )</td>
<td>27.371</td>
</tr>
<tr>
<td>Octadecane (internal standard)</td>
<td>( \text{C}<em>{18}\text{H}</em>{36} )</td>
<td>28.199</td>
</tr>
<tr>
<td>Octadecane</td>
<td>( \text{C}<em>{18}\text{H}</em>{38} )</td>
<td>28.312</td>
</tr>
<tr>
<td>Phytane</td>
<td>( \text{C}<em>{20}\text{H}</em>{42} )</td>
<td>29.152</td>
</tr>
<tr>
<td>Nonadecane</td>
<td>( \text{C}<em>{19}\text{H}</em>{40} )</td>
<td>29.999</td>
</tr>
<tr>
<td>Eicosane</td>
<td>( \text{C}<em>{20}\text{H}</em>{42} )</td>
<td>31.673</td>
</tr>
<tr>
<td>Eneicosane</td>
<td>( \text{C}<em>{21}\text{H}</em>{44} )</td>
<td>33.231</td>
</tr>
<tr>
<td>Docosane</td>
<td>( \text{C}<em>{22}\text{H}</em>{46} )</td>
<td>34.788</td>
</tr>
<tr>
<td>Tricosane</td>
<td>( \text{C}<em>{23}\text{H}</em>{48} )</td>
<td>36.235</td>
</tr>
<tr>
<td>Tetracosane</td>
<td>( \text{C}<em>{24}\text{H}</em>{50} )</td>
<td>37.682</td>
</tr>
<tr>
<td>Pentacosane</td>
<td>( \text{C}<em>{25}\text{H}</em>{52} )</td>
<td>39.035</td>
</tr>
<tr>
<td>Hexacosane</td>
<td>( \text{C}<em>{26}\text{H}</em>{54} )</td>
<td>40.387</td>
</tr>
<tr>
<td>Heptacosane</td>
<td>( \text{C}<em>{27}\text{H}</em>{56} )</td>
<td>41.849</td>
</tr>
<tr>
<td>Octacosane</td>
<td>( \text{C}<em>{28}\text{H}</em>{58} )</td>
<td>42.910</td>
</tr>
<tr>
<td>Nonacosane</td>
<td>( \text{C}<em>{29}\text{H}</em>{60} )</td>
<td>44.186</td>
</tr>
<tr>
<td>Triacontane</td>
<td>( \text{C}<em>{30}\text{H}</em>{62} )</td>
<td>45.462</td>
</tr>
<tr>
<td>Hentriacontane</td>
<td>( \text{C}<em>{31}\text{H}</em>{64} )</td>
<td>47.072</td>
</tr>
<tr>
<td>Docotriacontane</td>
<td>( \text{C}<em>{32}\text{H}</em>{66} )</td>
<td>48.682</td>
</tr>
</tbody>
</table>