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Characteristics and Formation Mechanisms of Tight Sandstone Reservoirs in the Huahai Depression, Jiuquan Basin

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It is significant to study the reservoir features and formation mechanisms of unconventional reservoirs. The reservoir characteristics of tight sandstone reservoirs in the Huahai Depression, Jiuquan Basin are systematically described in this paper, and in particular the micro pore structures of observed core samples are qualitatively classified. Fundamentally, this research is benefit for the efficient analysis of tight oil occurrence characters, accumulation mechanisms and seepage mechanisms, which subsequently would be meaningful for exploration and exploitation of unconventional reservoirs.

The tight oil reservoirs are anticipated to be widely developed in the Xiagou and Zhonggou formation, lower cretaceous in the Huahai Depression, Jiuquan Basin (Wang C.X., et al., 2005). Both the observed core and logging data indicate that lithology at the target area is mainly constituted of siltstone and grained sandstone. The study of sedimentary facies suggests the tight oil reservoirs are mainly distributed in the delta front and coast shallow-lake, where frontal sheet sand and shore-shallow lacustrine mixing beach are more prone of bearing hydrocarbon. The sandstone in this area is commonly classified into debris-feldspar and feldspathic lithic types with relatively low reservoir porosity and permeability, via the slice observation and laboratory measurement. The average porosity among all measured data is smaller than 10%, mostly between 2% and 7%, while the permeability often ranges from 0.001 to 1 mD.

There are mainly five pore types of tight sandstone reservoir in the Huahai Depression: (1) Original intergranular pore—with clear clastic particles boundaries and relatively large pore aperture (2–5μm). However, it is often not widely developed (Fig. 1a, b, c). (2) Matrix micro-pore—It is formed by the shrinkage process during the diagenesis of argillaceous in the sandstones, or the residual

macro-pores survived from the compaction process of silt particles (with diameter>0.003mm) (Fig. 1c, d, e). (3) Intergranular dissolution pore—with comparatively larger diameters, blur pore boundaries and the visible residual dissolution pores of different minerals including cutting grains and feldspars (Fig. 1d, g, h). (4) Intragranular dissolution pore—with relatively smaller diameters, and mainly formed by the dissolution of rock minerals such as feldspars and cutting grains. It can be developed independently (Fig. 1e, j), or along the joint fractures in the feldspars (Fig. 1g). The dissolution pores are widely developed in the research area. (5) Intercrystalline pore—the intercrystalline macro-pores between different crystals and assemblages of clay minerals including kaolinite, illite and montmorillonite (Fig. 1m, n, o).

The reservoir pore apertures in the Huahai Depression are often small and variable. In addition to the influence of sedimentation, diagenesis process plays a vital role in the formation of tight reservoirs. Generally, the diagenesis mechanisms can be mainly classified into four types: (1) Compaction—due to the small and complex particle sizes, the reservoir compaction in this area is intense, which makes these particles linearly or concavely and convexly contacted, and the original porosity lost 60% - 80%. (2) Carbonate cementation—the cementations in the Huahai Depression are often intensive and can be roughly described by the cementation process of different minerals including calcite, ferrocalcite and ferrodolomite. Particularly, sparry calcite in this area usually cements the intergranular pores and fractures, and therefore replaces the original minerals. (3) Transformation of recrystallization of clay minerals—the clay minerals gradually become illite and montmorillonite with the increase of buried depth in the Huahai Depression. These increased minerals take up and reshape the intergranular pores, and divide those big pores into small ones. Although the total porosity value is

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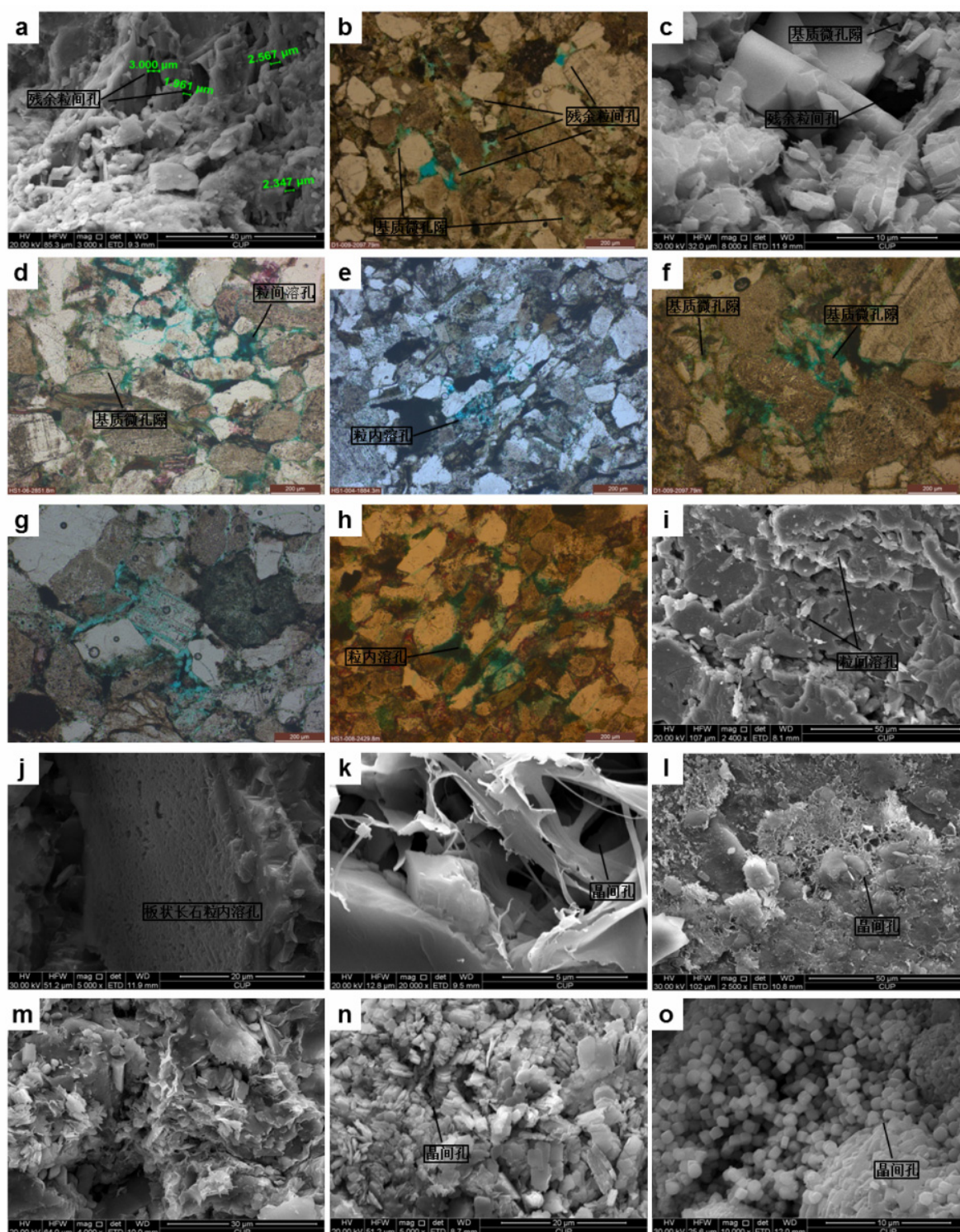


Fig. 1. Pore throat characteristics in Huahai Depression.

not affected, the distribution of pore geometries is obviously changed. (4) The pore increases by secondary quartz—although not commonly developed in this area, the secondary quartz could increase the pore spaces and subsequently form tight reservoirs.

References

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