



Thermochemical Sulfate Reduction and Its Petroleum Geological Significance of the Majiagou Formation in the Ordos Basin

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Abstracts: In recent years, there are many exploration breakthroughs of natural gas in the Ordovician Majiagou Formation, Ordos Basin. Domestic and foreign scholars have conducted a lot of research on the genesis of natural gas, and have come to two different understandings: some scholars believe that the gas source mainly comes from the Carboniferous-Permian coal-bearing strata of the Upper Paleozoic, the others scholars believe that the gas source is mainly marine carbonate rocks with low abundance of organic matter and high thermal evolution. The reason for the divergence between the two viewpoints is that the high-evolution natural gas components are single, the methane content is high, the heavy hydrocarbon content is low, the available geochemical information is limited, and the heavy hydrocarbon components were affected by secondary changes relatively easy (Zhang et al., 2007; Liu et al., 2013; Liu et al., 2016, 2017). Strengthening the study of organic-inorganic interactions and other changes has important guiding significance for clarifying the genesis and exploration the natural gas of Majiagou Formation in the Ordos Basin. The Majiagou Formation in the northern part of the Ordos Basin generally develops a layer of sulphur-filled dolomite. The sulfur associated with gypsum, secondary calcite and solid asphalt were found in cores of different depths. The carbon isotope composition of 23 secondary calcite samples was determined in stable isotope laboratory at Northwestern University, the test result show $\delta^{13}\text{C}$ value of -5.0‰ – -19.9‰ (VPDB) with an average value of -10.4‰ . The adequate sulfur sources, specific mineral combinations and significantly light carbon isotope composition of secondary calcite indicate that the Majiagou Formation has undergone thermochemical sulfate reduction (TSR) transformation in the Majiagou Formation. In the process of consumption of hydrocarbons by TSR, the carbon in the hydrocarbon gas participates in the reaction and eventually transfers to the secondary calcite, which becomes the carbon source of the secondary calcite, resulting in the carbon isotope of the secondary calcite being severely light. The intermediate product of TSR, sulfur and the final products, hydrogen sulfide and pyrite, are derived from the sulfate in the Majiagou Formation. TSR

changes the composition and carbon isotope composition of natural gas, so the effects of TSR should be considered when using alkane gas isotope for gas source comparison.

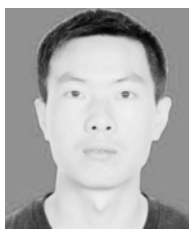
Key words: thermochemical sulfate reduction, Majiagou Formation, Ordos Basin

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References

- Liu, Q.Y., Worden, R.H., Jin, Z.J., Liu, W.H., Li, J., Gao, B., Zhang, D.W., Hu, A.p., Yang, C., 2013. TSR versus non-TSR processes and their impact on gas geochemistry and carbon stable isotopes in Carboniferous, Permian and Lower Triassic marine carbonate gas reservoirs in the Eastern Sichuan Basin, China. *Geochimica et Cosmochimica Acta*, 100(1): 96–115.
- Liu, W.H., Tenger, Zhang, Z.N., Luo, H.Y., Zhang, D.W., Wang, J., Li, L.W., Gao, B., Lu, L.F., and Zhao, H., 2016. An isotope study of the accumulation mechanisms of high-sulfur gas from the Sichuan Basin, southwestern China. *Science China (Earth Sciences)*, 59(11): 1–13.
- Liu, W.H., Zhao, H., Liu, Q.Y., Zhou, B., Zhang, D.W., Wang, J., Lu, L.F., Luo, H.Y., Meng, Q.Q., Wu, X.Q., 2017. Significance of gypsum-salt rock series for marine hydrocarbon accumulation. *Petroleum Research*, 2(3): 222–232.
- Zhang, T.W., Ellis, G.S., Tang, X.F., Walters, C., Kelemen, S.R., Gillaizeau, B., Tang, Y.C., 2007. Effect of hydrocarbon type on thermochemical sulfate reduction. *Organic Geochemistry*, 38(6): 897–910.

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