

Study on Optimization Technology of Tapping Potential Mode for High-Efficiency Wells at Fault Edge

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ABSTRACT

In the early stage of M Development Zone, the dense well pattern data were used to carry out three-dimensional structural modeling. Because the breakpoints encountered by some wells could not be combined, the spatial distribution of faults was not accurate enough, and the well location deployment should hide faults, which affected the remaining oil potential exploitation near the faults. Since 2008, the study of well-seismic combined with fine structure description has been carried out, and the accurate characterization of faults with a fault spacing of more than 3m has been realized. The research results will be used to guide the remaining oil tapping potential in time, and the risk area has changed into potential area near the fault. Through the study of technical boundaries such as fault optimization, well location optimization, well trajectory optimization and well completion optimization, the potential tapping technology of directional wells with large inclination at fault edge is established, and the idea of tapping potential by "sticking faults and cutting corners" is put forward, that is, drilling directional wells on parallel fault surface to tap remaining oil. The average daily oil production of single well with high inclination has been implemented, and the comprehensive water cut is 75.4%. The remaining oil at fault edge has been realized. Effectively tap of residual oil.

Key words—*Structural description of well-seismic combination, directional well with large deviation, well trajectory optimization*

1.INTRODUCTION

M Development Zone has reached a high level of development through multiple encryption adjustments, and has now entered the stage of double-extra-high water-cut development [1], and does not have the overall scale encryption adjustment potential. According to the statistics of the latest three-year production wells, the average water cut of the chemical flooding production wells that were put into production with uniform well layout was 94.1% at the initial stage, and 11.0% of the wells had water cuts below 85%, and the average daily oil production per well reached 7.9 tons; This part of high-yield wells are mainly concentrated in the area with imperfect well pattern at the edge of large fault. Therefore, through precise geological research, searching for remaining oil-rich areas, and drilling high-efficiency wells on the edge of the fault [2-3], it is possible to achieve high-efficiency tapping of potential in local areas.

2.WELL-SEISMIC COMBINED FINE RESERVOIR DESCRIPTION

The M development zone has a large number of faults and complex structure development. The breakpoints encountered by some wells cannot be combined. The understanding of the spatial distribution of the faults is not accurate, resulting in uneven deployment of well positions at the edge of the fault, and incomplete local injection and production systems, resulting in remaining oil enrichment. District [4].

Since 2008, in order to finely describe the structural status of the oil reservoir, the dense well pattern data has been used to carry out 3D structural modeling [5]. Through the study of well-seismic combined fine structure description, the accurate characterization of faults with a fault distance of 3m or more has been achieved, and the combination rate of fault points has been achieved. Reached 95.6%, an increase of 5.8 percentage points over the previous period. The comparison before and after the fault after interpretation shows that the large-scale fault changes in the well area

are relatively small, mainly manifested in the changes in local location, extension length or strike, which makes the description of large faults more accurate [6-7] and makes development adjustments daring to be close. The deployment of new wells on faults is conducive to tapping the potential of remaining oil at the edges of faults and structurally complex areas.

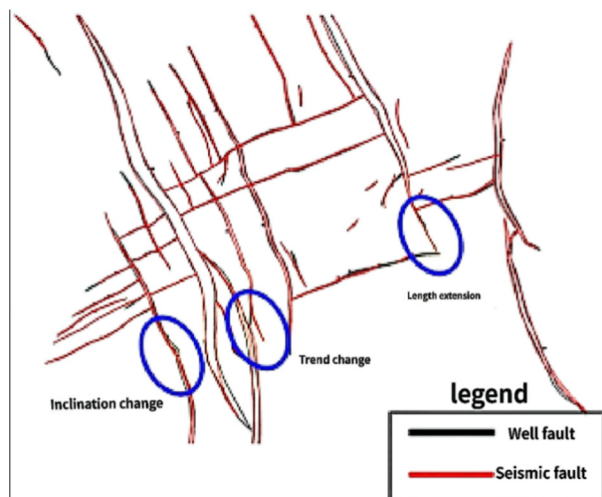


Fig.1 Comparison of changes in the top surface of the N2 reservoir before and after the well-seismic interpretation

3. STUDY ON THE TECHNICAL BOUNDARY OF HIGH-EFFICIENCY WELL EXPLOITING POTENTIAL IN THE EDGE OF FAULT

Due to the relative enrichment of remaining oil at the edge of the fault, conventional research methods cannot accurately describe the structural characteristics and potential scale of the fault. Therefore, the combination of well-seismic technology is the core and multidisciplinary reservoirs are used as the means to develop the technical boundaries of high-efficiency well tapping at the edge of the fault. Research, through deepening geological research, quantifying the scale of faults in potential areas, knowing the remaining oil finely, identifying advantageous well positions and sand bodies, and optimizing well trajectory design and completion methods to provide guarantee for the long-term and effective development of high-efficiency wells.

3.1 Optimal fault scale

First of all, it is necessary to clarify the scale of the fault in the potential tapping area. Development practice has proved that the remaining oil in the fault area is mainly distributed in an inclined three-dimensional space along the fault plane. Combining well-seismic knowledge with the results of fine structure understanding, clarified the idea of tapping the potential

of "sticking to faults and cutting corners" [8], that is, drilling directional wells parallel to fault planes to tap the remaining oil. The plane projection of the fault plane is regarded as the width of the fault zone. The fault zone has a low degree of perfection of injection and production. The larger the width, the larger the corner area and the more remaining oil. Therefore, large faults with a fault zone width of more than 150 meters, a fault distance of more than 20 meters, and a fault extension of more than 1 km are preferentially selected as potential areas.

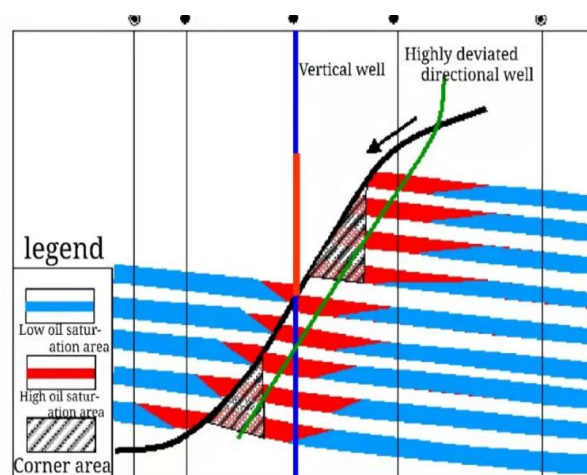


Figure 2 Schematic diagram of remaining oil potential in fault zone

3.2 Optimal well location and sand body type

Based on the selected faults in the well area, the remaining oil potential analysis is carried out, and the remaining oil in the area cannot be controlled by the existing well pattern[9]. According to the principle that the potential tapping layer is more than 150m away from the water injection well and more than 100m away from the oil production well, Analyze the injection-production relationship of oil and water wells around the fault on a well-by-well basis to clarify four types of potential areas.

First, development factors have caused the original well pattern to lack the production well point potential area, that is, the original strata production well in the well area is used as other strata production wells, resulting in the lack of production well points in this strata system, which has deployment potential; or the production well is scrapped, and the well area Poor utilization. Take Well A in Fig. 3 as an example. The polymer flooding well in the well area was put into development in 2004. In order to improve the production status of the first type of oil layer in the fault block, the original water drive formation development wells W1, W2, W3 and W4 were used in 2008. Mined for polymer flooding. Therefore, in order to make full use of the remaining oil potential of the reservoir, a highly inclined directional well A is deployed.

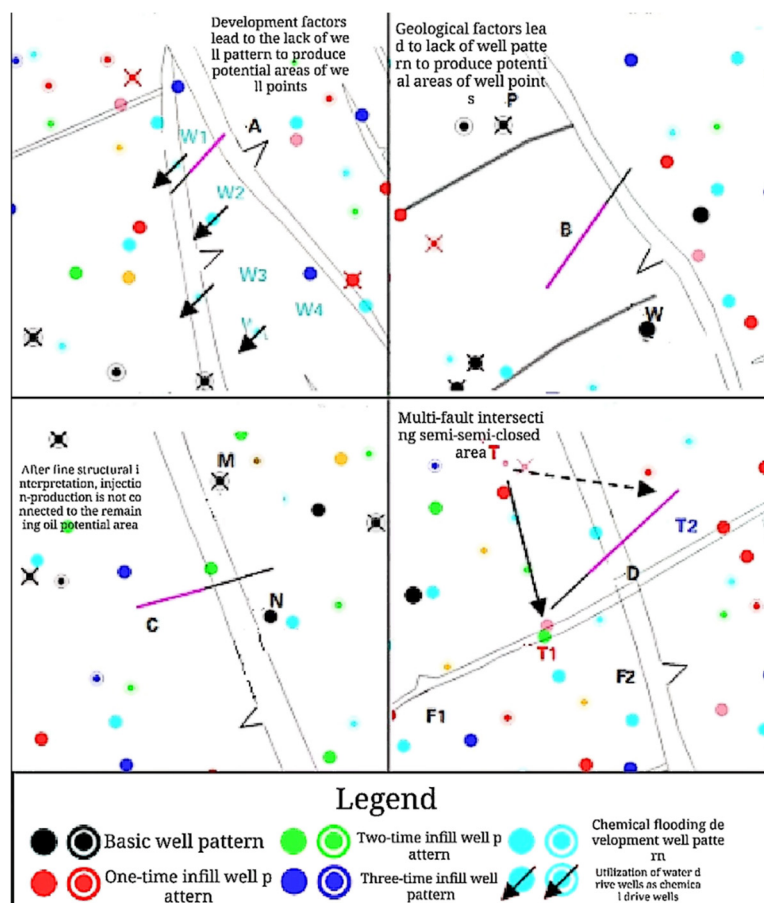


Figure 3 Schematic diagram of screening of potential well site types

Second, geological factors have caused the original well pattern to be missing the potential area of the production well points, that is, the development well has encountered large faults, some layers are missing, and the missing oil layer is poorly produced. The oil layer in the well area forms a remaining oil rich area. Take the well B in Figure 3 as an example. The injection well P and the production well W in the well area are in an injection-production relationship. Affected by the fault, the production well W encounters the fault at TIII-TVII, with a fault distance of 87.4 meters, so the direction is TIII. There are no production wells in the following horizons, and highly inclined directional well B can be deployed to tap the potential.

Third, after fine structural interpretation, injection and production are not connected to the remaining oil potential area, that is, affected by technical means, the accuracy of previous fault characterization is insufficient, and there are unattributed scattered breakpoints. After re-characterization, the connection relationship and horizon of well groups are clarified. Taking Well C in Figure 3 as an example, the injection well M and the production well N in this well area are in an injection-production relationship. Affected by the fault, the highly-deviated directional well area has no production well points in the TI-TVIII oil layer on the upper wall of the fault. Deploy

highly inclined directional well C to make up for the missing well points of the original well pattern.

The fourth is the intersecting semi-closed area with multiple faults. In order to avoid the fault zone and prevent the outflow of crude oil during the previous infill adjustments in the development zone, most of them choose to deploy oil production wells 70-200 meters away from the fault, so as to be near the fault. The formation of an imperfect injection-production relationship area or a local potential area without injection-production well points. Taking Well D in Figure 3 as an example, the primary infill well pattern where the injection well T is located in this well area is an irregular nine-point method area pattern. In order to avoid the effect of failure, the production well T1 at the edge of the fault is deployed at a distance of 150 meters from the F2 fault. , And reduce the deployment of a production well T2, resulting in remaining oil in the intersection area between the F1 fault and the F2 fault. Therefore, the highly-deviated directional well D is designed.

Through the above methods, four advantageous well positions can be determined, which have the potential to deploy high-efficiency wells. However, with the goal of screening superior sand bodies, the potential for deployment of high-efficiency wells can still be

determined. That is to say, it is determined that the remaining oil in the isolated channel sand or narrow channel sand body, away from the water injection well, is determined to be the remaining oil, and the thin on-surface and off-surface reservoirs are considered. Body matching. Taking Well L in Figure 4 as an example, the effective remaining oil thickness of the well is 19.1 meters, of which the effective thickness of the oil layer greater than 1 meter is 6.0 meters, and the ratio is 31.6%. Among them, tufted sand bodies account for 60.9% of the thick oil layers.

3.3 Optimal well track design

When deploying high-efficiency wells, on the one hand, in order to maximize the control of the geological reserves at the edge of the fault, it must be close to the fault; on the other hand, in order to prevent the drill from encountering the broken zone and affecting the

development effect, it is necessary to avoid the fault. Therefore, in order to rationally guide the optimization design of well trajectories, research on the scale of fractured zone was carried out. Through the research, the logging curves of the same horizon of the well drilled into the breakpoint are compared with those of the facing well. The electrical logging curves in the fracture zone have obvious response, which is characterized by the sawtooth of the resistivity curve, the increase of the acoustic time difference, and the decrease of the resistivity value. Using the characteristics of electrical survey curves, a method to describe the scale of the large fault fracture zone is established. The apparent thickness of the fracture zone is clarified, and the relationship between the width of the fracture zone and the fault distance is established. Generally, the scale of the fault fracture zone is 20-40m, and there are 25 fracture points in the combined fracture zone.

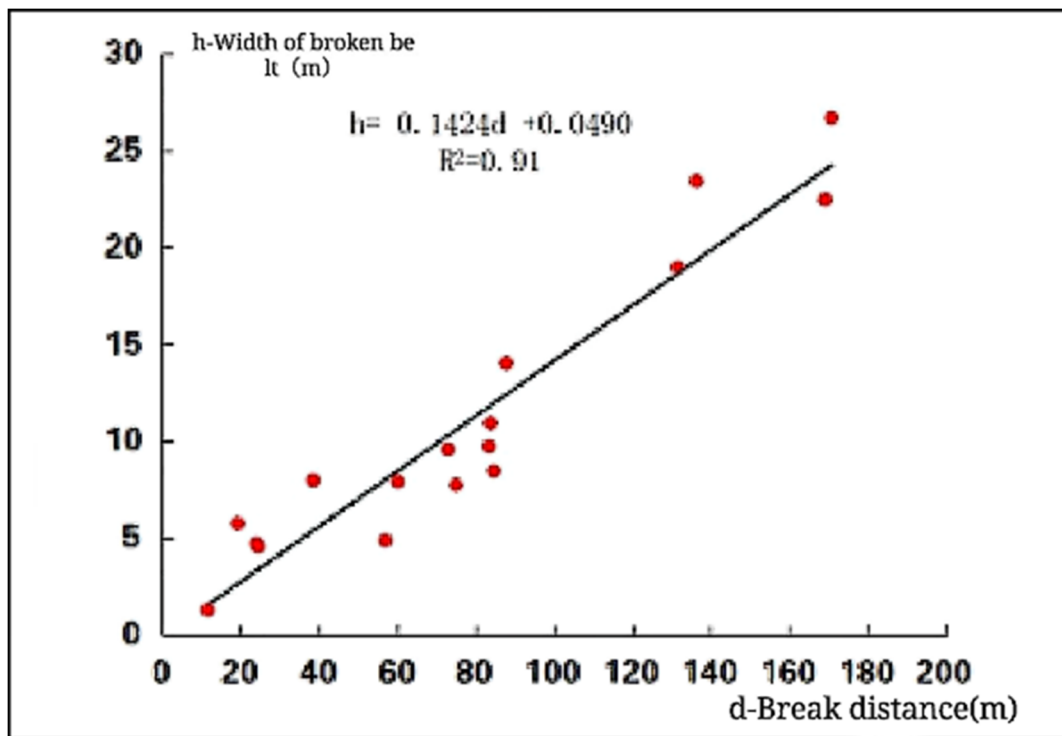


Figure 4 The relationship between the width of the broken zone and the break distance

3.4 Optimize completion method

Conventional well completion [10] has many small layers and large interlayer differences. It is difficult for a single completion method to achieve high-efficiency tapping potential of the entire well section. Therefore, it is optimized to "flow limiting fracturing + composite perforation" to reduce interlayer differences ; Conventional well completions are small and thin. Affected by well deviation, part of the bullets will be injected into the interlayer. The perforation direction is parallel to the oil layer by the fixed shot angle perforation

process [11] to improve the completion degree and avoid communicating with high water-bearing layers. The wells with small potential thickness and mainly thin and poor oil layers are perforated once, and the design fracturing completion ratio of the thin and poor layers reaches 83.3%. The wells with large potential thickness are implemented with stepwise perforation, and the effective perforation thickness is 18.5 meters. The effective thickness of the reserved hole is 7.3 meters to ensure the orderly succession of later production.

4.POTENTIAL TAPPING EFFECT OF HIGHLY INCLINED DIRECTIONAL WELL

Up to now, 18 highly-deviated directional wells have been put into production in the M development zone,

with an initial daily oil output of 9.7 tons and a water cut of 75.1%. The effect of drilling down wells in the interrupted zone is good. At present, a single well has produced a total of 5,700 tons of oil, increasing the recoverable reserves by 231,000 tons .

Table 1 Comparison table of the effects of tapping potential faults on the two disks

project	Number of wells	Initial stage of production			Cumulative oil production of single well (104t)
		Daily liquid (t)	Daily liquid (t)	water contentr(%)	
Fault hanging wall	6	46	7.8	83.1	0.52
Fault footwall	8	44	12.1	72.5	0.74
Fault two disc	4	24	8.5	64.5	0.32
Subtotal	18	39	9.7	75.1	0.57

5.CONCLUSIONS

1、 Well seismic combined with fine geological research improves the description accuracy of reservoir structure and reservoir, and provides a basis for accurately determining the injection production relationship and predicting the remaining oil.

2、 In some well areas where geological understanding has changed, the remaining oil is relatively enriched, and the original "risk area" has been transformed into a "potential area". As long as we emancipate our mind, move with the change, combine dynamic and static, and boldly practice, we can realize the efficient tapping of the potential of the remaining oil .

3、 The initial effect of high-efficiency well is good, but the remaining oil area is small, the perfection of injection and production is low, and the production decreases rapidly in the later stage. In the next step, the remaining oil in the fault area should be drilled, transferred, replenished, changed, adjusted and pressured to tap the potential as a whole.

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