

Diagenetic Heterogeneity and Its Effect on Tight Sandstone Reservoir Quality Under Multi-Episode Hydrocarbon and CO₂ Entrapment: A Case Study from the Lower Cretaceous Quantou Formation, Southern Songliao Basin, China

Cong Guan, Lianbo Zeng
China University of Petroleum (Beijing)

9.29.2020 - 10.1.2020 - AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

Complex diagenesis and primary sediment properties play a critical role in evaluating tight sandstone reservoir performance. In order to gain insight into diagenetic heterogeneity and its influence on tight sandstone reservoir quality under multi-episode hydrocarbon and CO₂ entrapment samples collected from Lower Cretaceous Quan 4th member in the Southern Songliao Basin are evaluated by thin section petrography, X-ray diffraction, SEM, cathodoluminescence, HPMIP, RMIP, and fluid inclusion analysis. The sandstones are feldspathic litharenites and lithic arkose. As a result of intensive compaction and cementation triggered by sedimentary, diagenetic and tectonic factors, the reservoir densified significantly and underwent strong heterogeneity with the porosity and permeability distributed in 2%~16% (average 8.5%) and 0.01~4.2×10⁻³ m² (average 0.157×10⁻³ m²) respectively. Two generations of carbonate cement are recognized in Quantou formation, as well as dawsonite cement developed locally, including early calcite cement and late ferrocalcite and ankerite cement, corresponding to two oil and gas charging events. Porosity loss related to compaction ranges 10.5%~23.1%, with an average of 17.5%. Porosity loss related to early calcite cementation and late carbonate cementation is 10.5%~23.1% and 1%~12.5% , with the average of 17.5% and 3.2% respectively.

While porosity increase related to dissolution is 0.2%~4.8%, average 2.3%; The sorting and mineral composition affect the compaction, and the intensive compacted samples are mostly from siltstone with high plastic mineral content. Calcite cementation is mostly developed at the bottom of the channel in contact with mudstones, which provide material source for it. The early calcite cementation has two aspects to the reservoir reconstruction. The early cementation inhibited the compaction, and easy to form high-quality reservoirs with the injection of late organic acid fluid and the dissolve of early cement. However, if the throats are blocked by early calcite cement, it is difficult for acid fluid to enter the pore in subsequent diagenetic period, resulting in reservoir densification. In addition, CO₂ gas reservoirs are developed in the southeast of the study area and accompanied by dawsonite cement of mantle origin which is controlled by deep major faults and makes the reservoir quality worse. The relative strength of cementation and dissolution ultimately affects the final quality of such tight sandstone reservoirs.