AAPG HEDBERG CONFERENCE
"NATURAL GAS GEOCHEMISTRY: RECENT DEVELOPMENTS, APPLICATIONS, AND TECHNOLOGIES"
MAY 9-12, 2011-BEIJING, CHINA

Carbon and Hydrogen Isotope Fractionation Characteristics and Mechanism in the Course of Gas-Generating and Thermal Evolution

WANG Yifeng[1,2], WANG Dongliang[1,2], MA Chenghua[1,2], LI Jin[1,2]

[1]Research institute of petroleum exploration and development-Langfang, Langfang City, Hebei province, China
[2]The key laboratory of gas reservoir formation and development, CNPC, Langfang City, Hebei Province, China

Select two types of source rock samples, Xiamaling Formation shale (Type I) and Xujiahe Formation coal (Type III), Which are high organic matter abundance, low maturity and large hydrocarbon- generating potential, do the thermal simulation experiment of hydrocarbon generation and expulsion, and then analyzed the gaseous and liquid products carbon and hydrogen isotope, at the same time, we analyzed the residual sample carbon and hydrogen isotope. The results indicated that:

(1) Carbon and hydrogen isotopes of Type I and Type III kerogens have no distinct fractionation in the course of hydrocarbon-generation evolution.

(2) In general, $\delta^{13}C_{kerogen} > \delta^{13}C_{oil} > \delta^{13}C_{gas}$ and $\delta D_{kerogen} > \delta D_{oil} > \delta D_{gas}$, the gaseous carbon and hydrogen isotopic fractionation effect is greater than liquid products, that is the smaller molecules the more fractionation effect.

(3) Along with the increment of thermal evolution degree, carbon and hydrogen isotope of two types of natural gas composition generated by shale and coal trends to become firstly light and then heavy , and the reason of the gaseous isotope became light initially is the kerogen or oil having adsorbed gas. in high temperature stage ,ethane and propane carbon and hydrogen isotope became light, maybe some composition can not cracking in light temperature cracked in high temperature.

(4) A preferable binomial relation exists between δD_{CH4} (or δD_{C2H6}) and maturity both the Type I organic matter and the Type III.

The relationship between the δD_{CH4} (or δD_{C2H6}) of Xiamaling Formation shale (Type I) gaseous products and the vitrinite reflectance is (fig.1):

$$\delta D_{CH4}=25.20Ro^2-43.51Ro-258.32 \quad ①$$

$$\delta D_{C2H6}=45.21Ro^2-113.36Ro-164.17 \quad ②$$

The relationship between theδD_{CH4} (orδD_{C2H6}) of Xujiahe Formation coal (Type III) gaseous products and the vitrinite reflectance is (fig.2):

$$\delta D_{CH4}=29.76Ro^2-57.321Ro-265.85 \quad ③$$

$$\delta D_{C2H6}=26.54Ro^2-46.835Ro-231.76 \quad ④$$

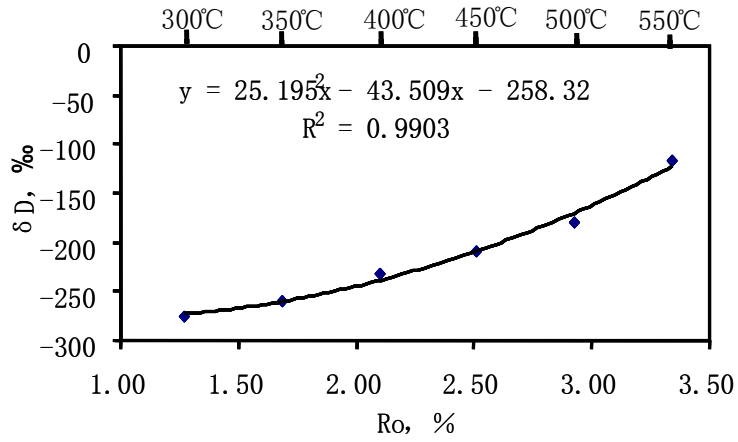

Fig.1. The relationship between thermal simulated gas composition $\delta D_{CH4}$of Xiamaling Formation shale (Type I) and maturity of organic matter

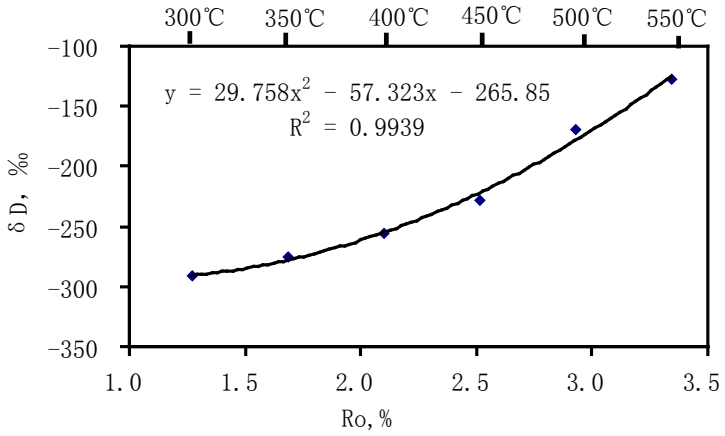

Fig.2. The relationship between thermal simulated gas composition $\delta D_{CH4}$of Xujiahe Formation coal (Type III) and maturity of organic matter

References

Lorant F, Behar F. Carbon isotopic characterization of late methane. The 20th International Meeting on Organic Geochemistry, Nancy, France, 2001, 10~14.

Schimmelmann A, Jean-Paul Boudou, Michael D Lewan, et al. Experimental controls on D/H and13C/12C ratios of kerogen, bitumen and oil during hydrous pyrolysis [J]. Organic Geochemistry, 2001, 32: 1009~1018.

LIU Wenhui, SONG Yan, LIU Quanyou. et al. Evolution of carbon isotopic composition in pyrolytic gases generated from coal and its main macerals. Acta sedimentologica sinica, 2003, 21: 183~189