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Study on the Genesis of Natural Gas in Yishu Graben, northeast of China

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Yishu Graben locates between Siberian plate and China-Korea plate in the northeast of China, which is a branch of the north-east Tanlu fault zone. It is a Cenozoic rift basin, and superposes on several different dimensions micro-plates and their jointing belts. Yishu Graben is made up of five primary building units, Tangyuan rift, Yilan uplift, Fangzheng rift, Shangzhi uplift and Shengli rift in sequence from north to south, developing a tectonic pattern of rift sandwiching uplift. The oil-gas exploration in the Yishu Graben began in the 1980s, and five industrial gas wells (one well in Fangzheng rift, four wells in Tangyuan rift and several abnormal gas measurement wells) have been found after 1990s. The formers thought that it was the Bio-methane gas, mixed with a little low maturity pyrolysis gas, and the gas source rock was low maturity source rock of Paleogene. However this study thinks that the gas genetic type of the Yishu Graben is rather complicated. There exists not only biogas but also petroliferous gas, coal-formed gas, inorganic gas, and combination gas which is mixed with each other.

The natural gas component in the Yishu Graben is mainly consisted of methane, and there are two distribution range of methane content. One is dry gas, methane content is high in hydrocarbons gas, $C_1/\sum C_n$ 0.99, and $\delta^{13}C_{CH_4}$ -63.88~36.94‰, which concludes biogenetic gas and pyrolysis gas; the other is a little wet gas with a relative low content of methane $0.70 < C_1/\sum C_n < 0.86$, and $\delta^{13}C_{CH_4}$ -50.31~40.82‰, which is accompanying gas. Furthermore, the natural gas examples from some particular wells have high content of CO₂, the content of CO₂ can be more than 90% in some of them, and $\delta^{13}C_{CO_2}$ -7.8~-3.5‰, which are inorganic gas. The natural gases of Fangzheng and Tangyuan rifts have their own characteristic.

The natural gases in Fangzheng rift are mainly distributed in Xinanchun&Wuyun formation (E_{2x+w}). There is biogenic gas that mixed with pyrolysis gas in gas reservoirs at the top of E_{2x+w} , such as the natural gases of Fang3 and Fang401. The gas source rock of the pyrolysis gas was lacustrine algae. And there is petroliferous gas in gas reservoirs at the bottom of E_{2x+w} , such as the natural gases of Fang4, Fang402 and Fang12, the gas source rock is terrestrial higher plants (Fig.1a). Obviously the natural gases of difference types are caused by different genetic mechanism between the top and the bottom gas reservoirs of E_{2x+w} .

The natural gases in Tangyuan rift are mainly distributed in Dalianhe formation (E_{2d}) and a few in E_{2x+w} . The gases genesis are more complicated. There are pure biogas reservoir, such as Wang2; biogenetic gas mixed with pyrolysis gas which came from lacustrine algae, such as Hu1 and Yong2; pyrolysis gas which came from terrestrial higher plants mixed with a few biogenetic gas, such as Tangcan2; and also pyrolysis gas is mixed with gases that both came from both lacustrine algae and terrestrial higher plants, such as Tang1 (Fig.1b).

Fangzheng and Tangyuan rifts are small graben basin, and they are 1460km² and 3320km² respectively. The deposit sediments of E_{2x+w} in Paleogene are mainly coal-bearing stratum, and there is usually oil shale at the bottom of E_{2x+w} . Some wells have a great quantity of mudstone in E_{2x+w} , the maximum thickness of monolayer was 150m with few coal sediments. The tectonic activities of Fangzheng and Tangyuan rifts were relatively strong in Paleogene. The lakes were very narrow, the slope was very steep and the depth was very deep. So that the source rocks were easily influenced by the border of the basin with higher plants importing, the organic phases also change fast and the preservation condition of organic matter is relatively well. The maturity of source rock is from immaturity to high maturity. All these lead to complex gas types. In addition, it also proved that good natural gas exploration prospects in Yishu Graben.

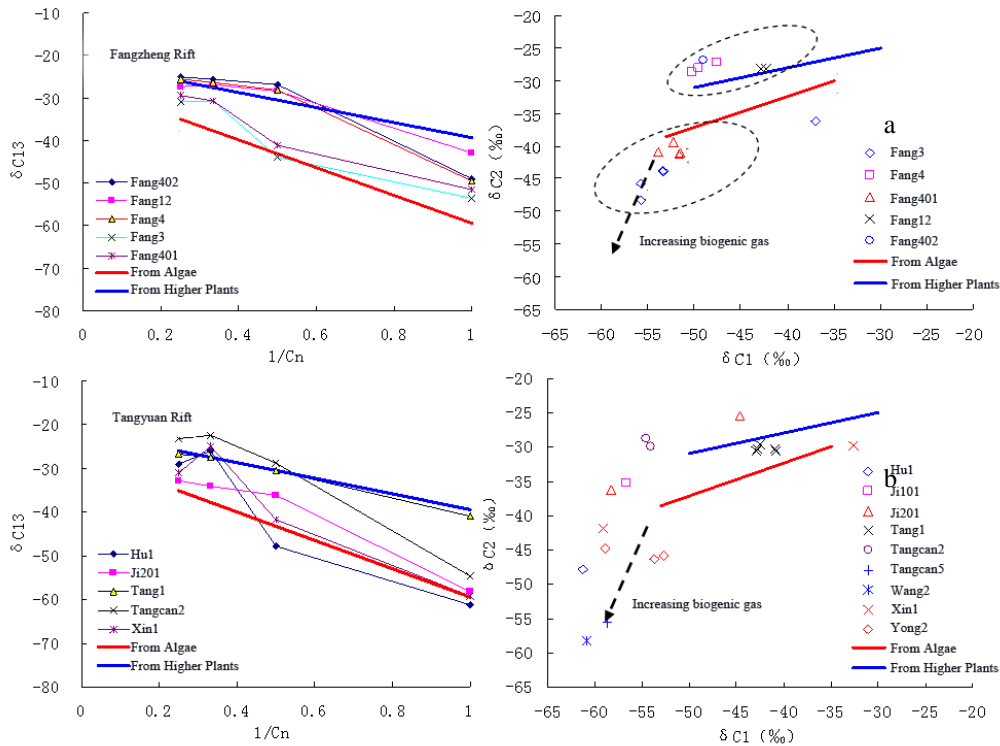


Fig.1 Types of Natural Gas in Fangzheng and Tangyuan Rift