Tectonic characteristics and distribution of Putaohua oil Reservoir in Changchang area of Songliao basin

Yan Chang1,2,*, Dameng Liu1
1China University of Geoscience, Beijing, China
2National Geological Library, Beijing, China

*Corresponding author e-mail: changyan1008@163.com

Abstract. Since the Late Jurassic in the Songliao Basin, the tectonic movement of Yanshan and Heshan has experienced a lot of tectonic movement. The tectonic activity has a clearer display on the seismic profile. The tectonic deformation is generally weak in the east, Features. The regional structure of the Chaoyang area is located on the Chaoyang terrace and Changchunling anticline belt in the central depression of the northern part of the Songliao Basin, and across the two tectonic units of the Chaoyanggou terrace and Changchunling anticline. The study area is characterized by a low tectonic pattern in the southwest and northwest. The highest point is located near the Chang72 well in the Changchunling anticline. The elevation is about -100 m, and the lowest point is the Zhou50 Well near the depth of about -1750 m. Based on the technical means such as splicing, closed difference correction, horizon calibration, seismic interpretation and attribute extraction of 9 seismic blocks in the study area, the seismic interpretation of the top of the Putaohua reservoir is completed, and the next step Style, tectonic evolution characteristics, oil and gas accumulation law and other research work to lay the foundation.

1. Introduction
With the continuous development of oil and gas, the unused reserves of Fuyu oil reservoir decreased year by year, and the oil field faced a serious shortage of reserve reserves. At the same time, during the evaluation process, a better oil-bearing display was found during the drilling and test oil in the Putao depression to the Chaoyanggou terraces, the Yudong-Taipingchuan area, and in the process of drilling and testing oil in the Putaohua reservoir.Zhao41, Zhao18-1, Shu38 and other exploration wells obtained oil, indicating that the area has a further evaluation of the potential. The seismic data collected in nine different periods are in the same way, and the Fuyu reservoir has been the main oil producing layer, and the lack of understanding of the study of the Putaohua oil layer. In order to evaluate and forecast the favorable area of the Putaohua reservoir, it is necessary to study the characteristics and distribution of Putaohua reservoir structure, so as to lay the foundation for the study of the next tectonic evolution and the study of hydrocarbon accumulation.

2. Regional Geological Survey
The Songliao Basin is located in the area of Zhaoyuan, Zhaozhou and Zhaodong three (city) counties in Heilongjiang Province. The western part is connected with Zhaozhou and Zhaoyuan oilfields. The
northern part is adjacent to the Yushu Lin oil field. The main body of the evaluation area is in Chaoyang Gutter on the ground, the exploration area of 1.450 km². The area is flat, the ground elevation of 125 ~ 185 m, a large area for farmland coverage, the southwest mostly reservoirs, swamps. The Chaochang area belongs to the continental monsoon climate, the annual average temperature is 3.6 °C, the annual precipitation is 440 mm, the annual frost-free period is 140 days. The northwest of the oil field is connected with the Harbin-Dalian Expressway and the traffic is relatively convenient.

The Chaochang area is located on the Chaoyanggou terrace and Changchunling anticline belt in the central depression of the northern part of the Songliao Basin, and transects two secondary tectonic units in the Chaoyanggou terrace and Changchunling anticline. The main tectonic units in this study area are Chaoyanggou terrace and Sanzhao depression (Fig. 1).

3. Tectonic pattern and developmental characteristics

Through the data of the previous seismic data, the work area includes Shangjia, Yuxi, Fengle, Southern of Fengle, Chaoyanggou, Shu25, Taipingchuan, southern of Taipingchuan and southern of Zhaoyuan 9 earthquake blocks (Figure 2) Splicing, to complete the closure of poor correction. According to the relevant explanatory data to restore the seismic work area, in order to understand the structure of the area and the evolution of the profile to lay the foundation.

3.1. Calibrate the earthquake horizon

Stratigraphic calibration is an important link in the interpretation of seismic tectonics. There are more evaluation wells and development wells in the study area, but most of the wells are only encountered in the quarry formation. In this paper, five wells with relatively complete formation in the area are
selected, and the corresponding synthetic seismic records are produced by using the acoustic time difference curve of these wells. The Rick wavelet is used to combine the old data and the exploration results of the adjacent area. Geological level calibration, as shown in Figure 3. Through the production of synthetic records and horizon calibration chart, the final calibration six levels such as T3, T2, T11, T1, T07, T04.

![Figure 3. Putaohua oil reservoir layering mark of Chuan7 drill hole](image)

T3 Reflective Layer Equivalent to the top reflection of the Denglouku Group. In the seismic section of the reflected energy is strong, the performance of strong amplitude, poor continuity of the reflection characteristics.

T2 reflection layer equivalent of the top of the Quantou Group reflection, the layer is the standard reflection of the region, the reflected wave group stability, in the profile of the strong amplitude, high continuous reflection characteristics.

T11 Reflective layer equivalent of the first layer of Yao Group reflection, that is, the top of the vineyard. The seismic reflection wave group is characterized by strong and medium amplitude.

T1 reflection layer equivalent of the top of the Yao group of the surface reflection, in the seismic profile has a clear wave impedance interface, reflection energy, continuity is good, the region can be continuous tracking.

T07 Reflective layer equivalent to the top of the Nen Group of the reflection, in the western part of the study area is more stable in the strong amplitude, high continuous reflection, the eastern performance of the continuous, medium amplitude reflection.

T04 Reflective layer equivalent to the top of the third reflection of the Nen Group, seismic reflection wave group showed strong amplitude, medium high continuous reflection characteristics.

3.2. Characteristics of fault development

The rupture of the Chaochang area is very developed, and it has certain regularity in both plane and profile. In the plane, the fault direction and the combination of the characteristics of the analysis of the geostress state, the balance profile production, oil source fault identification basis, and in the plane, the fault direction and the extension length is the evaluation of the trench system, trap evaluation As well as an important part of the reservoir model.

3.2.1. The profile of the fault. The faults in the seismic section of the study area are mainly faulted faults. The faults are mainly distributed in the T1 and T2 layers, and the faults are mostly "Y" and
"human" The interior is mostly ladder-shaped and graben. These fault patterns interact with each other to form the profile of the study area.

3.2.2. The surface combination and distribution of faults. In the study area, the fault is generally developed, the seismic solution is strong, and the plane combination of the fault system is complicated. In order to explain the plane fault and its combination characteristics in the study area, the seismic coherence technique is commonly used to provide the basis for the interpretation of the plane fault. The use of profile interpretation technology and seismic coherence technology can explain the fault more objectively and rationally, reduce the influence of subjective judgment and empirical factors, and improve the accuracy of fault interpretation. Figure 4 shows the isochronous coherence slices (970 ms) near the top of the Putaohua block in the Chaoyanggou block using LandMark software. The profile can be used to explain the fault, the coherence slice is used to determine the direction and distribution of the fault, and the tendency of the fault is determined by the sectional view, and the accuracy of the fault interpretation is improved. Figure 5 is the interpretation of the block after the fault plane plan. Compared with Figure 4 and Figure 5 can be seen that two good proof, fault interpretation is more reasonable.

![Figure 4. Coherent surface of the Putaohua oil layer (970ms)](image1)

![Figure 5. Polygon surface from LandMark](image2)

3.2.3. Characteristic of surface fault distribution. According to the fault distribution of the Putao area in Chaochang block (Fig.6), the fault direction is near northeast and north east, while the north east fault is smaller, the extension is not long, that is a secondary ground stress formation.

![Figure 6. Top fault profile of the Putaohua reservoir](image3)
The fault of the North-south are general development in the region, and was developed in the eastern part of the fault in Shangjia, Fengle, tree 25 three work areas, making these areas more intensive rupture. According to the development of the fault, the whole area can be divided into three fault zones, namely, the northwest zone, the multi-developed large-scale north-south fault area, the two north-facing fault-intensive areas and the southeastern only north-south to the middle extension of the length of the fault.

4. Plane structure features
Based on the restored seismic work area and the time-depth conversion results, the area tracking of the T1-1 reflection axis (Putaohua oil group) is carried out. T1-1 reflection axis in the seismic profile characteristics of stability, for a positive phase of the strong amplitude axis, clear horizontal continuity is good, the accuracy of the interpretation of the results of reliable.

By the study area, the top view of the Putaohua oil group (Fig. 7) shows that the long plot is as high as the northwest and the southeast is low. Northwest in the Sanzhao depression, gentle terrain, including the still home of the west, Fengle, Feng Le South, tree 25 and other regions. The strata to the southeast monoclinic, to the Chaoyanggou area, the formation of steep uplift, and then to the southeast to form a high part of the platform, constitute a "terraces."

Combined with the development of the fault, the fault is long in the Yuxi area (outside the work area) in the Sanzhao Sag, and the north-south direction is the main area. In addition to the northwest of Fengle, the fault is densely developed, The fault is complicated. And to the terrestrial region, the development of the north-south fault, in the south of the Taiping Chuannan block, the fault is basically not developed.

5. Conclusion
The results of seismic horizon calibration show that the top of the Putaohua oil layer, that is, the T11 reflection layer is a horizon with medium amplitude and medium high continuous reflection. In the study area, the fault is very developed, and there are some spreading rules in the plane and the profile: the faults on the section are "Y", "human", ladder and graben. Which is near-north-south and north-east, in which the faults in the north-south direction are larger and longer, which are considered to be formed by the main stress. The fault of the northeast fault is small and the extension is short, which is considered to be the secondary stress In addition, the whole area is divided into three fault zones, namely the northwest, north and southwest fault zones, according to the fault development condition. Through the development of the top surface structure of the Putaohua reservoir Contour map can be
seen, toward the long region of the overall high northwest, low southeast. Northwest in the Sanzhao depression, gentle terrain, including the still home west, Feng Le, Feng Le South, tree 25 and other regions. Strata to the southeast monoclinic, to the Chaoyanggou area, the formation of steep uplift, and then to the southeast to form a high platform, constitute "terraces."

References
[1] Zhao Yonggang, Zhang Shulin. (1): 21-25 (in Chinese with English abstract) [J]. Offshore oil, 2009, 29 (1): 21-25.
[2] Chen Fajing, Wang Xinwen, Chen Zhaonian, et al. Analysis of extensional rift basin [M]. Beijing: Geological Publishing House, 2004.
[3] Yang Mengmeng. Tectonic interpretation and reservoir prediction technology development and application [D]. Beijing: China University of Geosciences, 2011.
[4] QIN Jing-jing et al. Mechanical Interpretation Method and Application of 3D Earthquake [J]. Energy Technology and Management, 2010, 5: 12-14.
[5] Feng Jianwei. Structural evolution and oil control effect of the Wuxia fault zone in the Junggar Basin [D]. Shandong: China University of Petroleum (East China), 2008.
[6] He Zhiyong. Structural evolution and hydrocarbon enrichment of tree 25-Shang 2 block in Songliao Basin [D], Beijing: China University of Geosciences (Beijing), 2011.
[7] Chen Fajing, Zhao Hailing, Chen Zhaonian, Wang Xinwen. Tectonic characteristics and geodynamic background of Mesozoic and Cenozoic extensional basins in eastern China [J]. Geosciences, 1996, 21 (4): 357-365.
[8] Hu Wang-shui. Construction and structure of oil and gas in northern part of Songliao Basin [J]. Natural Gas Industry, 1996, 9: 20-24.
[9] Chen Zhaonian, Chen Fajing. Kinematic characteristics of reverse tectonics in the Songliao Basin [J]. Modern Geology, 1996, 10 (3): 390-396.
[10] Chen Zhaonian et al. Tectonic evolution of Fuyu reservoir in Changchang area of Songliao basin [J]. Modern Geology, 2008, 8: 512-519.
[11] Chen Zhaonian, Wang Xiaomin, Chen Shan, et al. Tectonic evolution of Fuyu reservoir in Changchang area of Songliao basin [J]. Modern Geology, 2008, 22 (4): 512-517.
[12] Song Junqiu. Effects of Plate Movement on Tectonic Evolution of Songliao Basin [J]. Science and Technology Innovation Review, 2008, 30: 59-60.
[13] Wang Yi, Jin Zhijun. New Method for Restoring Formation Denudation in Sedimentary Basins [J]. Earth Science Exhibition, 1999, 10: 482-486.