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The Analysis of Light Hydrocarbon Characteristics in Hutubi and Huoerguosi Oil and Gas Field

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Abstract: Hutubi and Huoerguosi oil and gas field is located in the southern margin of the Zhungeer basin. As an important oil gas area of Western China they have been the source of attention for many scholars widely. Now, there have been breakthroughs in the exploration theory. However in the genesis, the source sentence still exists as the consciousness is disputed. This paper, through the analysis of the components of light hydrocarbon characteristics in the natural gas, digs into the analysis problem arising from a large number of basic data statistics and experiments (including isotopic characteristics of benzene, toluene, cyclohexane, n-heptane, methyl cyclohexane, 2-methyl cyclopentane, and pentane)，and discusses the origins of the natural gas and source of Hutubi and Huoerguosi oil and gas field. The natural gas from Hutubi and Huoerguosi oil and gas fields has the same source, *i.e.* type III as a precursor of hydrocarbons, which is a typical coal type gas and comes from the coal-measure hydrocarbon source rocks from the Jurassic times.

Keywords: Benzene, cyclohexane, hydrocarbon source rock, isotopic characteristics, light hydrocarbons, toluene.

1. FOREWORD

Hutubi, Huoerguosi oil and gas field is an important oil and gas field in Western China and southern Zhungeer, since it is rich in resources such as the Permian Triassic, Jurassic, regional development, Cretaceous, third and sixth series of the Quaternary sedimentary strata, and the maximum thickness of the sedimentary rocks. The possible source of rocks of Permian, Triassic and Jurassic is the third and fifth series of the Cretaceous in the Junggar basin, which is the region with the most of such source rocks. Now many scholars have done a lot of research in the area on geochemical characteristics of natural gas [1-10], and have made some conclusions. However, in the study of the components of the natural gas, it has been gathered that the light hydrocarbon is not found deep enough. In order to solve this problem, this paper has proposed the genesis characteristics of light hydrocarbons found in the natural gas to have a further discussion related to the natural gas, and identified the genetic problem for providing a strong basis for the exploration.

2. ANALYSIS OF THE CHARACTERISTICS AND CAUSES OF NATURAL GAS IN LIGHT HYDROCARBON COMPOSITION

The light hydrocarbon C6-C7 in Hutubi oil and gas field shows that the light hydrocarbon composition have the advantage of C6-C7 where the content of straight chain alkanes is 50%~ 65%, the naphthenic hydrocarbon content is 25% ~ 30%, and the aromatic hydrocarbon content is 15% ~ 25%. The Triangular diagram of the natural gas in Hutubi and Huoerguosi shows that the distribution characteristics of the light hydrocarbon chains of C7, two-methyl cyclopentane and methyl cyclohexane, are similar. The light hydrocarbon in the gas of Hutubi and Huoerguosi oil and gas field is between 10% ~ 20%. The two-methyl cyclopentane is part of the light hydrocarbon in Hutubi gas field which is relatively lower that is between 30%-50%, but the two-methyl cyclopentane in the gas of Huoerguosi oil and gas field have a higher content which is between 50%～60%. The methyl cyclohexane content in Hutubi gas sample is between 40%～60% which is higher than that in Huoerguosi which is between 30%-40%. In the two oil samples and gas samples, two-methyl cyclopentane, C7 branched and methyl cyclohexane in Hutubi gas field distribution is similar, indicating that they have a similar source. The C7 compounds in different types of light hydrocarbon fractions of Natural gas often have different sources. Toluene more comes from humic type of organic matter. The content of naphthenic hydrocarbon both in coal oil and coal gas is relatively higher, and the paraffin is rich in sapropelic type of source rocks. So it can be used to divide the types of natural gases.

The content of toluene in Hutubi gas field is very low (Fig. **2**) that is less than 25%; the content of C7 cycloalkane is between 35%-40%; C7 alkane is between 35%-50%; condensate oil in Hutubi gas field has a low percentage of toluene that is about 22%; the content of C7 alkane is about 30%, and the content of C7 cycloalkane is relatively higher, reaching up to 50% and has the typical characteristics of a coal-related gas.

C7 light hydrocarbon in n-heptane (nC7) mainly comes from algae and bacterial lipid. It can reflect the parameters of maturity. Methyl cyclohexane mainly comes from higher

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plants, lignin and cellulose and is good for reflecting the terrigenous material types. Various structures of two-methyl cyclopentane mainly come from aquatic organisms and lipid compounds.

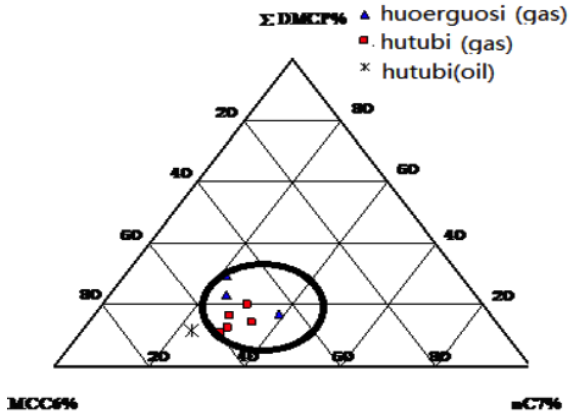

Fig. (1). Hutubi -Huoerguosi light hydrocarbon composition of C7 triangular diagram.

In the natural gas samples of Hutubi, Huoerguosi oil and gas field, content of n-heptane dimethylcyclopentane is less than 40%, while the total distribution of dimethylcyclopentane is in the range of 10%~30%. The content of methylcyclohexane forms one of the oil samples from Hutubi with up to 65% contents of n-heptane while the content of dimethylcyclopentane is less than 25% and 20%, respectively. The matrix of hydrocarbon belonging to type III suggests that the coal-type gas is the main type of natural gas. Methylcyclohexane is the main component of humic gas. We can use IMCC6 to distinguish between oil and gas products by hydrocarbon source rocks from different sedimentary environment and matrix types. IMCC6 is taken for 50%± 2% as the critical value, that is product with the value below this can be regarded as the sapropelic gas produced by the sapropel type (Type I, II), while one with the value above this can be regarded as humic gas (Ximing Hu *et al.*, 1990) [7].

Based on the above criteria, the value of IMCC6 of the four detected gas samples from Hutubi gas field is in the range of 49.6%～59.4% with the average value of 55.3%, suggesting that the natural gas of this area is humic gas. The value of IMCC6 of the two gas samples detected from the Huoerguosi gas field is in the range of 48.9%～52.3%, suggesting the presence of humic gas, similarly. In addition, the value of IMCC6 of the three detected gas samples from Hutubi gas field is relatively higher that is in the range of 53.2%～64.1% and 57.7% as an average, strengthening the conclusion that the source rock of this area is the humic matrix.

3. THE CARBON ISOTOPES OF LIGHT HYDROCARBONS COMPOSITION CHARACTERISTICS AND GAS SOURCE ANALYSIS

Plenty of research shows that contents of light hydrocarbon are small in the natural gas composition although the characteristics of the composition distribution of carbon isotope are significant for the natural gas causing the benzene and toluene isotopes in the light hydrocarbon of the natural gas to have a good stability with the increasing thermal evolution. This mainly reflects changes in the organic matter. Plenty of research conducted using numerous samples from the late "9th Five-Year" Plan shows that carbon isotopes of benzene and toluene in the natural gas produced by the hydrocarbon source rock of a single organic matter source relatively have a good stability with the increasing thermal evolution, whereas those from the mixed organic matter source make some changes (Li Jian *et al.*) [7]. Thus, we can determine the gas source from the research on benzene and toluene isotopes of the light hydrocarbon found in the natural gas. Benzene, toluene, cyclohexane, methylcyclohexane and other carbon isotopes values in the natural gas of light hydrocarbon, make a relatively ideal parameter for gas to gas-source of rock correlation.

The carbon isotopes of the natural gas in Hutubi gas field and Fukang Jurassic Badaowan coal mine pyrolysis of the light hydrocarbon monomers were determined. The results are shown in Tables **1** and **2**. From the graph of Fig. (**1**), it can be seen that in the Hutubi natural gas with light hydrocarbon, carbon isotopes distribution is very similar; the isotopes are heavier indicating that they have a common source.

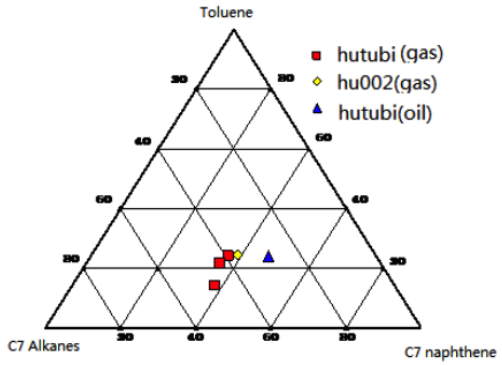

Fig. (2). Hutubi gas with light hydrocarbon toluene; C7naphthene, C7alkanes make composition triangle of cycloalkanes.

Carbon isotopes *e.g.* benzene and toluene of a natural gas light hydrocarbon are mainly influenced by the type of a parent material, the thermal evolution and migration effects, so they can be used to identify the type of organic matter. From the natural gas in Hutubi gas field light hydrocarbon, the existing data of carbon isotopes can be viewed in Table **1**: $\delta\ 13C_{benzene}$ is between -20.3 ‰～ -21.7‰, the average is -21.1 ‰; $\delta\ 13C_{toluene}$ is between -17.9 ‰～ -19.5 ‰, the average is -18.9 ‰; isotopic values are relatively heavy.

The test results in light of the hydrocarbon monomers and carbon isotopes of the two-chamber pyrolysis gas in the Fukang mining Jurassic Badaowan Group at 500°C and 600°C are shown in Fig. (**1**) and Fig. (**2**). The average for δ 13C benzene is -23.2 ‰, that for the $\delta\ ^{13}C$ toluene, is -23.2 ‰, and for the δ 13C methyl cyclohexane, is -23.8 ‰. Compared with the isotopic composition of the natural gas in Hutubi gas field for the light hydrocarbon, carbons isotopes of benzene, toluene, methyl cyclohexane Jurassic and eight carbon coal rock by pyrolysis of bay group are the light products (Fig. **3**).

Table 1. Hutubi natural gas light hydrocarbon isotopes.

Number	Horizon	$\delta^{13}C_{HEX}$ ‰	$\delta^{13}C_{BEZ}$ ‰	$\delta^{13}C_{CYC}$ ‰	$\delta^{13}C_{HEP}$ ‰	$\delta^{13}C_{MCH}$ ‰	$\delta^{13}C_{TOL}$ ‰	$\delta^{13}C_{OCT}$ ‰
hu2	E_2Z	-24.41	-20.27	-21.54	-23.55	-21.06		
hu2005	$E_{1-2}Z$	-24.77	-21.73	-22.59	-25.30	-21.84	-19.31	
hu002	K_2	-25.15	-21.39	-23.47	-25.05	-21.83	-17.90	
hu001	E_2Z	-24.91	-20.96	-23.22	-25.24	-21.53	-19.48	-25.33
Average		-24.81	-21.09	-22.70	-24.78	-21.56	-18.90	-25.33

Table 2. Fukang Jurassic coal pyrolysis carbon isotope data.

Isotope Temp	Horizon	$\delta^{13}C_{BEZ}$ ‰	$\delta^{13}C_{MCH}$ ‰	$\delta^{13}C_{TOL}$ ‰
500℃	J1b	-23.5		-22.4
600℃	J1b	-22.9	-23.8	-24.0
Average		-23.2	-23.8	-23.2

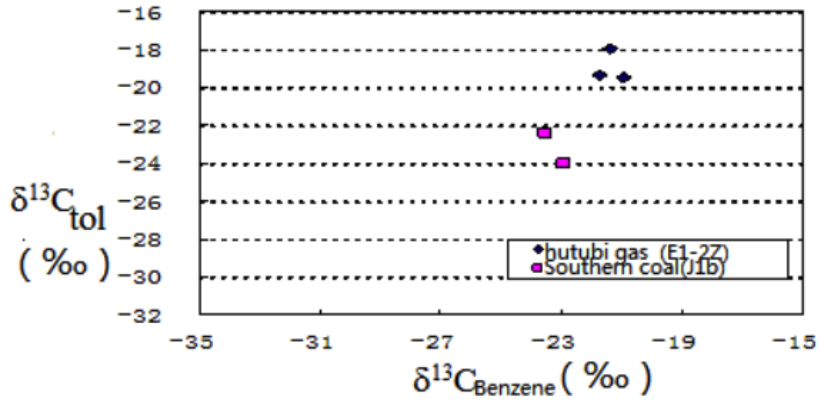

Fig. (3). Hutubi natural gas field and the Jurassic coal pyrolysis of benzene, toluene isotope distribution diagram.

In a comparative study of the light hydrocarbon and carbon's isotopes of natural gas in Talimu Basin, Kuche depression, Erdos upper, lower Paleozoic, Huguoyi (2005, 2007) put forward the division standard of coal type gas as follows: δ ^{13}C benzene >-24 ‰, δ ^{13}C toluene >-23 ‰, δ ^{13}C, cyclohexane >-24 ‰, and δ ^{13}C, methyl cyclohexane >-24 ‰ [9, 10]. According to this standard, Hutubi natural gas light hydrocarbon and carbon isotopes' distribution in the coal type gas is similar to that of the pyrolytic isotope product of coal and light hydrocarbon distributed in the coal type gas from the southern margin of the Badaowan Formation. The light hydrocarbon and carbon isotopes composition is similar to that of the natural gas in Hutubi, which is a product of the Jurassic coal pyrolysis.

The distribution information of the natural gas component, light hydrocarbon composition and carbon isotopes, shows that the natural gas in in Hutubi, Mahe and the Huoerguosi oil and gas field is the coal type gas, is mainly obtained from the Jurassic coal-measure hydrocarbon source rocks in this region.

CONCLUSION

The analysis results for the C7-branched, dimethylcyclopentane and methylcyclohexane distribution in the two oil and gas samples from Hutubi gas field show that they have the same distribution besides having the same matrix.

2) The n-heptane content of the natural gas samples from Hutubi and Huoerguosi gas fields was less than 40%; the distribution of dimethylcyclopentane ranges from 10%~30%, and the content of methyl-cyclohexane is over 45%. The content of methyl-cyclohexane in one oil sample from the Hutubi gas field was up to 65%, while that of n-heptane was less than 25%, and that of dimethylcyclopentane, less than 20%. The matrix of hydrocarbon belongs to type III which can serve as evidence that the main type of natural gas in this area is the coal-type gas.

3) Through the analysis of the four detected gas samples from Hutubi gas field we found that the value of (I_{MCC6}) shows distribution ranging from 49.6%～59.4% with an

average value of 55.3%, showing that the natural gas is humic gas in this area. The (I_{MCC6}) value for the two detected gas samples from the Huoerguosi shows distribution ranging from 48.9%～52.3%, which shows the same type of natural gas, namely humic gas. In addition, the value of (I_{MCC6}) for the three gas samples detected in Hutubi gas field is correspondingly high which shows their distribution between 53.2%～64.1% with an average value of 57.7%, suggesting that the source rock in this area is made of the humic matrix.

4) The carbon isotopes of the light hydrocarbons are distributed in the coal-type gas zone, while that of the coal rock pyrolysis product are formed in the same zone (the southern margin of Badaowan). They are also distributed in the coal-type gas area, having the same composition. The results show that the natural gas in Hutubi is the product of Jurassic coal rock pyrolysis in this area. From the component of the natural gas, the composition of the light hydrocarbon and the distribution of carbon isotopes, we can draw the conclusion that the natural gas in Hutubi, Mahe and Huoerguosi is the coal-type gas, mainly comes from the coal-measure source rock from Jurassic time of this area.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

Declared none.

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