

Geochemistry characteristics and genetic types of natural gas in central part of the Tarim Basin, NW China

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According to the chemical, carbon isotopic, and hydrogen isotopic compositions and ³He/⁴He ratios of 127 natural gas samples, the natural gas in the Tarim Basin is mainly composed of gaseous alkanes dominated by methane. The contents of the gaseous alkanes decrease with the increase of their carbon numbers. The CO₂ and N₂ contents of less than 5% samples are >80%. The dryness coefficients of the gaseous alkanes are in the range of 39.9%-99.8%, with the highest found around the west slope of the Manjar Sag (JLK gas field, SN gas field, etc.), and decrease along the direction to the central basin. The δ¹³C values of CH₄, C₂H₆ and C₃H₈ in the platform area of the Tarim Basin vary in the range of -54.4‰~-24.4‰ (an average value of -39.2‰), -43.1‰~-26.7‰ (an average value of -36.1‰) and -37.9‰~-21.6‰ (an average value of -31.8‰), respectively. The overall carbon isotopic composition of the alkanes is δ¹³C₁< δ¹³C₂< δ¹³C₃< δ¹³C₄ and partially varies to δ¹³C₁>δ¹³C₂ or δ¹³C₃> δ¹³C₄ for some gases. δ¹³C₁< δ¹³C₂ was attributed to TSR (thermal sulfate reduction) and δ¹³C₃> δ¹³C₄ was caused by the mixing of the natural gases of the same genetic type formed at different stages. The methane hydrogen isotopes (δ²H-C₁) of the natural gases in the Tarim Basin are in the range of -195‰~-122‰ with an average value of 156‰. The methane hydrogen isotope fractionations of some natural gas samples showing the characteristics of a typical freshwater depositional environment (δ²H-C₁<-180‰) might be caused by low-temperature water-rock interactions in the lacustrine environment. The ³He/⁴He ratios of the natural gases in the Tarim Basin are in the range of 2.3×10⁻⁸~66.8×10⁻⁸, suggesting that there is no deep mantle-derived gas in the platform area of the Tarim Basin. The high ³He/He⁴ ratios might be attributed to the residue gases in the rocks produced by the Late Hercynian volcanic activities. In addition, the decay of ⁶Li (n, α)³H(β)³ to ³He occurred in the Li-rich volcanic rocks also contributed to the high ³He/⁴He ratios of the oil-type gas. The carbon isotope fractionation of alkane gas indicates that the natural gas in the platform area of the Tarim Basin is oil-type. The modified plots of lnC₁/C₂ vs. lnC₂/C₃ and C₂/C₃ vs. δ¹³C₂-δ¹³C₃ of the natural gases indicate that the genetic types of the oil-type gas in the Tarim Basin

includes kerogen-cracking gas, oil-cracking gas, oil- and gas-cracking gas, gas-cracking gas and the mixture of the kerogen-cracking and oil-cracking gases. The gas evolved from gas-cracking gas, to oil- and gas-cracking gas and oil-cracking gas along the direction from the west side of the Manjar Sag to the central Tarim Basin. The natural gases in some areas of Tazhong are the mixtures of the kerogen-cracking and oil-cracking gases. The natural gas in the platform area of the Tarim Basin has various geochemical characteristics caused by the diverse formation environments, genetic sources, tectonic activities and thermal evolutions.