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Geochemical Analysis and Origin of Gas in Volcanic Reservoirs of the Songliao Basin in China

Tao S.Z., Chen Z.Y., Pang Z.L., Mi J.K., and Yang C.

Research Institute of Petroleum Exploration & Development, Petrochina, Beijing 100083, China;
tsz@petrochina.com.cn

Volcanic reservoirs were developed extensively in the Songliao Basin in China, mainly intermediate and basic rocks in the north part, intermediate and acid rocks in Xujiaweizi of the south part, and acid rocks in the Jinglin block. The natural gas in the volcanic reservoirs of the Songliao Basin has a wide range of composition, with alkanes being dominant in most cases and carbon dioxide in some wells. Generally, the gas in the volcanic rocks near deep faults has high contents of carbon dioxide, whereas the gas in volcanic rocks far away from faults is low in carbon dioxide.

The gas in the volcanic reservoirs is of multiple origins, including abiogenic-gas of probable mantle origin commonly found in wells with high carbon dioxide content, and organic gas mainly derived from organic matter in the basin. The abiogenic alkanes have $\delta^{13}\text{C}$ values in the order of $\delta^{13}\text{C}_1 > \delta^{13}\text{C}_2 > \delta^{13}\text{C}_3 > \delta^{13}\text{C}_4$, which is opposite to that of alkanes of organic origin. The $^3\text{He}/^4\text{He}$ ratios of the fluid inclusions from the volcanic reservoirs range from 0.286×10^{-6} to 7.33×10^{-6} , with an average of 2.48×10^{-6} , and R/Ra ratios of 0.26~5.24, mostly >1, indicating mixed origins of noble gases from the crust and the mantle. The gas in fluid inclusions from the volcanic reservoirs has $\delta^{13}\text{C}_1$ values from -17.1‰ to -28.7‰ (PDB), $\delta^{13}\text{C}_2$ from -23.4‰ to -32.4‰ (mostly about -25‰), and $\delta^{13}\text{C}_{\text{CO}_2}$ from -10.97‰ to -21.73‰, which are significantly different from the isotopic compositions of the gas in present reservoirs, suggesting that some abiogenic alkane may have been charged into the reservoirs during the geologic time. The early-charged CO_2 is mainly organic origin, while abiogenic CO_2 was charged during the main accumulation period, indicating the mixed origin of gas in the volcanic reservoirs of the Songliao Basin. Abiogenic-alkane, He, especially CO_2 in the natural gas, indicate the mingling of some abiogenic gas in the gas.

According to the relationship between distribution and occurrence of volcanic rocks and faults, we found the abiogenic gas reservoirs distributed near fault zones but organic and mixed gas reservoirs far away from fault zones. The geochemical study on natural gas would be helpful in finding out the origin

and spatial distribution pattern of gas in the deep volcanic reservoirs and direct further gas exploration in the Songliao Basin.

References:

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