Research on Combined Method of Sedimentary Facies under Multiple Conditional Constraints

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Abstract. When we were studying the oil field, this article described the morphology, scale, and connectivity of sand bodies by observing the combination of sedimentary facies in the oil field. At the same time, we also found that the sand body is related to the origin, distribution, physical properties, and Changes in heterogeneity, etc., these factors play a crucial guiding role in the development and adjustment of oil fields. However, in specific phase belt combinations, subjective influence factors are relatively large, and the phase belt maps of oilfields have certain limitations in the development adjustment process. In this paper, the sedimentary facies of the Sapu oil layer in the Harwin Oilfield are re-understood through various constraints such as regional sedimentary environment, well-seismic combined reservoir prediction results, and the matching relationship between fluids and structures on the plane. We make the combination of facies zones more reasonable. Accurate, providing a basis for adjustment of oilfield water injection development.

Keywords. Sedimentary facies belt combination; sedimentary environment; well-seismic combination; multiple conditional constraints.

1. Introduction
The study of sedimentary facies is an important work in the exploration and development of oil and gas fields. The distribution pattern of channel sands has a very important guiding role in waterflooding development of oil fields. The Harwin oil field is currently in a high water cut stage, with scattered sand bodies in the oil field, an oil-water well ratio of 3.2: 1, a low degree of waterflood control, and poor injection-production system adjustment effects. By applying multi-conditional constraint sedimentary facies identification and combination, we deployed fine sand bodies and then adjusted the oilfield development.

2. Geological background
The regional structure of the Harwen Oilfield is located in the secondary structural unit of Qijia-Gulong Sag in the central depression area of the Songliao Basin. The east and west sides are respectively raised to the Daqing Changyuan and Longhupao terraces. Low tectonic pattern. The top structure of the grape flower oil layer we mainly mined is simple and gentle. Through research, we found that the faults in the south are more developed, and the number of faults in the north is less. The faults are all normal faults,
and the trend is mainly northwest, and a few are north-south. Average porosity 15.1%, with an average air permeability of 14.7Md, belonging to a low-porosity and low-permeability reservoir.

3. Sedimentary facies identification
Based on the fine division and comparison of the oil layers in the Harwin Oilfield, based on the regional sedimentary environment evolution characteristics and core data, this paper has established five typical sedimentary logging facies models to study the main bodies of the underwater diverting channel and the inner front edge. Mat-shaped sand, inner leading edge non-subject mat sand, outer leading edge non-subject mat sand and outer leading edge non-subject mat sand (Figure 1)

In this paper, using the logging facies model, we combined the logging curve response characteristics to identify the logging facies of single wells and sand bodies in the study area one by one: we completed the interpretation of 1,489 small-layer sedimentary facies in 94 wells in the study area, of which 164 small-layer developments Underwater diversion channels; the average thickness of a single sand layer is 3.5 meters, and the effective thickness is 1.7 meters.

4. Multi-conditional constraint sedimentary facies belt combination
Based on the anatomy of the sand body of the dense well network, we found that the delta sedimentation model is used as a guide, the single well lithology and electrical characteristics are used as the basis, the seismic attribute prediction is used as a reference, and the multi-conditional constraint facies combination is used to characterize the sand body development. The cloth shape, scale, and connectivity [2] make the sand body transition and boundary characterization more reasonable and accurate. After the restraint, the shape of the sand body changed greatly, and the channel scale, extension length and combination method also changed.

4.1. Combine the regional sedimentary environment to determine the direction of the river
The Harwin oilfield is mainly controlled by the western and northern provenances. The grape flower oil layer is dominated by the inner front of the delta, the river course is near north-south, and the Sartu oil layer is dominated by the outer front of the delta (Figure 2).
4.2. Well-seismic combination to predict sand bodies

This paper uses the seismic data in combination with the drilling data to carry out comprehensive reservoir prediction (Figure 3). We track the channel direction, characterize the sand body boundary, predict the lithological thickness, and more accurately implement the spatial distribution characteristics of the reservoir.

We have studied the development of underwater diverted rivers with large thickness and obvious seismic response characteristics. The sand bodies show obvious stripe distribution from north to south, and trace the river direction to north-south (Figure 3-a, b). It can be seen from the sandstone thickness prediction map that the sandstone thickness change trend has a good matching relationship with the sedimentary microfacies. In the northern part of the work area, the maximum thickness of sandstone is 16m, which is obvious near north-south stripe; in the southern part of the work area, the thickness of sandstone is generally between 5-10m, and the stripe is good. The mat-shaped sand corresponds slightly (Figure 3-c).

The sandstone thickness contour map is processed, and all sandstones with a thickness greater than 4 meters are set to red. It is clear that the lithological thickness and sedimentary facies have a good matching relationship. The area with a thickness greater than 4m shows a near-north-strip direction.
Cloth, which corresponds slightly to the submarine diversion channel at the leading edge of the delta (Figure 4).

Figure 4. Isothermal thickness of Pl6 sandstone in Harwin-Xingxi area:

4.3. Contrast log curve shape
In this paper, by comparing the log curves of adjacent wells, we divide the wells with the same shape or high similarity into the same sand body: for example, the Pl6 layer developed in two adjacent wells of A and Wen B, and the sedimentary microfacies are all underwater diverted channels. The shape of the curve is approximately the same (Figure 5), and there is no fault development between the two wells. Therefore, the plane sedimentary microfacies were re-adjusted for this purpose, and they were classified as rivers of the same period. There are no wells in the northwest of the study area. Control the direction of the river channel and change it from north to south (Figure 6).

Figure 5. Comparison of A and B log curves.

Figure 6. Pl6 sedimentary facies map of Harwen oilfield.

4.4. Relationship between fluid and tectonic plane
The combination of fluid and structural plane-constrained constrained belts follows the principle of structural high-level oil layers and low-level water layers, and divides fluid and structural well locations into different sand bodies. The C6 Pl6 logging is interpreted as the same layer of oil and water with a structure of -1791 meters, and the D6 Pl6 logging is interpreted as an oil layer with the structure of -1803 meters. When the facies zone is combined, the two wells are disconnected and divided into different sand bodies (Figure 7).
Figure 7. Comparison of the reference fluid structure before and after the facies belt in Harwen Oilfield

Multi-conditional constrained sedimentary facies belts were combined, and a total of 42 facies belt charts of each sedimentary unit in Harwin Oilfield were compiled. The statistical analysis was classified into:

1. The Sartu reservoir is mainly composed of mat sands, which can be divided into three types according to the composition and distribution characteristics of sedimentary microfacies (Figure 8): Class I mat sands are stable and the main mat sands are relatively developed. It is distributed in flakes and corrugations; Type II mat-shaped sand is intermittently distributed in sheet form, and the main mat-shaped sand is scattered in a 坨-like pattern; Type III sand bodies are scattered and the body is basically undeveloped.

Figure 8. Analysis chart of development scale oil field of river sand body

2. Grape flower reservoirs are mainly distributed in the north-south direction, and can be divided into three types according to the differences in the development scale of the sand bodies of the river (Figure 9): Class I small and medium-sized underwater diverted rivers, with a width of 300-700 meters Type II mainly consists of narrow-strip underwater diversion channels, generally less than 300 meters in width, and type III does not develop rivers. It mainly develops sheet-like mat sand with stable plane distribution and scattered main mat-like sand.
5. Conclusions and recommendations

(1) Comprehensive use of various data such as earthquakes, cores, and logging curves can improve the rationality and accuracy of the combination of river prediction and sedimentary facies;

(2) The Putaohua oil layer is dominated by the delta front leading edge, while the Saertu oil layer is dominated by the delta front leading edge;

(3) Grape flower and Saltu reservoirs are classified into three types according to sedimentary microfacies and distribution characteristics, one of which is the main force layer;

(4) The reasonable combination of sedimentary facies can make the sand body's distribution morphology and injection-production connection more reasonable, and make the development and adjustment of the oilfield more targeted.

References

[1] Chen Gongyang et al. Distribution characteristics of tight sandstone gas reservoirs under the control of sedimentary facies. Petroleum and Natural Gas Geology. 6, 2017, pp. 467-477

[2] Zhang Guangquan, et al. Sedimentary facies analysis of the first member of the Lower Shihezi Formation in the Daniudi gas field, Ordos Basin. Journal of Northeast Petroleum University. 04, 2017, pp. 54-61

[3] Li Quan, Wu Wei, etc. Application of seismic sedimentology method in determining the boundary of sedimentary facies. Journal of Southwest Petroleum University, 8, 2010, pp. 50-55.