Hydrocarbon Generation Simulation of the Cambrian Yuertusi Formation and the Cambrian Hydrocarbon Source in Tarim Basin

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Black shale is developed at the bottom of the Lower Cambrian Yuertusi Formation in the Tarim Basin, which has got a high TOC (>12%) and is characterized by laterally continuous distribution, and has been proven to be a good source rock. Though some gas fields derived from Cambrian source rocks have also been discovered (such as Hetianhe gas field), there are still different viewpoints and understandings on hydrocarbon sources and main hydrocarbon source rocks. In this study, relying on the thermo-compression simulation experimental technique, hydrocarbon generation simulation experiments under formation conditions for the hydrocarbon source rocks of Yuertusi Formation are carried out, the relationship between this set of hydrocarbon source rocks and hydrocarbon in the Cambrian System in the platform-basin transitional area is discussed.

Presently, hydrocarbon is only produced from the Cambrian System in Zhongshen well areas in the platform-basin transitional area. The pay formations are Xiaoerbulake Formation ($\in_1$x), Wusonggeer Formation ($\in_1$w) of the Lower Cambrian and Awatag Formation ($\in_2$a) of the Middle Cambrian Series from bottom to top. Geochemical analysis shows the hydrocarbon in Xiaoerbulake Formation has an obvious higher thermal evolutionary degree, and the thermal evolutionary degree is gradually decreased upward. The aridity coefficient of natural gas increases from bottom to top (0.63 → 0.98), and the carbon isotopes of natural gas light up from bottom to top (eg, $\delta^{13}C_1$: -41.4 ‰ → -51.4 ‰), accompanied by the carbon isotope distribution of condensate alkanes lighting up from bottom to top.

Continuous hydrocarbon generation simulation experiments (using simulating temperatures from 300℃ to 500℃) are carried out under 60MP net lithostatic pressure and 30MP fluid pressure under reservoir conditions adopting the thermo-compression simulation experimental technique under reservoir conditions with samples of Yuertusi Formation shale of the Lower Cambrian taken from an outcrop in the western margin of Tarim Basin. The single molecule carbon isotopes of liquid hydrocarbon and gaseous hydrocarbon expelled under various temperature spots are analyzed using the Gas Chromatography-Isotopic Mass Spectroscopy Coupled Technique. The results show that the isotopes of single molecule carbon of the normal paraffin in the oil expelled from Yuertusi Formation shale under a relatively low simulation temperature (less than 375 ℃) is around - 35.4‰～- 31.1‰, which have close distributional characteristics with the single molecule carbon isotope of the condensate from Wusonggeer Formation and Awatag Formation (- 37.8‰～- 32.6‰). Whereas, under a high simulation temperature (>400 ℃) the single molecule carbon isotope of the normal paraffin in the oil expelled are around - 29.1‰～- 26.9‰. Their distributional characteristics are close to those of the single molecule carbon isotope of condensate from Xiaoerbulake Formation (- 29.5‰～- 26.3‰). Considering the distributional characteristics of carbon isotope of methane, ethane and propane series, the simulated gas generated by the mudstone of Yuertusi Formation under a temperature of 425℃ is closer to the natural gas from Xiaoerbulake Formation, the simulated gas generated under a temperature of 415℃ is closer to the natural gas from Awatag Formation, and the simulated gas generated under a temperature of 400℃ is closer to the natural gas from Wusonggeer Formation.

It can be concluded that the hydrocarbon from Zhongshen well areas in the platform-basin transitional area of Tarim Basin is mainly the product of different evolutionary phases of the hydrocarbon source rocks of the Cambrian Yuertusi Formation. This study indicats that the Cambrian hydrocarbon source rocks may be the major hydrocarbon source rocks in the platform-basin transitional area of Tarim basin, which has important guiding significance for hydrocarbon exploration in the platform-basin transitional area of Tarim Basin.

Key words: hydrocarbon generation simulation; hydrocarbon sourc; carbon isotope ;Cambrian; Tarim Basin