



The Formation Mechanism of Tight Sandstone Reservoir in Northern Songliao Basin

Jingya Zhang (1,2,3), Guangdi Liu (1,2), Guohui Li (4), Shizhen Tao (5), Zhe Cao (1,2), Mengya Jiang (1,2)

(1) College of Geosciences, China University of Petroleum(Beijing), Beijing, China, (2) State Key Laboratory of Petroleum Resources and Prospecting, Beijing, China, (3) Unconventional Oil & Gas Cooperative Innovation Center, China University of Petroleum, Beijing, China, (4) Daqing Oil Company Exploration & Development Research Institute, Daqing, China, (5) Research Institute of Petroleum Exploration & Development, PetroChina, Beijing, China

Generally speaking, the oil in sandstone reservoir whose porosity is lower than 10% and overburden matrix permeability is lower than 0.1mD can be called “tight sandstone oil”. Currently, tight oil has become a research focus in global unconventional petroleum geology. In China, it is also widely distributed and explored in several basins, especially in Gaotaizi and Fuyu reservoirs in Songliao Basin, which is one of the three areas with over one hundred million tons of oil reserves. However, the sandstone reservoir in Songliao Basin has very poor physical property with average porosity of 8.54% and permeability of 0.49mD. In most cases, the formation of tight reservoirs is affected by two aspects, primitive components of sediment and the diagenesis process subsequently.

In this study, four controlling factors on densification process of Fuyu tight reservoir in northern Songliao Basin are recognized according to thin section and scanning electron microscope observation, and these factors contribute to reservoir densification jointly. The first factor affecting sandstone reservoir densification is strong compaction because of high content of rock debris and clay matrix in rocks. There is as much as 30% content of plastic debris such as slate and schist debris in the reservoir, which tended to transform easily and fill in pores in the process of compaction, resulting in rapid densification of reservoir. The second one is the precipitation of large amounts of illite. There are three appearances of illite as flake, needle shape and bypass shape, among which the flake one usually formed in primary sedimentation. Illite filled in all kinds of pores and throats, not only making the porosity decreased significantly, but also making fluid flow percolate through throat more difficultly. Although abundant intercrystalline pores developed in illite, most of them were invalid. The third factor is early calcite cementation. In the early diagenesis stage, sparry calcite cement developed widely. It often presented poikilitic morphological characteristic, with clastic grains floating among. According to the statistics, the content of early calcite cement ranges from 10% to 50%, correlating negatively with reservoir porosity. The last factor for reservoir densification is the combined impact of late calcite cement, authigenic clay minerals and authigenic quartz in buried diagenetic stage. The late calcite cement usually filled in residual intergranular pore which had greatly decreased after strong compaction. The authigenic chlorite membrane presented between late calcite cement and clastic particles, while the authigenic illite often grew in dissolved pores. The content of authigenic quartz was low, but non-negligible, and the quartz overgrowth also made contribution to reservoir tightness. In conclusion, the four factors controlled the densification process of Fuyu tight sandstone reservoir jointly and altogether.