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Research of Characteristics in Chang 9 Member of Yanchang Formation in Hongjingzi-Luopangyuan Area

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1 Reservoir lithology characteristics

Hongjingzi-Luopangyuan region mainly developed lithic arkose sandstone, with arcose and feldspar lithic sandstone, detrital components are main of feldspar, then quartz and debris. In the rock, feldspar (mainly plagioclase) content is greater than 25% quartz content is less than 34% on average, and debris is about 20%. In general, reservoir has the characteristics of the low mineralogic maturity. Granularity is mainly fine-medium-grained sandstone, cemented types mainly developed membrane porosity, porosity type. Matrix is less than 3%. Above all, It has the characteristics of the medium degree of sorting and roundness, the lower content of matrix, the higher composition maturity. Sandstone interstitial material content is from 9% to 11%, its components are main of chlorite, kiesel, laumontite. the degree of medium. Calcite is rich in cement in part.

2 Pore combination and pore structure characteristics

2.1 Pore combination characteristics

Hongjingzi-Luopangyuan region Chang 9 reservoir pore combination mainly develop dissolved pore-intergranular pore (Table 1), a few of micro-cracks. Primary intergranular pores are filled with chlorite, ferrocalcite cements, so we also call them remanent intergranular pores. The rate of intergranular pores is more than 80% of the total face rate, pore connectivity is very poor. In the region, the Face rate of Hongjingzi is the highest, about 9.84%, followed by Hujianzi, the lowest is Luopang- yuan, approximately 7.67%. Above all, It has the characteristics of low

porosity. Hongjingzi -Luopangyuan Chang 9 Reservoir Sandstones pores constitute is seen in Table.1.

2.2 Pore structure characteristics

Hongjingzi-Luopangyuan region Chang 9 reservoir pore throat combination mainly includes medium-fine pores-medium-fine throats. The capillary pressure curve reflects the relationship of capillary pressure and saturation curve, a certain capillary pressure corresponds to a certain pore throat radius. Mercury intrusion Experiment results show that: the average throat radius is generally from 0.02 to 7.72 μm , the average is 1.30 μm . Expulsion pressure is low, generally from 0.01 to 1.5MPa, the average is 0.60MPa. Throat median radius is from 0.01 to 2.11 μm , an average of 0.22 μm . Sorting coefficient is 3.56, which belongs to moderate sorting. The maximum injected mercury saturation is 99.19%, an average of 72.37%, the maximum ejection efficiency is 46.58%, an average of 33.61%. All above these factors determine Hongjingzi-Luopangyuan region Chang 9 reservoir has a good reservoir properties.

2.3 Physical properties

According to 68 wells, 233 samples porosity and permeability data statistics and analysis: porosity is from 2.9 to 19.1%, an average of 10.2%, permeability is from 0.0234~40 $\times 10^{-3}\mu\text{m}$, an average of 3.79 $\times 10^{-3}\mu\text{m}$. Based on clastic rock gas reservoirs classified national standards (SY/T5601-2009), Hongjingzi-Luopangyuan region Chang 9 reservoir belongs to low porosity and low permeability reservoir. A clear positive correlation between porosity and permeability indicates that the permeability of reservoir is mainly controlled by the development of matrix rock and pore throat conditions. From previous porosity and permeability data analysis, it is not difficult to find the permeability of some samples

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Table 1 Hongjingzi –Luopangyuan Chang 9 Reservoir Sandstones pores constitute

Horizon	Region	Intergranular pore	Intragranular dissolved pore	Micro-crack	Total face rate	samples
Chang 9	Hongjingzi	8.21	1.09	0.54	9.84	99
	Luopangyuan	6.70	0.72	0.25	7.67	57
	Hujianzi	6.95	1.58	0.53	9.06	77
Total		7.42	1.16	0.45	9.03	233

differ 1 to 2 quantity degree, which reflects that the connected pores micro-cracks are rich in sandstone reservoir, and it is highly consistent with lamella and scanning electron microscope analysis. therefore, the micro-cracks play an important role in improving reservoir porosity and permeability.

3 The impact of diagenesis on reservoir properties

3.1 Cementation

Cementation is a process of mineral deposits and consolidations, which reduce the pore space in reservoir. Hongjingzi-Luopangyuan region Chang 9 reservoir cementation types are main of carbonate cement, siliceous cement, clay mineral cement. The major minerals in carbonate cement are ferrocalcite and calcite. Authigenic carbonate minerals form mosaic dense cemented in the part to block pores, reduce the porosity and damage the reservoir properties. Siliceous cement mainly display the secondary outgrowth of detrital quartz, which fill with pores and throats to variate the pore structure and reduce permeability. Although the secondary outgrowth of detrital quartz are common, the cements filling volumes are small, and the secondary outgrowth of early quartz cementation has a positive significance to enhance the sandstone compaction resistance ability and preserve the primary intergranular pores. The clay minerals cement are main of chlorite. Not only does chlorite film prevent debris particles from pore water and the secondary outgrowth of quartz, but also it is benefit for the preservation of primary porosity and the improvement of reservoir properties.

3.2 Demidation

Denudation can form a large number of intergranular

dissolved pores, intragranular dissolved pores, casting pores and caverns. The most widespread and intense dissolution in Hongjingzi-Luopangyuan region Chang 9 reservoir is matrix, followed by mud debris, which play an important role in producing the secondary dissolution pores and improving pore structure. In addition, the form of broken cracks in fracturing may contribute to improving the porosity and permeability.

4 Conclusions

From the above analysis, Hongjingzi-Luopangyuan region Chang 9 reservoir is major in lithic arkose, followed by arkose and feldspar lithic sandstone. Detrital components are main of feldspar, then quartz and debris. Pore combination mainly develop dissolved pore-intergranular pore, a few of micro-cracks. Pore throat combination mainly includes medium-fine pores-medium-fine throats. All in all, The reservoir is typically low porosity and permeability sandstone reservoir.

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Key words: characteristics, sandstone, Cementation

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