IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 06, Issue 01 (January. 2016), ||V1|| PP 26-30

Research on Identification Methods of Dominant Seepage Channel in Water Flooding Sandstone Reservoir

LIU Jiyu[1], XU yang [1], DU Xinyang [1]
[1](*Northeast Petroleum University, Heilongjiang Daqing 163000，China)*

Abstract: - In view of the actual situation that there exists advantage channel in long-term water flooding sandstone reservoir, on the basis of static and dynamic data in oilfield development, through a comprehensive study of core description, logging interpretation, dynamic analysis, we have established different levels of logging response standard of advantage channel, at the same time analyze the geological forming conditions, which provides a quantitative basis for effective identification of the flow channel. It is of great significance to deepen the understanding of oil-water movement rule of old water-drive oilfield.

Keywords: - *Dominant channel; Logging response standard; Identification method*

I. INTRODUCTION

Sandstone reservoir is given priority to argillaceous cementation, after a long period of water injection development, clay particles adsorbed on the pore surface of rock will go through the effect of hydration, dispersion, migration when encountering water, then the cementation of reservoir gradually weakened, the throat space expands, and the pore throat space becomes smooth, coordination number of pore throat increases. After the above changes, reservoir heterogeneity is gradually deepened, thus forming advantage seepage channel in high permeability reservoir where the throat increases larger. However, the existence of an advantage flow channel seriously restricts the late water injection effect. Therefore, in order to effectively guide the development and adjustment of water-drive sandstone reservoir in "twin" period, and further improve the recovery ratio, it is necessary to study ways to establish scientific, accurate, convenient operation identification standard of flow advantage channel, thus providing reliable theoretical basis and technical support for fine description of flow advantage channel [1].

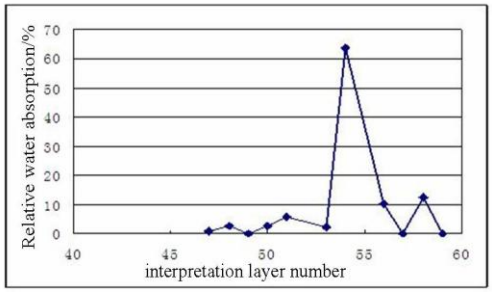
II. THE DISCRIMINANT CONDITIONS OF DOMINANT CHANNEL

The formation of dominant channel first has to meet a certain conditions, and after the formation of different scales of dominant channel, the dynamic development data and log response both showed a significant change, therefore we can use the dynamic development data to determine the current dominant channel, then set up different levels of logging response standard, analyze the geological forming conditions at the same time [2]. Taking jin 16 block of liaohe oilfield as an example, we established the identification standard of the dominant channel [3].

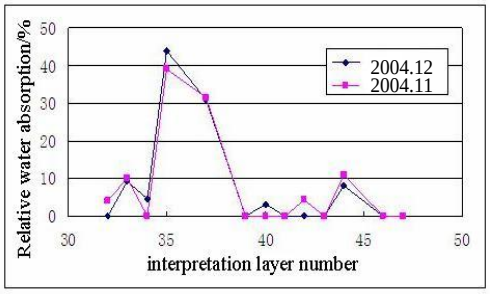
2.1 Variation characteristics of dynamic data

(1) Well layers that with big different water uptake or the layers that the water uptake changes rapidly

The proportion of thickness in the total thickness of some strong water absorption layer is small, but the injection profile shows that the injection rate is far more than other layers, it should be the location where the big channel develops.Layers that have high water absorbing display in each of the injection profile or layers that the water quantity change rapidly has the characteristics of a big hole（Fig 1）.



JIN 2-BING 5-136well



JIN 2-6-227well

Fig 1 Vertical analysis diagram of injection percentage of wells with abnormal water absorption profile

(2) The moisture content is high

Another prominent manifestation of the formation of an invalid and inefficient circulation channel is the moisture content. If there exist mutations of moisture content, there must be an abnormal situation underground. Wells that single well production data show the quantity of water increases suddenly but the quantity of oil falls sharply is easy to form a large hole（Fig 2）.

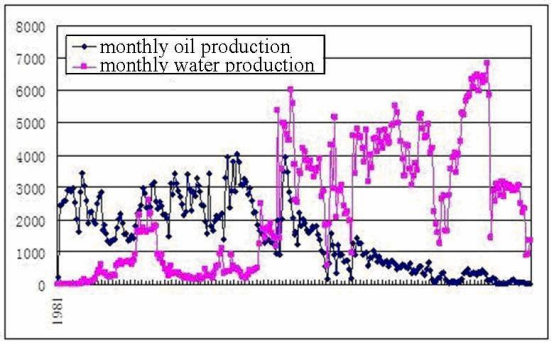


Fig 2 Curve shows the quantity of water increases suddenly but the oil falls sharply

(3) Tracer shows that the breakthrough of injected water happens in individual direction of well groups
As a result of the existence of plant heterogeneity, in the injection-production well groups, the injected water mainly flows along a high permeability zone, this position is seriously flushed, and it is easy to form a big hole.
(4) Pressure changes in the bottom hole of wells
Pressure changes in the bottom hole of injected wells reflect the connected relationship between injection wells and production wells. After the formation of invalid and inefficient circulation channel, fluid flows in pipe flow conditions, the seepage resistance is small, the pressure in the bottom hole of oil wells increases gradually close to that of water wells. Once without the invalid and inefficient circulation channel, water injection rate would be proportional to the injection pressure. If the water injection pressure is the same, but water injection rate increases rapidly, or water injection rate keeps constant but pressure drops, then it indicates that there appears inefficient and ineffective circulation channel in strata.
(5)The test of carbon oxygen shows that the difference between the original water saturation and present water saturation is big
According to the test data of carbon oxygen, both the permeability and the difference between the original water saturation and present water saturation of the sample of dry layer are small, the difference of permeability from weak water flooded layer to strong water flooded layer is small, but the difference of water saturation values increase gradually（Fig 3）.

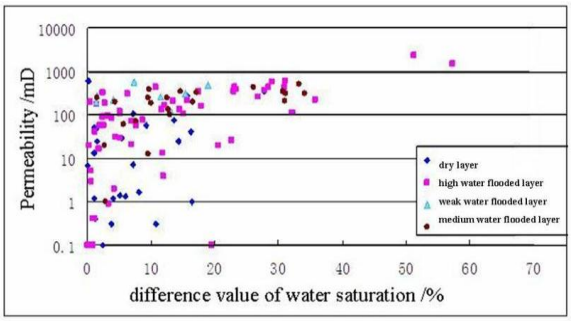


Fig 3 Crossplot of water saturation and permeability of different water flooded layers

2.2 Research of the method of using conventional logging data to identify macroscopic throats of sandstone reservoir
Because of the influence of different water conditions on the well logging curve is different, according to the well layer that has identified a big hole, selective logging curves of different period for the contract to reflect the influence of different watered-out degree to logging curve [4].
(1)The amplitude of microelectrode curve decreases, indicating reverse rhythm of the reservoir
Microelectrode curve mainly measures the resistivity of the flushed zone near the borehole, its amplitude value mainly depends on the contribution of the resistivity of mythologic frame, the contribution of the fluid resistance of internal pore is small. After the big hole forms, the wettability changes from partial oil-wet to partial water, and reducing the resistivity of the rock skeleton, under the condition of the same lithology, the amplitude value of microelectrode curve decreases obviously.
(2) The SP curve rises

Sp curve mainly measures the ion exchange capacity of a fluid interface, higher amplitude value shows the enhancement of the fluid exchange capacity. After a long-term strong erosion of injection water, formed after the big hole, the shale content and oil content is greatly reduced, greatly reducing the resistance of ion exchange, making water flooded reservoir has the characteristics of water layer, thus causing the spontaneous potential value rise（Fig 4）.

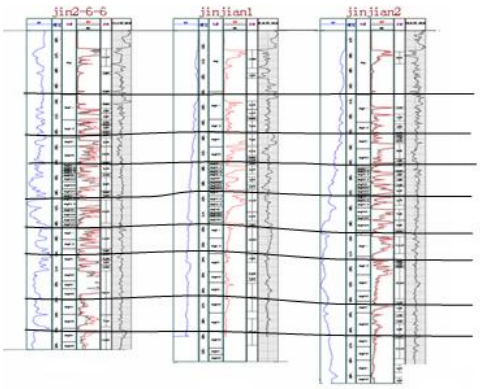


Fig 4 Comparison chart of logging curve in different period

(3) The resistivity value of R045 curve declines dramatically

R045 curve mainly reflects the resistivity of reservoir far away from borehole. The main contributor of the resistance is the rock skeleton and oil in the pore. Oil in the core is replaced by injection water after the big hole formed, the wettability of the rock turns into hydrophilic, reducing the resistivity of the rock skeleton, so the amplitude of each resistivity curve is obviously reduced.

(4) The sound wave curve value increases

Porosity will increase after oil layer being water flooded, sound wave curve will rise. After the big hole forms, sound wave curve will continue to rise, but the amplitude is small, the acoustic curves appear abnormally high value only in individual layer.

(5) Caliper curve expands

Shale content will drop after oil layer being water flooded, part of the cementing material of rock skeleton will be washed away by injected water, decreasing the degree of consolidation of the rock skeleton, then rock will become loose, it is easy to cause wall collapsed phenomenon, enlarging the hole diameter.

(6)The natural gamma decreases

After oil layer being water flooded, injected water will carry scoured argillaceous flow, the accumulation of mud will happen where energy reduces, so the rise and decrease of natural gamma are random and not fixed after oil layer being water flooded. But the phenomenon of accumulation of argillaceous will be greatly reduced after the formation of a big hole. So the natural gamma reduction is one of the symbols of the formation of a big hole.

2.3 Using geological characteristics to judge macroscopic throats

(1) Permeability and the average radius of pore throat

According to oil and gas reservoir evaluation method, dividing sandstone oil reservoir according to the pore radius median (R50), the distribution of R50 between 15 microns - 25 microns reservoir is defined as the macroscopic throats reservoir, and R50 more than 25 microns is defined as big channel reservoir. R50 and average pore throat radius are basically identical, and it also applies to the average radius of the pore throat（Fig 5）.

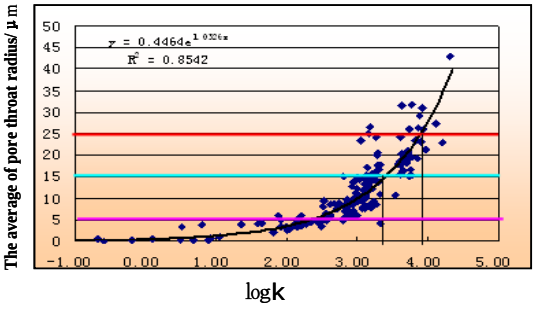


Fig 5 crossplot of pore throat radius and permeability

From the permeability and the pore throat radius diagram we can see that when the permeability is greater than 6000 md, reservoir is corresponding to extra big channel; When the permeability is in the 6000-2000 md, reservoir is corresponding to big channel; When the reservoir permeability is between 200-2000 md, it belongs to the conventional channel; When the reservoir permeability is less than 200 md, the corresponding channel value is small, the wash washing is difficult to apply to this range. Displacement efficiency increases with the increase of permeability, the possibility to produce dominant channel greatly increases.

(2) Differential standards of permeability

Dominant water flow channel is the extreme manifestation of contradiction in laminates. Thus it is controlled by the intraformational heterogeneity. According to sealed coring data statistics, in the present well pattern and injection-production pressure system, the formation of dominant water flow channel is closely related to the differential permeability, when the reservoir permeability differential is less than 4, the permeability of the reservoir that forms the dominant flow channel should be greater than 150 mD; When the reservoir permeability differential is more than 8, the permeability of the reservoir that forms the dominant flow channel should be greater than 100 mD; When the reservoir permeability differential is between four to eight, the permeability of the reservoir that forms the dominant flow channel should be greater than 150 mD. It is can be seen from the figure the more serious the reservoir heterogeneity is, the more easily to form the dominant water flow channel; Reservoir that permeability is less than l00mD is not easy to form dominant water channel. Statistics show that most of the differential of dominant water flow is more than five, among the samples the differential between 5-10 accounts for about 10% of the total, in the other 90% well layers which can produce the big hole, its differential and the nearby differential are all above 10（Fig 6）.

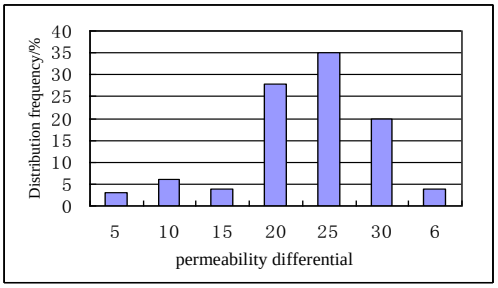


Fig 6 Distribution figure of different big hole thickness and permeability differential

(3) The variation standard of permeability

From the historical physical changes of coring well, it can be seen that the longer the washing time is, the smaller the proportion of low permeability samples, the bigger the proportion of high permeability samples, since 2007, the samples of the core whose permeability between 1000 and 10000 mD accounts for more than 50%.

Wells in the work area is divided into two symmetry by time, respectively making the figure of permeability variation characteristics and the contour figure of average radius pore throat of two symmetry(Fig 7 ,Fig 8), and comparing the permeability changes of different times in a similar position, it can be seen that:

①Permeability is less than 100 mD, permeability changes little;

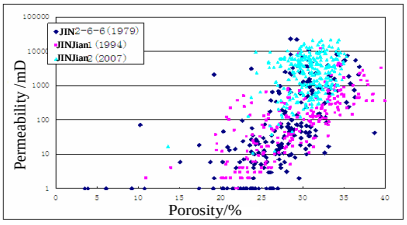
②Permeability between 100 and 500 mD, where permeability with strong changes is about 1.2 to 2.5 times;

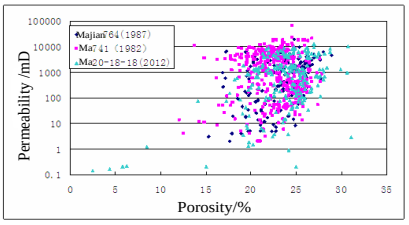
③Permeability between 500 and 1000 mD, where permeability with strong changes is about 1.6 to 3.1 times;

④Permeability between 1000 and 2000 mD, where permeability with strong changes is about 1.7 to 3.5 times;

⑤Permeability greater than 2000 mD, where permeability with strong changes is about 1.3 to 2.5 times.

After a long period of water washing, the maximum permeability is all within 30000, permeability change is small, it proves that permeability will not continue to increase. Thus, permeability change can also be seen as one of the identification standard of the macroscopic throats.





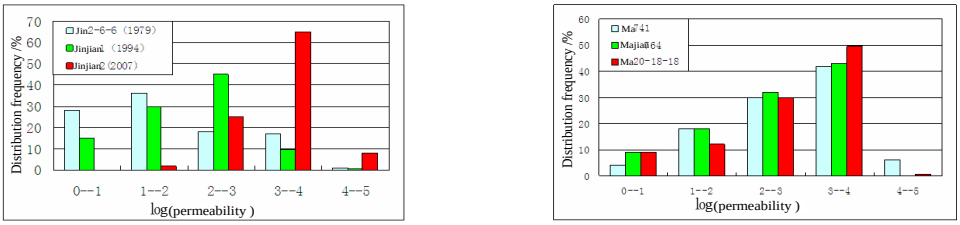
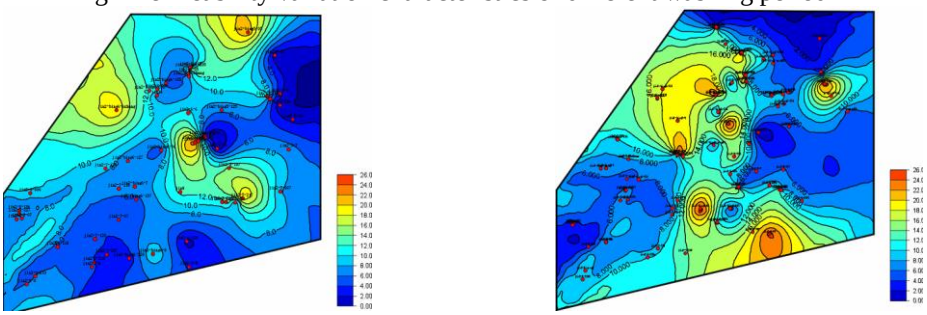


Fig 7 Permeability variation characteristics of different washing period



contour diagram of pore throat distribution of Xing 1 layer before 1995

contour diagram of pore throat distribution of Xing 1 layer after 1995

Fig 8 Contrast figure of pore throat distribution before and after 1995 of JIN 16 block

III. CONCLUSION

The dominant water flow channel is one kind of widespread reservoir characteristics in the middle and later periods of the development of the old water flooding oil field, through the analysis and study of the causes and characterization parameters, establishing identification standard of dominant water flow channel from the static and dynamic angle. Providing strong technical support for effective identification of dominant water flow channel of old water drive sandstone reservoir, effectively improve the description precision and accuracy of residual oil, thus providing important basis for selective plugging, oil displacement, and chemical flooding optimization formula system of the old water flooding oil field.

REFERENCES

[1] XIAO Honglin. Research on identification standard of advantage channel of sandstone reservoir［J］. Engineering technology popularization.2014, 16:68-69.

[2] ZHANG Xiaolu. The micro characteristics and identification standard of advantage channel［J］. Inner Mongolia petrochemical industry.2013,16:146-149

[3] SUN ming, LI Zhiping .Identification and description of dominant seepage channel in waterflooding sandstone reservoir［J］. Fault block oil and gas fields, 2009, 16(3):50-52.

[4] WANG hong. Application of identification technology of dominant channel in fuyu oilfield［J］. China petroleum and chemical industry standard and quality, 2011, 4:268.