Structural Characteristics of Fuyu Oil layer in 401 block, Sanzhao Depression, Songliao Basin

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Abstract

This paper takes Sanzhao Depression in Songliao Basin as the research target describes the horizontal and sectional characteristics of T2 tensional fault system in Sanzhao Depression. This paper proposes: The stratum of Fuyu oil layer is relatively higher on SW while lower on NE. Normal faults cross each other and form a network structure in planar while the sectional profile display multiple structure types such as horst, graben, stepped blocks and uplift in graben.

Keywords

Songliao Basin, Sanzhao Depression, Fuyu oil layer, structural characteristics.

1. Introduction

Sanzhao Depression is the secondary tectonic units of Songliao Basin which is also part of a first-order tectonic unit-the central depression. After years of exploration, people has achieved certain understanding about the reservoir forming mechanism and oil distribution of Fuyu oil layer in Sanzhao Depression. It is a system of generational seal in above and accumulation in below. The main hydrocarbon source rock is in the 1st member of Qingshankou formation and over-pressurized oil migrated down to Fuyu Formation below through the opened faults [1]. The main expulsion stage of the source rock in Qingshankou Formation is the over-pressured releasing period after the hydrocarbon generation threshold was achieved. The over-pressured release took place once in late Nenjiang deposition and once during later Mingshui deposition [2]. Overpressure in the 1st member of Qingshankou formation was the force of hydrocarbon migration downward and opened faults were good path [3].

This paper deeply investigated the characteristics of faults in Fuyu oil layer. The study provides strong supports and directions for future exploration of Fuyu oil layer.

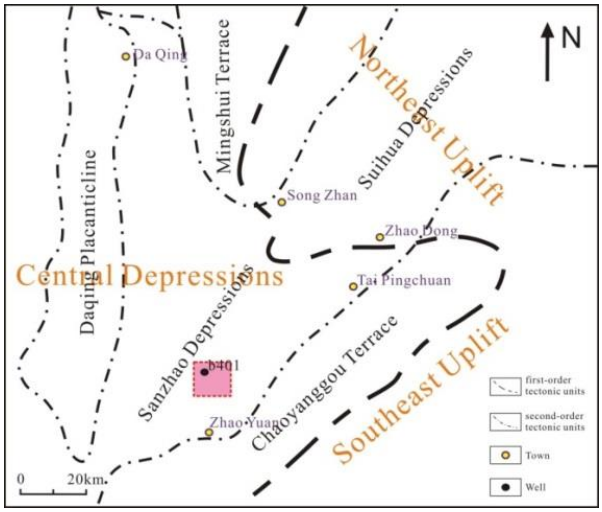

Fig. 1 Geographic location of the study area

2. Geological setting

Sanzhao Depression is located in the northern part of Songliao Basin. It,s a secondary tectonic units of central depression, B401 block located in southern part of Zhaozhou nose structure in Sanzhao Depression. It,s the main oil and gas enrichment zone, with area about 82km^2 (Fig. 1).

The lower Cretaceous is composed of Huoshiling, Shahezi, Yingcheng, Denglouku and Quantou Formations in the study area, while the upper Cretaceous is composed of Qingshankou, Yaojia, Nenjiang, Sifangtai and Mingshui Formations.

3. Structural Characteristics

3.1 Characteristics of fault in plane distribution

The structure map of Fuyu oil layer top surface shows that the whole region has little structure change range with the average depth around -1700m (Fig. 2). The tectonic lowest point is located in the northeast corner of the study area, with the depth about -1830m. The tectonic highest point is in the southwest corner, well with the depth about -1625m. Structural trend in the study area is high in the northwest and low in the southeast with ladder-like downdip. The formation in the entire study area is relatively flat, with dip angle about 5 °, while it can be up to 15 °only in the vicinity of the fault.

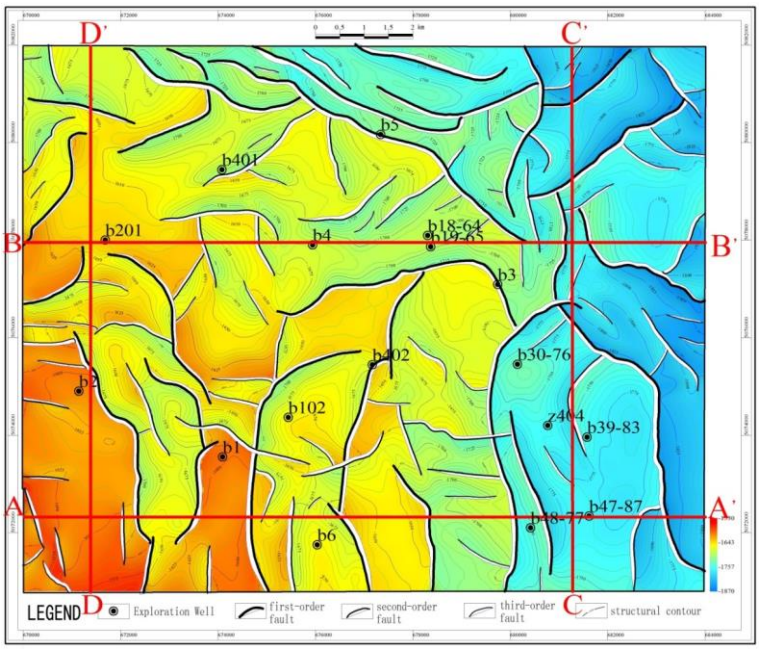

Fig. 2 Structural map of T2

The faults distribute complexly in the plane. According to the fault strike, it can be divided into three groups of major faults: south-north, west-east and northwest-southeast, with extending scope from several kilometers to more than ten kilometers. The fault throw of these faults is about 60m and the dip is about 75 °. These faults cross each other and formed a network structure in planar view. In addition, there are still some small or medium faults nearby. Due to the complexity of faults and the stratum deformation caused by the later reverse tectonic movement, there are numerous structures like horsts, stairs, grabens formed in the study area.

3.2 Characteristics of fault in section

As we can see from the seismic sections (Figs. 3~5), faults developed near T_2 interface in the study area are all normal faults. These faults mostly developed throughout Quantou formation and Yaojia formation vertically. A small amount of them are restricted from the top of Quantou formation to the bottom of Qingshankou formation (around the T_2 interface).

Specific features of the faults are as follows: ①fault throws are small (less than 80m), and it can be clearly observed that faults throw are maximum near the T_2 axis while gradually decreases to

disappear in the upper or lower stratum. ②These faults are all high-angle faults. Faults dip between T_2 and T_{1-1} reflection layer are about 60 °, and about 80 °under the bottom of T_2 and above the top of T_{1-1} reflection layer. ③Faults tendency are different with structures like same-trend groups, opposite-trend graben and horst groups.

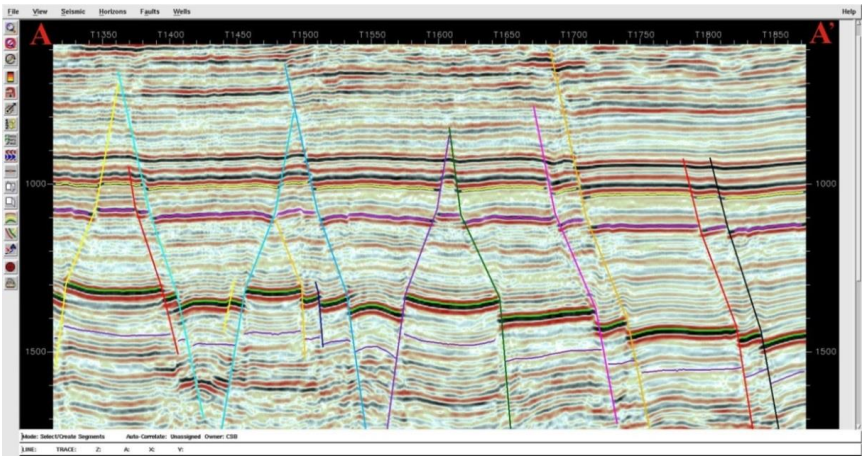

Fig. 3 Seismic section(line828)

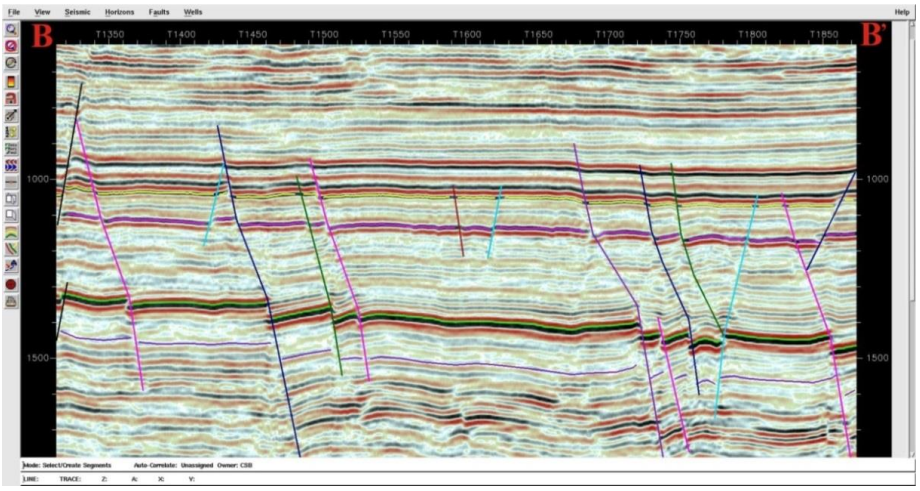

Fig. 4 Seismic section(line938)

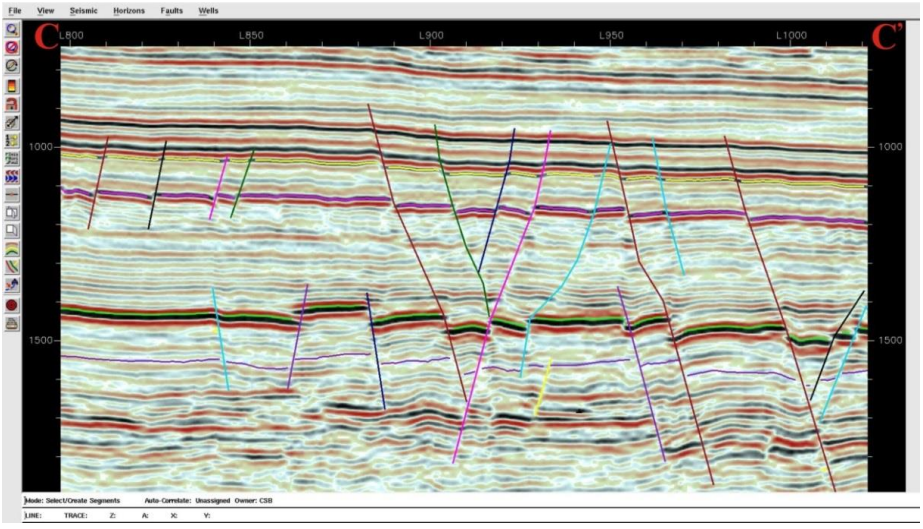

Fig. 5 Seismic section(trace1767)

3.3 Sealing property of fault

Fault throw of Fuyu oil layer in the study area were less than 80m， and the large thick shale of Qingshankou Formation cover on Fuyu oil layer. The faults formed shale smear under the influence

of mudstone shearing, cap rock remained intact, and the faults have good vertical sealing. Therefore the lateral sealing of faults is the point in fault sealing property evaluation.

In this paper, the lateral sealing of typical fault in the study area was evaluated by using Knipe triangular diagram [4]. The triangular diagram characterizes the docking feature of two fault walls in different fault throw conditions. Calculating magnitude of SGR in docking area by using fault throw and cumulative thickness of mudstone in fault zone. SGR is the ratio of shale in the fault zone. The calculation formula is as follows:

$$SGR = \frac{\sum (Vsh \bullet \Delta Z)}{D} \times 100\%$$

In the formula, SGR is the ratio of shale in the fault zone, %; Vsh is the ratio of shale in the formation, %; ΔZ is the thickness of different formation in the range of fault throw, m; D is the fault throw, m.

If SGR is less than 15%-20%, the fault wouldn't have an effective sealing property, in contrast, if SGR is more than 15%-20%, the fault would have good sealing ability. Research on fault sealing capacity has been done by choosing the typical fault nearby Well-b2 and Well-b3 in study area. By calculating the magnitude of SGR, we can find that all of the SGR are more than 20%, which shows that the faults have good sealing ability (Fig. 6).

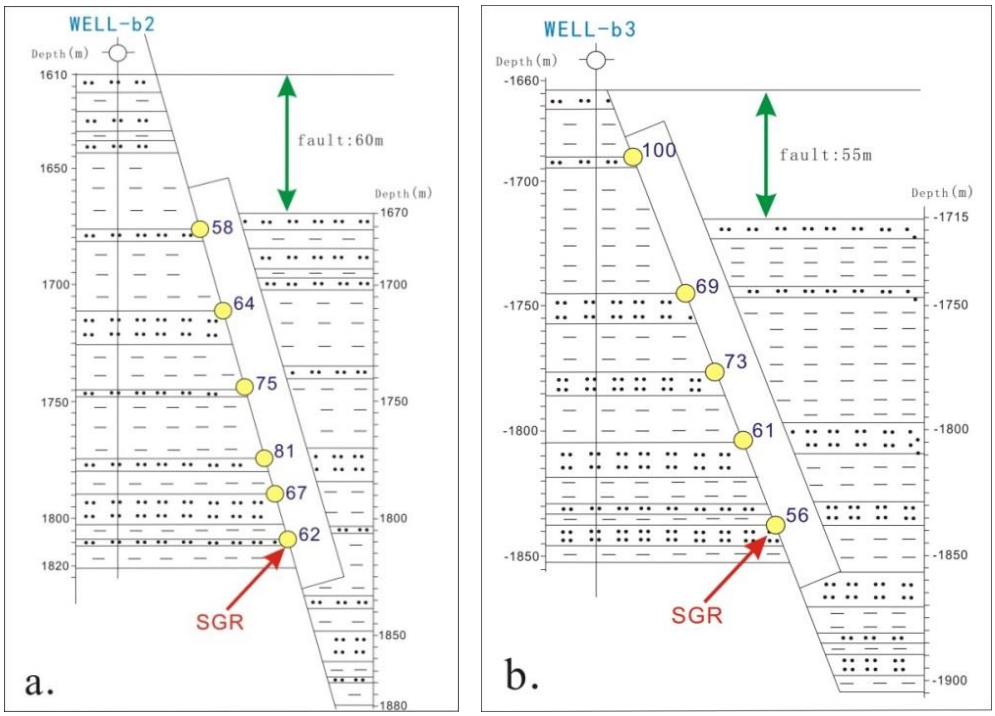

Fig. 6 SGR of faults

a. Fault on the eastern side of Well-b2, b. Fault on the eastern side of Well-b3

4. Conclusion

1. Fuyu Oil layer is mainly controlled by normal faults, including a group of faults in S-N, one in E-W and one in NW-SE in the study area.

2. The structural highest point is in the SW corner and the whole structure inclines from SW to NE. The sectional profile displays multiple structure types such as horst, graben, stepped blocks and uplift in graben.

References

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