Analysis on the Control of Faults on the Formation of P-1 Reservoir in Syncline Area of X Oilfield

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Abstract. Hydrocarbon occurrence in Putaohua Formation of Xujiaweizi Syncline area is largely controlled by three types of faults. The long-term faults were the conduit of hydrocarbon from source rock Q1 to Putaohua reservoir. These long-term faults could cause new accumulation and leakage of accumulated hydrocarbon simultaneously during their active time. The middle-term and short-term faults are the sealing faults to enforce the entrapment of hydrocarbon in the fault-block traps. The relationship of fault conduits with the related traps is the main controlling factor for the hydrocarbon distribution in the faulted blocks around the center of Xujiaweizi Syncline. This hypothesis can well explain why the central portion of the syncline is with poorer accumulation than the surrounding horst blocks in which the accumulation are rich in their anticline structure traps.

Keywords: fault conduit, up-dip and down-dip migration, accumulation and leakage, Xujiaweizi Syncline.

1. Introduction
Syncline of X oilfield is an important part of Sanzhao sag, the main hydrocarbon-generating depression in S basin. In recent years, under the guidance of the theory of hydrocarbon-rich depressions, the fine oil and gas exploration has shifted from the nose-like structural belt around the syncline to the center of the syncline, and a large area of oil-rich blocks in P-1 reservoir have been found in the syncline slope area and center of X Oilfield, showing the trend of "full depression and oil-bearing", prompting some scholars to put forward the geological understanding of oil-rich sag oil-gas syncline reservoir-forming [1–4].

2. Basic geology of the study area
The syncline of X oilfield refers to the central part of the Z depression, the main hydrocarbon-generating depression on the east side of the placanticline of S basin, which includes the center of the depression and its surrounding slope area. As a whole, the structure is high in the northwest and low in the southeast, showing a tectonic pattern of "two uplifts sandwiched by one depression". The top surface of P-1 is between -1385 and -1475m above sea level, with a structural height difference of 90m. The main faults are nearly north-south trending, accompanied by north-west trending faults. The near-south-north-trending fault divides the P-1 oil layer into multiple structural units, which are the northwest horst
syncline belt, the west graben anticline belt, the central horst syncline belt, the northeast graben anticline belt, and the southeast graben anticline belt.

3. The basic geological conditions of P-1 reservoir formation
The high-quality source rocks in Q-1 section provide abundant oil source conditions for P-1 reservoir. The faults with multi-stage activities have great differences in reservoir forming significance, which can be divided into long-term faults, medium-term faults and short-term faults according to their development periods. Long-term fault is the key oil source fault in the formation of P-1 reservoir. The mid-term fault, as a shielding fault, is beneficial to the formation of P-1 fault block trap. Short-term faults complicate oil reservoirs.

The plane distribution of the three types of faults is quite different. Long-term faults are mostly distributed on the west side of syncline center of X Oilfield in nearly north-south direction, while medium-term faults are mostly developed on the west side of syncline center in nearly north-south direction. Short-term faults are numerous and extend short, and most of them are distributed on the east side of syncline center. This distribution pattern affects the effectiveness of P-1 reservoir traps.

4. Oil source fault migration and accumulation mechanism
Due to the difference between the opening and closing of the oil source fault during the active period and the dormant period, there are two-sided characteristics in the formation of oil reservoirs.

The active period of oil source fault is favorable for oil and gas migration. In the downthrown side of fault, due to compression and torsion, the strata appear as reversed anticlines, and the dip angle of strata is upward. The oil and gas pumped into the reservoir continue to migrate in the upward dipping direction, forming upward charging. The high oblique position accumulates to form an anticline or fault anticline oil reservoir, which is conducive to the accumulation and preservation of oil and gas. In the upthrown side of the fault, the oil source fault is also a blocking fault of the reverse roof fault block, which is not conducive to oil and gas accumulation.

5. Oil and gas accumulation model
Based on the above analysis, the oil and gas generated by the source rocks in Q-1 section migrated upward along the oil source fault, and the reservoir-forming mode of P-1 reservoir in syncline structural belt of X Oilfield was established with different migration and accumulation modes of "upward charging" or "downward charging" as the main line in different structural parts on both sides of the fault, as shown in Figure 1. The X oilfield graben-type anticline accumulation and horst-type syncline edge fault block accumulation are different from the syncline wing and slope area accumulation, which are the characteristics of X oilfield syncline central area accumulation.

![Figure 1. Reservoir forming model of P-1 reservoir in syncline structural belt of X Oilfield](image-url)
6. Conclusion
The X Oilfield syncline area is a multi-fault block oil and gas accumulation area complicated by multiple active faults. The trenches are intertwined, and anticlines and synclines coexist. Each fault block has unique trap characteristics and hydrocarbon migration and accumulation patterns, and the configuration relationship between each fault block and the oil source fault plays an important role in controlling hydrocarbon accumulation.

In the high part of the graben-type anticline formed by the downthrown side of fault, the oil source faults are mostly distributed in the lower part of the periphery of the fault block. The above-charged oil and gas migrated along the oil source fault migrated into the P-1 oil layer and accumulated to form an anticline or faulted anticline reservoirs are conducive to oil and gas accumulation and preservation. Mid-term faults and late faults are more likely to form traps, and these traps must require oil source faults in the downward-dipping direction to provide oil and gas in order to accumulate and become effective trap.

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