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The Study of Reservoir Properties and Heterogeneities in Block M Oilfield Power

Hou Rui

[1] *The Department of Electrical Information Engineering, Northeast Petroleum University, Daqing 163318, China*

Abstract: In high water cut stage, reservoir heterogeneity is the main cause leading to uneven use of the reservoir and increasing the development difficulty of remaining oil. high capacity channels is a direct result of development differences. The determination of high capacity channels formation conditions has important guiding significance to determine the distribution rule of high capacity channels and make enhanced oil recovery. In this paper, with the data of different periods coring wells, dynamic and static data of production wells, the causes and conditions for the formation of are analyzed, then it's concluded that unconsolidated rock, high oil viscosity, long-term high intensity of water is the main reason for the formation of high capacity channels, the key condition for the formation of high capacity channels is reservoir properties and heterogeneities, high capacity channels are More easily formed in reservoirs where permeability is between 100-10000,porosity is between 25-30%, Heterogeneity coefficient is greater than 2 and thickness is greater than 3m.

Keywords Oilfield Power; High capacity channels; Genesis and formation conditions; Reservoir; Heterogeneity coefficient

INTRODUCTION

After 40 years of water flood development, reservoirs have uneven swept out, the difficulty of producing remaining oil is increased every year In Liaohe Oilfield[Wang Baoe *et al.*, 2013]. In recent years, with deep flooding technology deepening, expanding the scale of the flooding, to determine the location and formation of the high capacity channels, improve the accuracy of geological understanding has become the key issues urgently in development work. In this paper, through the researching of coring wells and dynamic and static data of production wells, the conditions and causes the formation of large pores in the area were analyzed, so as to determine deep flooding blocking object and preferred flooding system[Xu Jianjun *et al.*, 2013].

GEOLOGY IN THE STUDY AREA

Study area is located in central western depression of Liaohe Oilfield, the purpose layer located in Xinglongtai reservoir EOGENE SHAHEJIE formation, The depth of wells is about 2100m-2500m, the average total thickness is about 215.35m[Xing Long *et al.*, 2007].

According to core, logging and previous research data, It's suggested that the purposes layers in M area is formed on the fan delta sedimentary environment, and the mainly sub-phases is fan delta-front faces and prodelta faces, where distributaries channel and mouth bar are main reservoirs[Xu Jianjun *et al.*, 2014].

FORMATION AND CONDITIONS OF HIGH CAPACITY CHANNELS

The reservoir Rock in M Block is mainly consisted of lithic feldspathic sandstone, quartz accounts for about 12-45%, with an average content of 29.8%; feldspar accounts for about 30-49%, with an average content of 40.6%; debris accounts for 11-55%, with an average content of 29.6%; the rock particles has the characteristics of poor roundness, usually subangular, coarse grain size, median grain size is generally 0.11mm-2.95mm, an average of 0.92mm[Zhang Naibo *et al.*, 2011]. sorting coefficient is average 2.05. Interstitial material is mainly consisted of mud and a small amount of carbonate. the above characteristics are shown that there has a low structural maturity and compositional maturity in the reservoir of study area, and the characteristics of near-source deposition is reflected[Xu Jianjun *et al.*, 2011].

Genesis of high capacity channels

The analysis of thins and electron microscope photos showed that the cement type is basal cementation and porous cementation, especially in most strong washed cores base cementation is more common[Lopez M.E. *et al.*, 2005]. From comparison of electron micrograph photos of Before and after water flooding cores, the cement in the strongly washed pores is took away by injected water, it's lead to relatively clean pores and reduced hinder to the injected water(Fig.1), this is a typical microscopic features of high capacity channels.

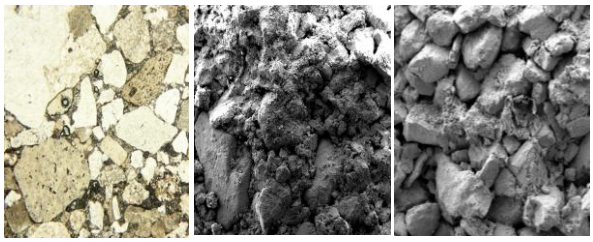


Figure 1. The photos of different cementation degree

The crude oil viscosity of purpose layer in the study area is about 50-70mPas, it belong to heavy oil. The flow experiment of cores showed that the greater the viscosity of the crude oil, the greater viscosity difference between oil and water, the Sand is more prone to product. When the flow rate is higher than the threshold of sand production, at the same flow rate, the greater the viscosity of the fluid, more sand is produced. with the increase of the volume of injected water multiples, the differences of high and low permeability layers are more obvious, high capacity channels are more likely to develop. Meanwhile, the higher the viscosity of the fluid, the stronger the carrying sand ability and the greater drag force on the sand, so the sand production is intensified. Moreover, with the longer oil exploration time, oil viscosity is greater, the difference of oil and water viscosity increase, high capacity channels are easier to form[Liu Zhengliang *et al.*, 2013].

Impact of reservoir

The reservoir of study area has properties of medium-high porosity and permeability. Taking the physical properties from three different periods coring to compare (Fig.2), from the point of view of porosity, the samples of porosity less than 15% are less, and its ratio substantially unchanged before and after water flooding; the number of samples in the porosity range of 15-20% increase first and decrease later, the number of samples in the porosity range of 20-25% decreased first and increased later, the number of samples in the porosity range of 25-30% decreased first and unchanged later, the number of samples that porosity more than 30% are essentially unchanged.

From the point of view of permeability, the number of samples that permeability less than 10×10-3μ m2 are substantially unchanged before and after water flooding; the number of samples in the permeability range of 10-100 × 10-3 μ m2 increased first and decreased later; the number of samples in the permeability range of 100-10000 × 10-3 μ m2 decreased first and increased later; the number of samples that permeability greater than 10000×10-3 μ m2 are essentially unchanged. it showed the permeability range acted by injected water is 100-10000×10-3μ m2, injected water take away some fine particles from big pores, these particles jam the small pores, so the samples in permeability range of 10-100×10-3μ m2 increased, then with more and more fine particles in small pores were taken away, the pores in permeability range of 100-10000×10-3 μ m2 increased.

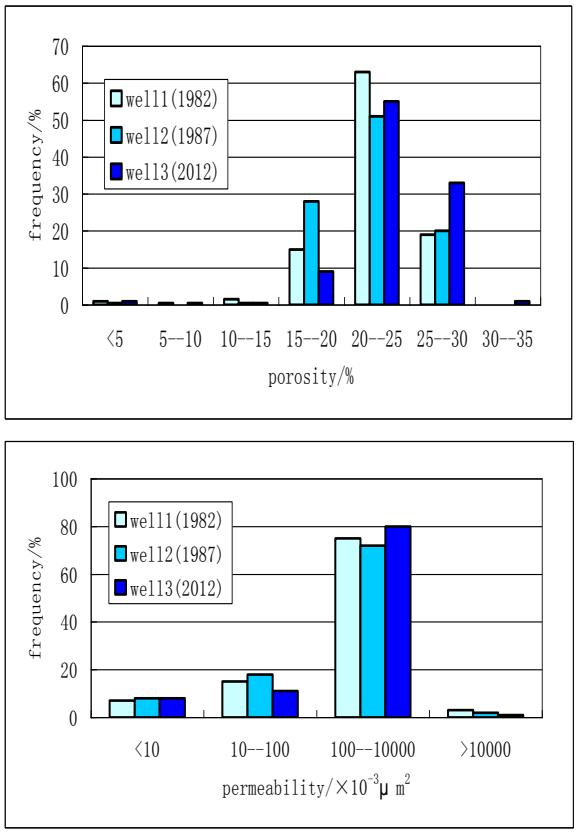


Figure 2. Porosity and permeability of three different periods coring wells distribution histogram

The impact of reservoir thickness

From Statistics of sand thickness distribution, it can be found that the higher the degree of absorption, the higher the proportion of thick sand layers(Fig.4). In the reservoirs of Good and better absorption, the proportion of sand layers thickness greater than 3m is 37%; in the reservoirs of poor absorption, the proportion of sand layers thickness greater than 3m is 15%; and in the reservoirs of no absorption, the proportion of sand layers thickness greater than 3m is only 10%, while the proportion of sand layers thickness less than 1m is highest. Thus, thickness of reservoir is also a factor that impact the high capacity channels formation. It’ s mainly due to the greater thickness of sand layers, the greater gravity impacting water injection. especially for positive rhythm of river sand, water advance along the bottom of the positive rhythm reservoirs, the result is, on the one hand the bottom of reservoir erosion intensity and producing more volume of sand, so high capacity channels are easy to form; at the same time, the formation of high capacity channels exacerbated the develop of vertical

heterogeneity of the reservoir, so that the amount of water absorption is further increased.

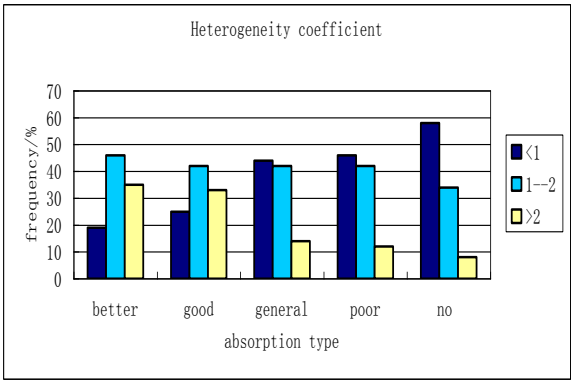


Figure 3. Heterogeneity coefficient distribution histogram

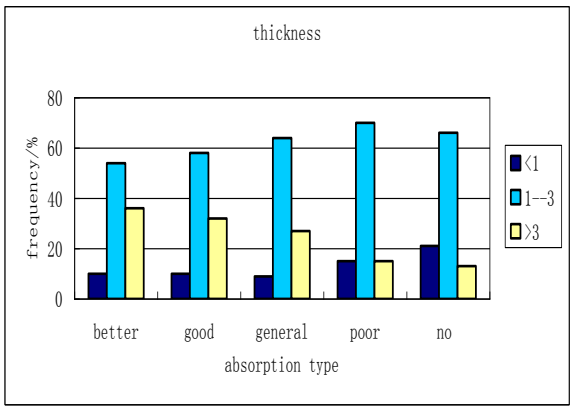
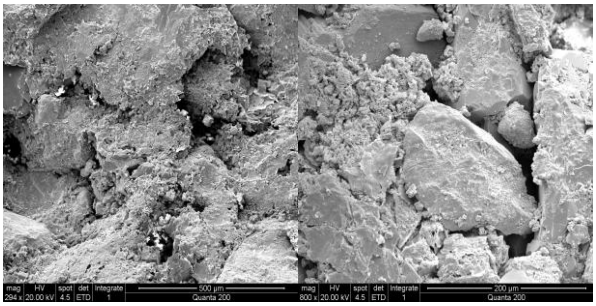


Figure 4. Thickness distribution histogram

Influence of pore structure characteristics

The role of injected water is not only destroying the rock skeleton but also changing the reservoir pore structure. It enables pore throat radius to expand and high capacity channels to form. In High water stage, The reasons of pore throat radius increases are main included: First, some cement of pore throat is washed by water, it can be take out at the same time of mining oil, so the pores get cleaner; Second skeleton is affected due to water erosion, the Weak rock particle contact can be widen and the Connectivity of pores get better.



2174.63m, weak wash 2284.41m, strong wash

Figure 5. Contrast section of diffrent wash degree

From Fig.5, it can be seen when water wash weakly, more illite, kaolinite and other clay minerals are attached to the surface of rock particles, when water wash strongly, the wall of holes becomes smooth, especially the amount of fine small clay minerals get fewer, Some clay minerals are still preserved in form of messy pile at small throat position, visible, on the effect of water brushing, some small material can be take away somewhere, and some can be enriched, so some pores get cleaner and wider, this is the root cause of the pore structure changes.

CONCLUSION

In summary, unconsolidated rock, high oil viscosity, long-term high intensity of water is the main reason for the formation of high capacity channels.

The key condition for the formation of high capacity channels locate in reservoir, where permeability is between 100-10000, porosity is between 20-30%, Heterogeneity coefficient is greater than 2 and thickness is greater than 3m.

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