Main Controlling Factors and Potential Analysis of Putaohua Oil Layer Reservoir Formation in Daqingzijing Oilfield

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Abstract. Putaohua oil in Daqingzijing Oilfield has the characteristics of shallow bury, high yield and outstanding benefits. Based on the anatomical work of the development zone, effective reservoir prediction techniques as a means, and the study of the accumulation rules of oil reservoirs as the core, it is clear that the development of the old wells to review oil source faults, effective reservoirs, and blocking conditions through the development of the entire region is a major constraint. The key three elements of formation of Putaohua reservoir in the Daqingzi oilfield are comprehensive analysis, and it is believed that the Daqingzi Putaohua oil layer has an exploration potential of 10,000 tons, and it is the main object of exploration in the middle and shallow layers of Jilin oil field in recent years.

Introduction

For a long time, due to the rapid changes in deposits, the complex types of reservoirs, and unclear control factors for reservoir formation of the Putaohua oil layer in the Daqingzijing area, it has been used as a probe for exploration of strata deployment and has not received sufficient attention. However, during the exploration of the Putaohua oil layer in the Daqingzijing area, a number of industrial oil flow wells were discovered. The daily production of the single well test oil reached a maximum of 83t/d, demonstrating the value of the exploration benefits of the Putaohua oil layer. Therefore, it is necessary to address the situation. The research on the main controlling factors of the formation of the Putaohua oil layer in Daqingzi wells will further implement the overall resource potential of the Putaohua oil layer in the study area and guide the next exploration and deployment.

General Survey of Putaohua Oil Layer in Daqingzi Area

The Daqingzijing area is located in the middle of the Changling depression in the central depression of the southern Songliao Basin. (picture 1). Presenting the structural appearance of "two slopes and one depression" . The east and west sides of the slope are asymmetrical, the west wing is relatively steep, the east wing is relatively gentle, and the central north-south or north-south westward faults are particularly developed, forming a central fault zone. The putaohua sandstone is a fluvial delta-facies sedimentary process. The water flow from the bottom to the top is the transition from the delta plain subfacies to the delta front subfacies. The main sedimentary microfacies include mesh river channels, natural embankments, crevasse fans, flood plains, underwater distributary channels, and underwater distributary channels. The main sedimentary microfacies include mesh river channels, natural embankments, crevasse fans, flood plains, underwater distributary channels, and underwater distributary channels. The main sedimentary microfacies include mesh river channels, natural embankments, crevasse fans, flood plains, underwater distributary channels, and underwater distributary channels.
The main types of reservoirs are sandstones of joining river channels and channel branches. The thickness of sand bodies is generally between 2 and 6 m. The sand bodies are mainly distributed in strips, and the lateral change is rapid. All along, this area is the main battlefield for exploration of Jilin Oilfield. The favorable exploration area of the Putaohua oil layer in this area is 700km². There is no overall contiguous submission of tertiary reserves, and the exploration level is low. At the same time, the area has a moderate reservoir depth (400 to 1900m), good porosity (porosity 8% to 27%, permeability 0.1 to 30md), and good oil test results. Specifically, (there are 29 test wells in the Putaohua Formation, including 18 industrial wells and 10 production wells) Shows good beneficial result potential for exploration. At present, there are nearly 1200 wells drilled for the lower Gaotaizi reservoir in the study area, which provides valuable information for the study of the Putaohua reservoir. Based on the comprehensive analysis, it was clarified that there are three main controlling factors for the accumulation of Putaohua oil layer in the entire region:

**Breaking through the T2 and T1 Breaks Is the Oil Source Fracture in the Putaohua Oil Layer**

According to the review of the statistics of the old wells in the study area, the distribution of oil and gas is highly heterogeneous, and the overall oil content of the central fault zone is good. There are 35 test wells in the whole area, and there are 16 oil and oil layers for the test, of which 15 are located. In the central fault zone, only the Heilok 84 well in the eastern slope area was tested with oil, and only 15.6 tons of oil was accumulated (Figure 2).
sealability, and the strike of the fault is oblique to the extension direction of the sand body, and it is easy to form various fault-lithologic composite oil and gas reservoirs in this area. The main north-southwest direction concentrates on the central fault zone. The central fault zone is mostly a reverse fault with good sealability, and the strike of the fault is oblique to the extension direction of the sand body, and it is easy to form various fault-lithologic composite oil and gas reservoirs.

According to statistics of test oil and logging data, this type of reservoir accounts for about 70% of the research area. Analyzing the reservoir types in the central fault zone and the eastern slope zone, it is not difficult to find that the main reservoir type in the central fault zone is a fault-lithologic reservoir, while the eastern slope zone is lack of developing faults, and the reservoir types are mostly lithologic oils reservoir. At present, it has been found that the reservoir types in the study area are mainly divided into four types, namely: updip property closed reservoirs, fault-lithologic composite reservoirs, broken nose tectonic reservoirs, and lithologic reservoirs. According to statistical findings, the fault-lithologic composite reservoir dominates in the study area, followed by lithologic reservoirs, and the anticline-lithologic composite reservoir and fault-nosed structural reservoir account for the least proportion. (picture 3)

![Figure 3. The map of Daqingzijing Putaohua oil reservoir.](image)

The formation and distribution of oil and gas reservoirs are the result of the comprehensive action of various geological elements such as the birth, storage, cover, transportation, circulation, and protection. No matter which type of trapping and accumulation, the above-mentioned accumulation elements must be well matched and matched. The first section of the study area and the first section of the study area are source rock formations, and the Yao 1 formation is a reservoir formation, which forms a typical upper-subsoil and lower-biogenic storage and storage combination judging from the source rock conditions, the evolution of the basin in the south of the Songliao Basin has mainly experienced two stages: faulted depression and depression, and the formation and distribution of its source rock are also mainly concentrated in these two periods. During the depression period, there were two sets of hydrocarbon source rocks in the basin, the Qingshankou Formation and the Nenjiang Formation. The comparative analysis of former oil sources shows that the oil source in the sub-pore Putaohua oil layer of the Black Emperor Temple in the southern part of the study area is mainly from the Nen 1st section, while the oil source of the Putaohua oil layer in the Daqingzijing area mainly originates from the Qing 1st section, which is combined with the development of the fault system in the area. The characteristics of the structure and the importance of controlling the faults. The shallow faults in the study area have a certain period, which can be divided into four phases: 1. Early fractures: Break through the T2 reflector and terminate inside the Qingshankou Formation, which has no effect on the accumulation of the Putaohua oil layer.; 2. Second-phase fracture: Break through the T2, T1 reflection layer, terminate in the interior of the Nenjiang Formation, extend for a long time, present a strip distribution, and play a major role in controlling the formation of the Putaohua oil layer.; 3. Third-phase fracture: Break through the T1 reflection layer and terminate inside the Nenjiang Formation, and adjust the rearrangement of the Putaohua oil layer.; 4. Late fracture: Within the development of the Nenjiang Formation, it is relatively undeveloped. The vertical distance is small and the extension length is short. It has no effect on the accumulation of Putaohua oil layer; Judging from the secondary interpretation of the
old wells in the region, the completed wells that reach the oil discharge standard in the Putaohua oil layer of Daqingzijing area are located near the breakage T2 and T1 faults. (Figure 4)

![Figure 4. Distribution of Putaohua oil layers’ wells.](image)

**Having High Quality and Effective Sandstone Reservoirs (GR<80)**

A total of 17 exploratory wells for oil flow from the entire area were counted, and the natural gamma values were all less than 80. The sandstone shale content of the failed wells was obviously high, indicating that the quality of the reservoirs was a key factor in the formation of the Putaohua oil layer. Through the analysis of the distribution characteristics of the grapevine sandstone deposits in the entire region, five main sand channel sand bodies with north-north-east spreading are developed throughout the region, and are gradually branched to the front edge zone. Through the statistics of known wells, the oil wells in the entire region are developed. The reservoir GR values are all less than 80, such as Well Black 43, GR 76, Nissan Oil 5.8t; Well Heil 63 had a GR of 71 and a daily oil production of 9.61t. 85% of the test and production wells are located at the intersection of the main channel sand bodies and the river branches. Therefore, the development of high-quality reservoir sand bodies is an important factor in the accumulation of the Putaohua oil layer in this area.

**Characteristic Parameters Geostatistical Inversion Technique Is an Effective Reservoir Prediction Method.** The prediction of effective reservoirs in the Putaohua oil layer thin sandstone has always been a difficulty in the exploration and deployment of the Putaohua oil layer in the study area. There are two major problems: the rapid horizontal change of sandstone and the small difference in the wave impedance of sand and mudstone in the vertical direction. Difficulties started from drilling physics analysis and found that density curve, velocity curve, and wave impedance could not distinguish between reservoir and non-reservoir in the study area, but natural potential curve and natural gamma curve were very sensitive to reservoir response characteristics (Figure 5).
Therefore, the geo-statistic inversion was used as the core technology to control the horizontal distribution characteristics of the grape flower reservoirs, and the natural potential curve was used as the characteristic curve to control the accuracy of the reservoir's longitudinal resolution, and further the oil and electricity characteristics of the Putaohua oil layer were obtained. Recognize that the division of reservoirs and effective reservoirs is further achieved through deep lateral resistivity curves. The forecasting process is divided into two steps: 1. The geostatistical inversion of characteristic parameter control using natural potential curves is compared with the traditional geostatistical inversion technique in the longitudinal direction. Due to the control of the natural potential curve, the resolution is obviously enhanced, and the sandstone distribution characteristics and geology are horizontal. Understanding is also more consistent (Figure 6). Compared with traditional prediction methods such as stratigraphy and highlighting techniques, geostatistical inversion prediction using feature parameters is more clear and reliable.

![Figure 5. Convergence of SP and GR in Daqingzijing grapevine.](image)

In the process of dividing effective reservoirs, a deep lateral resistivity cloud transformation technique was used to improve the prediction of the effective reservoir conformance rate. The intersection of single well impedance and deep lateral resistivity shows that there is a certain relationship between them, and not a regular linear relationship. The cloud transformation is a non-linear stochastic simulation method. It transforms one variable into another variable through probability field simulation. And follow the complex nonlinear relationship between the two variables. Cloud transformation in earthquake reservoir prediction by establishing a cloud model.

![Figure 6. Comparison of characteristic parameter inversion and conventional prediction techniques.](image)
The overall thickness of the sandstone is large, the physical conditions are good, and it intersects with most of the faults in this area that intersect with the T2 fault. The two have a good matching relationship. The easy formation of large-area fault-lithologic oil solves the function relationship between the linear deviation point and the overall attribute data, breaks through the bottleneck of the simple linear transformation between different attribute data in the past, and enhances the reliability of reservoir physical property prediction results. After the cloud change technique, a deep lateral resistivity body was calculated.

The Effective Reservoir and Oil Source Fault Must Have a Good Matching Relationship (The Fault Completely Cuts off The Sand Body or the Reservoir Pinch Off). The reasons for the failure of exploratory wells in the Putaohua oil layer in the study area were anatomized from the development area. Taking the Hei 64 well as an example, the sand body passed through the Hei 43 well area and the Hei 115 well area in the southwest direction, and the sand body was cut to the periphery of the two well areas. The oil source fault of T2 was completely cut to form a large-scale reservoir, while the Black 64 well did not completely cut the sand body due to faults and lacked shielding conditions. (Figure 7) The reason for the failure of the Putaohua oil layer in the Well 139 well is also because of the poor relationship between the fault and the effective sand body, resulting in the failure of reservoir formation.

It is also consistent with the current understanding of the reasons for the loss of exploratory wells and development wells in the study area and the current understanding of the formation conditions of the Putaohua oil layer. Taking the wells of Hei 62, Qian 156, Hei 151 and Hei 155 as examples, the reason for the failure was that they did not encounter sand bodies of the main channel of the grape plant. The sandstone is of high mud content and poor reservoir conditions cannot be accumulated. The matching relationship between the effective sandstone and the oil source fault in the Well 157 area is completely cut off, and the updip direction also completely forms the obstruction condition, so the reservoir is formed as a whole.

Daqingzijing Putaohua Oil Layer Has a Resource Potential of X0,000 Tons

After clarifying the overall oil-gas accumulation and accumulation characteristics of the Putaohua oil layer in Daqingzijing area, we can see that In the Central Fault Zone, there is a large number of faults through to the T2 fault, where there is ample oil supply and its reservoir; the eastern fault zone is faulty; the oil source faults in the eastern fault zone are not developed, and the oil accumulation in the central fault zone is mainly controlled by high quality sand bodies. The formation of an upwardly inclined oil-repellent layer is relatively harsh.

According to the level of implementation, the resources of the grape oil reservoir in the study area can be divided into three types of favorable areas. One type of implementation of oil-bearing areas: through the review of old wells, according to the understanding of reservoir electrical standards, fully based on the known well trap oil-bearing area; The second type of favorable
oil-bearing area refers to the fact that there are already wells in the block to confirm the oiliness of the block, but the level of well control is relatively low, which does not meet the need for well control. The three types of favorable area for reservoir formation refer to the three reservoir accumulation keys with oil source faults, high-quality sand bodies, and shielding conditions in accordance with the formation of the Putaohua reservoir. Comprehensive research results have confirmed that one type of favorable area Xkm² has been implemented, the effective reserves X tons, the second type favorable area Xkm², the reserve size X tons, the favorable area of three types of reservoirs Xkm², and resources have been determined in the Daqingzijing area. Potential are X tons.

**Conclusion**

By studying the main controlling factors of oil accumulation in Daqingzijing Putuohua oil layer, it is believed that oil source faults, effective reservoirs and sealing conditions are the key factors for hydrocarbon accumulation. Although the grapevine reservoir is thin and changes rapidly, the study area. The overall resource potential of the Putaohua oil layer is relatively large. Under the guidance of the correct understanding of reservoirs, effective techniques can be used to achieve profitable exploration of the Putaohua oil layer.

![Figure 8. The favorable area map of Daqingzijing Putaohua oil layer.](image)

**References**


