P134-TU

GENESIS OF HYDROGEN SULFIDE IN LOWER TRIASSIC FEIXIANGUAN RESERVOIRS IN THE NORTHEASTERN SICHUAN BASIN, SW CHINA

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Significant sour gas accumulations have been discovered recently in Triassic reservoirs in the northeastern Sichuan Basin, SW China. The reservoirs occur mostly in the oolitic shoal facies, with mean porosities up to 13%-17%. Among the proven gas pools discovered in the Triassic Feixianguan Fm, the largest contains up to 250 billion cubicmeters. The gases are generally dry, containing 70-80% methane, 5-20% H_2S and trace amounts of other gaseous hydrocarbons. The presence of H_2S in the natural gas not only reduces its economic value, but increases the health and safety risks from drilling and production to transportation. A sour gas well blowout in the Luojiazhai gas field in northeastern Sichuan Basin occurred in December 2003. This led to a death toll of 243 people. As a result of concerns about the potential reoccurrence of such an event a study was undertaken to improve our understanding of the origin of the sour gas accumulations and to develop predictive tools for evaluating the sour gas risk.

Preliminary data presented in several Chinese publications (Jiang et al., 2002; Wang et al., 2002; Zhu et al., 2004,2005,2006; Ma et al., 2005; Zhang et al., 2006) indicate that the H_2S was likely derived from thermochemical sulfate reduction (TSR) occurring in the Triassic reservoirs. The main evidences include: sulfur crystals exist in the cores; a large area of corroded holes, secondary calcites and pyrite crystals obviously be seen under the microscope; the gaseous hydrocarbon with high content of H_2S has a heavy $\delta^{13}C$ value; the $\delta^{13}C$ value of carbonate is particular negative; The $\delta^{34}S$ value of H_2S(+10.3 ‰-+13.7 ‰) is lighter than that of anhydrite(+13.7 ‰-+25 ‰)(Zhu et al,2005).

However, with the development of natural gas exploration in Sichuan basin, some geologic phenomenas are difficult to explain in TSR reaction. Horizontally, the thickness of anhydrite in Feixianguan reservoirs is not big, and the content of H_2S in natural gas is also high and usually reaches 100 to 250 g/m^3 even in no anhydrite place. Vertically, the anhydrite distributes above the main gas production formation, so there are no enough conditions to cause TSR reaction in reservoir. In additional, anhydrite existing in the tight stratum mainly distributes in vein or maculose. It has relationship with the developing degree of cracks and

mostly distributes along the cracks.

Based on the analysis and summary of the current research status of H_2S genetic mechanism at home and abroad , these experiment techniques such as Gold tube pyrolysis, hydrous pyrolysis and quartz tube pyrolysis have been used to simulate the generation of H_2S. The results show that it is very easy that the reaction of sulphur and n-hexane, and the quantity of generating H_2S is very large under the lower temperature. Reverse, it is very difficult that the reaction of $CaSO_4$ and n-hexane, and the quantity of generating H_2S is very small under the higher temperature. The content of H_2S is as high as or even over the methane during the simulation experiment of immature marl with high organic matter content , better type and large amount of FeS_2 in Feixianguan Fm.

In addition, a series of experiments such as ferrous sulfide reacting with hydrochloric acid, sulfur and calcium sulfate reacting with n-hexane respectively, heating marl has been done. The experiment results show that the values of $\delta^{34}S$ in all reaction resultants are higher than the reactants. Theoretically, in the process of generating H_2S that S^{2-} combine with the H^+, $^{34}S^{2-}$ is easier to combine H^+ and form more stable H_2S and with heavier isotope than $^{32}S^{2-}$. According to that conclusion, if the H_2S generates from the anhydrite reacting with hydrocarbon, the $\delta^{34}S$ value of H_2S should be heavier than that in anhydrite. The $\delta^{34}S$ value of H_2S generated by microbial effect is obviously negative.

In conclusion, the H_2S in reservoir maybe directly originate from source rock or microbial effect of sulfate in stratum. In the long geological history, many cyclic reactions have occurred, such as oxidations, forming free sulphur and H_2S derived from the reaction of free sulphur with hydrocarbon. Finally, form the similar $\delta^{34}S$ value between the H_2S of natural gas and the free sulphur in reservoir.