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BIOGENIC GAS OCCURRENCE AND SOURCE KITCHEN IDENTIFICATION IN THE QAIDAM BASIN, NW CHINA

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The highest biogenic gas field in the world with an average elevation exceeding 2800 m locates at Sanhu area in the eastern part of the Qaidam Basin, NW China. The gas was reservoired in the Quaternary lacustrine and swamp facies of unsolidified sandstone and mudstone interbeds with burial depth shallower than 1900 m. The reservoir was characterized by high porosity of 24-40% and source rock was characterized by low TOC of 0.3%. Low temperature, high salinity and high depositional rate are ascribed as main controls for gas generation and syn-depositional anticlines since Pleistocene are responsible for gas accumulation (Dang et al., 2003). Gas and mineral geochemistry, micro-organism detection coupled with formation water analysis are carried out from two systematically canned cutting sampling wells and other representative locations to investigate biogenic gas generation mechanism and identify biogenic gas source kitchen.

Gas geochemical analysis of 12 gas samples from 6 gas fields shows gas dryness larger than 0.95 and methane isotope values of $\delta^{13}C$ in the range of -68.5 to -60.5‰, representing typical biogenic gas. However, detailed gas geochemical analysis of 36 canned cutting top gas samples from Well XS3-4 in the depth of 50 to 1700 m illustrates different genetic pathways (Figure 1). Although carbon dioxide reduction is dominant mechanism for most biogenic gas cases, gas derived from microbial fermentation occurs at both shallow (about 300 m depth) and deep (about 1700 m depth) intervals, suggesting diverse origins of biogenic gas. Minor amount of ethene and propene are also detected from these gas samples, suggesting that gas generation process is still going on.

Specific biomarkers such as 2,6,10,15,19-pentamethylicosane (PMI) are commonly used to diagnose methanogenesis activity from archaea. Geochemical analysis of 24 immature source rock extracts reflects that the concentration of PMI shows positive correlation to ratios of C_{21}^{-}/C_{22}^{+} normal alkanes, C_{27}/C_{29} regular steranes, tricyclic/pentacyclic terpanes, and Rock-Eval S_1/S_2, indicating intrinsic relationship between type of organic matter and depositional environment and biogenic gas generation. Laboratory simulation results from 3 rock samples

and 1 recent sediment substantiate this conclusion. Meanwhile, our results also suggest that methanogenesis activity is closely related to chloride ion content.

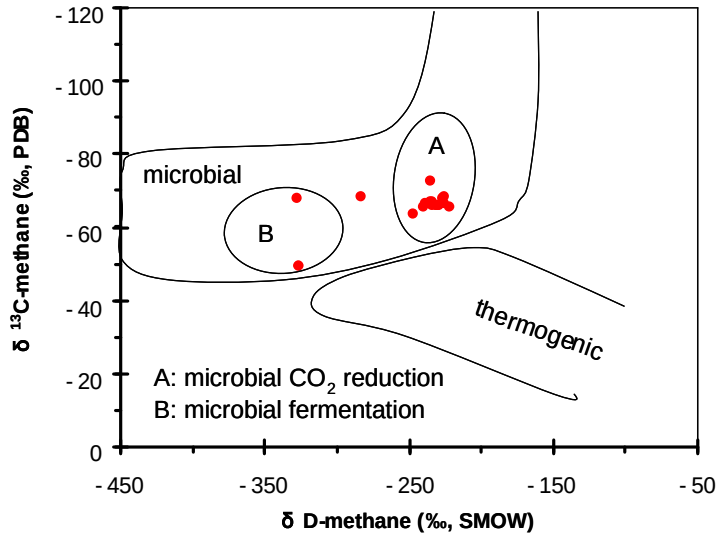

Figure 1. Gas generation pathway classification on the base of stable carbon and hydrogen isotope of methane for Well XS3-4 (modified from Whiticar, 1999)

Sedimentary analysis on the base of 27 canned cutting samples and well logs for Well SN2 and XS3-4 illustrates that semi-deep lacustrine facies are methanogenetically more active than these in shallow lacustrine and shore facies. Most biogenic gas in the Sanhu area is formed in semi-deep lacustrine facies. Moreover, methanogenetic activities are burial depth related on geological profiles. Methanogen and their relevant microbial reside in depth usually shallower than 2000 m, significantly dropped over 1500 m deep and rarely detected deeper than 1700 m. Geological evidence integrated with geochemical analysis suggest that biogenic gas source kitchen in the Sanhu area locates at the Central Depression semi-deep lacustrine facies with burial depth less than 1800 m and gas accumulates at the Northern Slope due to regional groundwater drainage.

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