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Application of Fault Sealing Property Analyzing by Tracer in Oilfields

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Abstract. In complex small fault-block oilfields developed by water flooding, it is a general method to qualitatively determine fault sealing ability by water flooding response and conventional tracer tests. Nitrates are the very common tracer which is mainly used in cross-well monitoring to study the reservoir connectivity among wells. A fault in Block G5 of JD oil field has been proved unseal through comparing the permeating velocity of different tracers, which provides a geological basis for further development of this oilfield. The method of qualitatively monitoring faults sealing properties among wells by using tracers can combine with conventional fault contraposition analysis and plugging coefficient method to get a better judgment on fault sealing property.

Keywords: Fault; Sealing Ability; Tracer; Petroleum

1. Introduction

Recent years, fault sealing ability analysis has become an important method to reduce the risk of exploration & production in oilfields. Shale gouge ratio (SGR) is often used in fault sealing property analysis. This method is based on data analysis, so the conclusion cannot be always one hundred percent certain. If the production data as the tracers test has been used in the analysis, the fault sealing property must be certain ([1], [2]).

The tracer technology has been proved to be an efficient tool to investigate reservoir flow performance. Tracer test data have been used to reduce the uncertainty of well-to-well communications. Injected tracer can follow pathways away from the production well. If there is a fault between the injected well and production well, the fault must be unseal. The fault sealing property which analyzed by the tracer test is more certain ([3], [4]).

2. Geological Setting

JD oil field is a complex small fault-block oilfield located on the North of China. Influenced by the tectonism of Zhangjiakou-Penglai fractured-belt and regional tectonic stress field of Bohai bay basin, a lot of secondary fault-block oil reservoirs and faults have grown in the oil field. Block G5 is a deep fault-block oil reservoir in JD oil field (Fig.1). And at present it is in the water flooding development phase. The tracer test has been taken in order to investigate the communication among the injection wells and the production wells. In the Block G5, there is a normal fault between the injection well and the production well. So the fault sealing property can be detected through the tracer test [5].

The fault is located on the south edge of Well G5, which is a water injection well. And it is named Fault G5S. The Fault G5S fault is strikes NE, dips to SE and dip angle is 46°. The dip slip is about 100m.

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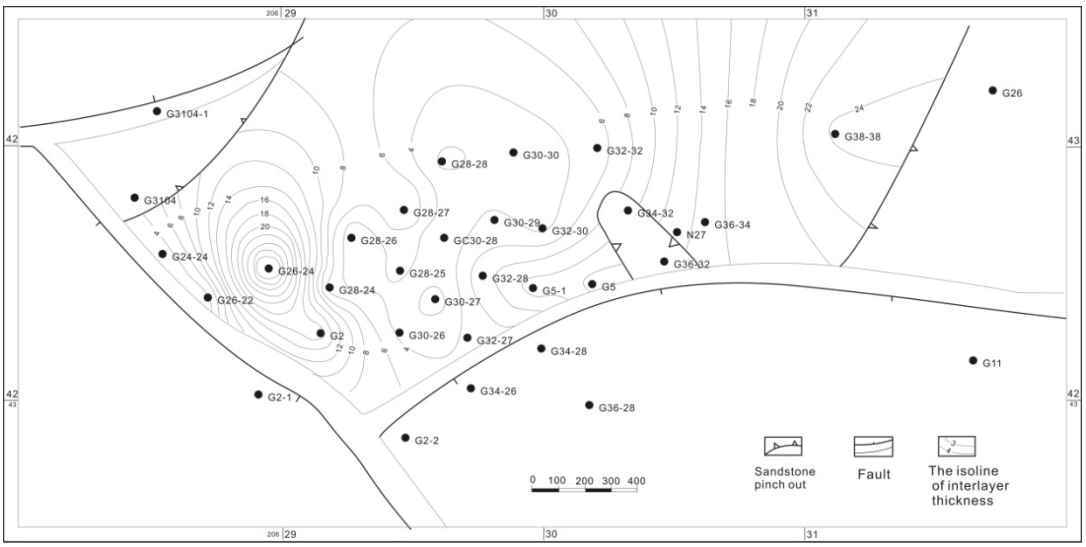

Fig.1 Structural map of Es in block G5

3. The tracer test and fault seal property analysis

Based on the rule and characteristics of bottom fluid pressure distribution in Block G5, Well G5 is designed for the injection well of tracer (Fig.2), at the same time, other production wells around Well G5 are monitored. Sodium nitrates are the common tracer which mainly used in the study of reservoir connection and the monitor among wells. 10% sodium nitrite solution was injected into Well G5, and then the sodium nitrite concentrations in the output liquid of the wells around Well G5 were detected. The conditions of well-to-well communication can be calculated from the sodium nitrite concentration.

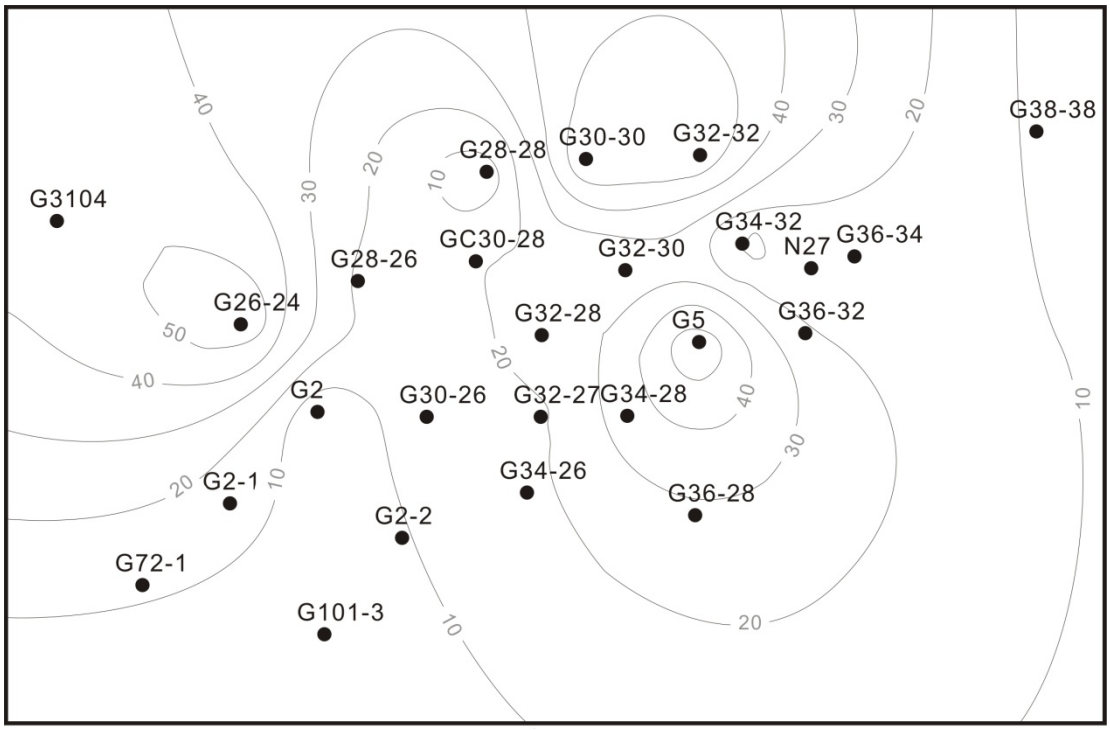

Fig.2 Distribution of Bottom fluid pressure in block G5

Sodium nitrite began to be detectable in the production wells around Well G5 after 14 days of tracers injecting. The wells that tracers are detected tracers include G30-29、G32-30、G32-28、G34-28、G34-32、G36-32. The direction and velocity of water injection could be calculated according to the time of appearance of tracers and distance between wells (Table1).

Table1 Monitoring data of tracer in G5 well groups

Wells	Appearance time（d）	Distance（m）	Velocity（m/d）
G30-29	36	450	12.5
G32-30	36	290	8.06
G32-28	14	419	29.93
G34-28	39	274	7.03
G34-32	44	306	6.95
G36-32	18	315	17.5

In the same layer, the tracers were detected in six wells. Due to the influence of heterogeneity, the velocity of water injection was obvious difference among wells. The speed of water injection to G32-28 and G34-32 wells was 29.93m/d and 6.95m/d respectively, which were the fastest and slowest speed. It is obvious that the effective direction of water injection is east-west direction. G34-28 and G32-30 were two wells which have the same velocity of water injection on opposite sides of the G5S fault. This shows that Fault G5S has no remarkable effects on water flow (Fig.3). Therefore, the Fault G5S is unsealing at this depth.

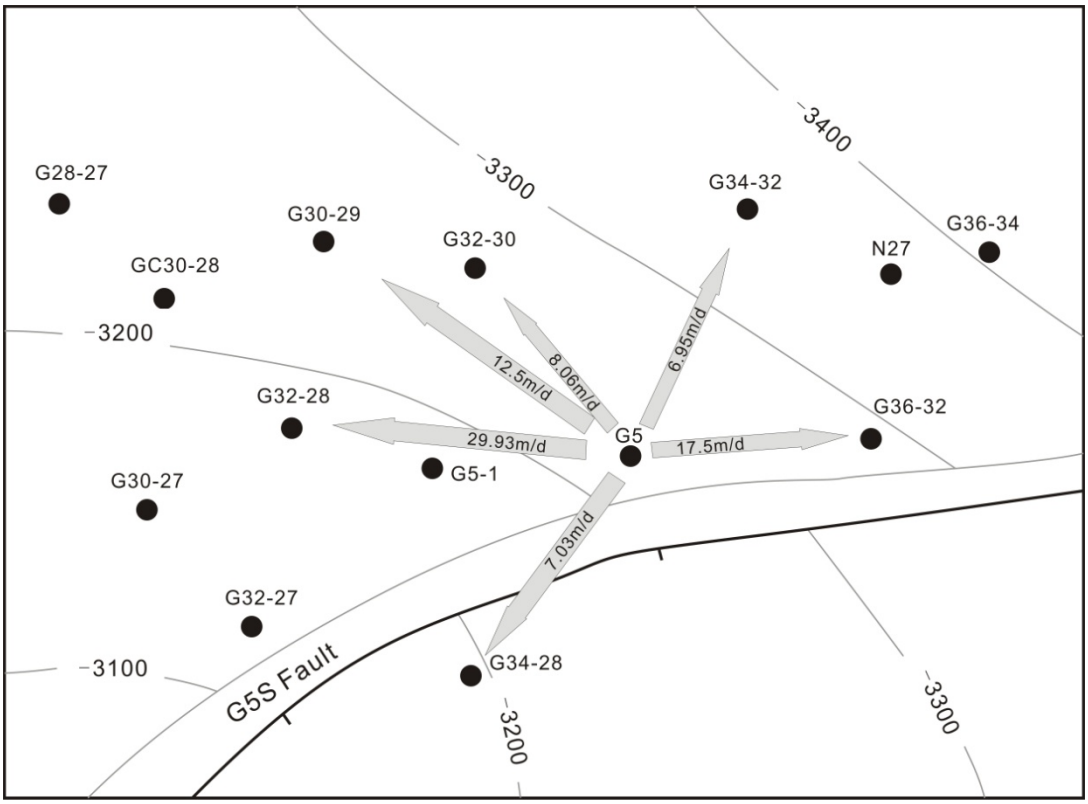

Fig.3 Expanded direction and velocity of water flooding in G5 well groups

4. Conclusions

The initial objective of tracer test of block G5 is to study the conditions of communication between the water-injection well and the production well. Block G5 happens to have a fault among the wells. And the result of tracer test reflects that the fault is unsealing.

The result is not very important, however, two suggestions can be got. First, the tracer test is a good method to analysis the fault sealing property. If it is combined with shale gouge ratio (SGR), the result will be more certain. Second, production data has important roles in many aspects and could meets limitless needs. Making full use of production data could reduce cost and enhance efficiency well.

Sodium nitrite is not the best tracer, even though it is now in widespread use. It owns some disadvantages such as long testing time, complex sampling and poor repeatability. There is still work need to be done to improve the performance of tracer because a combined geological and geochemical approach is necessary to better estimate fault sealing property.

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