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The Nano-Macro Pore Network and the Characteristics of Petroleum Migration and Accumulation in Chang 8 Tight Sandstone Reservoir in Heshui, Ordos Basin

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Tight oil generally refers to the oil stored in the tight sandstone reservoir or tight carbonate reservoir that the overburden matrix permeability is less than or equal to 0.1 mD (equivalent of about air permeability less than 1.0 mD) (Zeng et al., 2014).The tight oil resources are widely distributed in China, among them the Chang 6-Chang 8 of Yanchang formation in Ordos basin is an important tight oil reservoir where large tight sandstone oil reservoirs have been found in Chang 8 of Heshui,Jiyuan and Xifeng area with years of exploration, and the Xifeng oil field's crude oil reserve is about 100 million tons, with the newly raised total oil reserves including proven oil in place ,controlled reserve and predicted reserve reaching 2. 2 billion tons (Ding et al., 2011). In this article ,we take the tight sandstone reservoir and oilfield in Chang 8 of Heshui area in Ordos basin as an example, on the basis of geology and Petroleum geology study in this district, using the FIB technology and 3D CT tomography to reveal the Nano-Macro pore and throat systems of the tight sandstone reservoir, and to research the characteristics of petroleum migration and accumulation in the systems.

The tight sandstone reservoir of Chang 8 in Heshui district, Ordos basin, has three types of storage space in nano-macrometer pore and throat systems including intergranular pore, intragranular pore and micro cracks. The pore and throat radius distributes in the nano to macro levels, with obvious characteristics of the typical tight sandstone's pore and throat systems (Bera et al., 2011). The radius of pore and throat that distributing in nano-meter's level mainly concentrate between 100 and 500 nm and the volume of pore distributes in a range of 0-0.01 μm^3, in contrast the macro-meter's level pore and throat's radius concentrate between 2 and 20 μm, with pore's volume distributing in a range of 50-500 μm^3. We select 28 typical tight sandstone samples from Chang 8 of Heshui area to perform the 3D CT Scanning experiments. On the basis of the results of this research ,We divide the pore and throat into three types by the pore throat aspect ratio on the morphology :shape of tube bundled structure, with the aspect ratio greater than 3.0; stripped structure, having a ratio between 1.3 and 3.0; spherical structure, with the ratio less than 1.3. To compare and match the results of the two experiments: comparing and matching the pore and throat structure with its morphological features, we can find the intragranular pore has a lower aspect ratio and matches with the spherical structure, the intergranular pore generally is corresponding to the stripped structure, having a middle aspect ratio, and the mcro cracks have a high ratio and correspond to the shape of tube bundled structure (Fig 1).

One dimensional petroleum migration simulation experiments (oil displacing water) have showed that the flow in tight reservoir follow the non-darcy flow mechanism and also exist the start-up pressure gradient (SPG) (Dmirriyev et al., 2011; Zeng et al.,2 014),the start-up pressure gradient is affected by various factors such as porosity, permeability, oil viscosity and so on. The permeability has good correlation with the SPG, however the other factors do not. The expiriments verify the existence of the Start-up Pressure Gradient in nano-macro pore network systems. At the same time, the two-phase (water displacing oil) flow experiments give us a comprehensive understanding of the flow mechanism in tight sandstone reservoir: this type reservoir is generally water-wetting, with a large amount of irreducible water whose saturation can reach to about 40%. High irreducible

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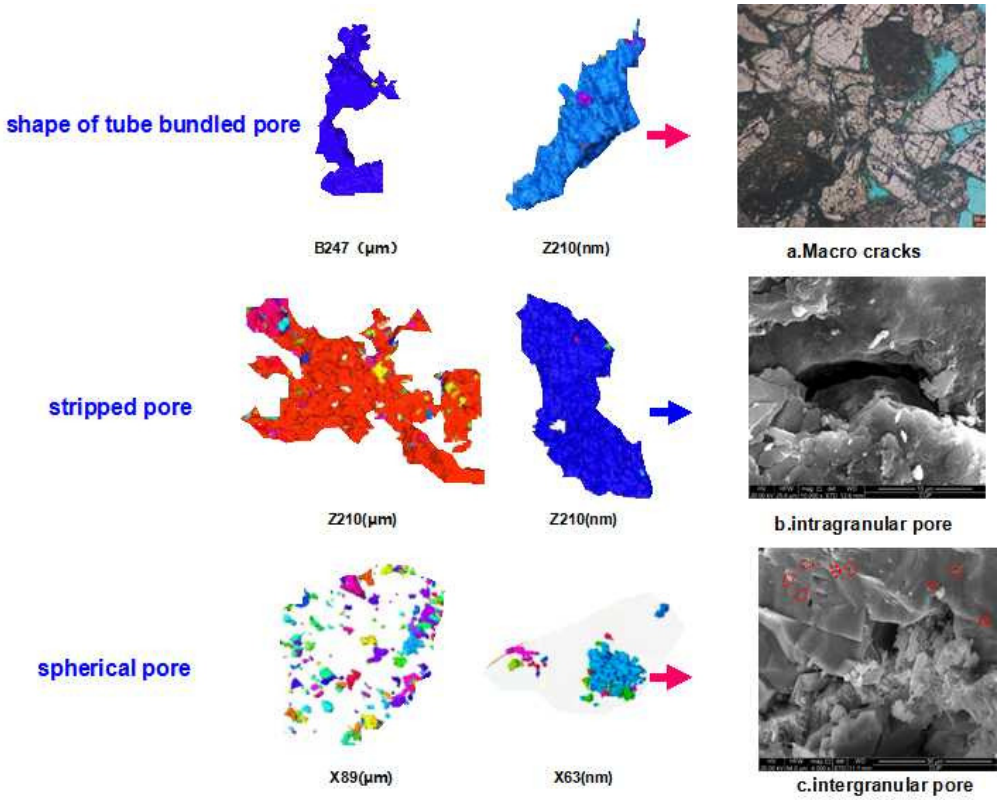


Fig. 1. The results of SEM and CT Scanning for pore and throat structure of tight sandstone reservoir in Chang8, Heshui.

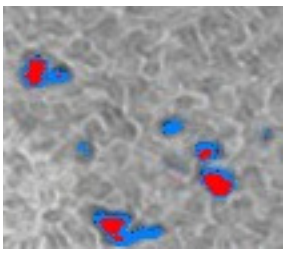
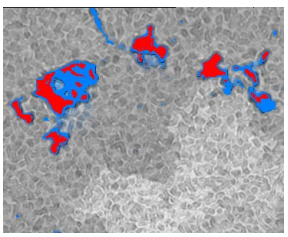
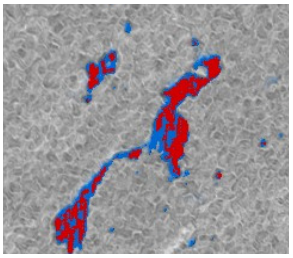
Pore and throat morphology	The storage characteritics of oil in the reservoir
”spherical” pores (intragranular pore)	
“stripped” pore (intergranular pore)	
macro cracks (hape of tube bundled)	

Fig. 2. The accumulation state of of in the nano-macrometer pore networks .

water saturation makes the petroleum can not migrate in a long distance, which leads to the oil migrated and stored in the nearer reservoirs.

The samples that have been performed in the one-dimensional simulation experiments are designed for the 3D Scanning research to enlighten the state of oil accumulation in tight sandstone. The scanning results reveal the differences of oil accumulation states in different kinds of pore space and different structures. Oils in the "spherical" pores (intragranular pore) are distributing in isolation , those in the "stripped" pore (intergranular) have a bead and block distribution, but in contrast oil in macro cracks (shape of tube bundled) have a relatively concentrated distribution, with a higher oil saturation (Fig. 2).

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