Analysis on the changing law of sand body in narrow and small distributary channel after intensification

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Abstract. Since the production test of Beizhong Block began in 1965, due to the need of development and adjustment, multiple sets of well patterns have been encrypted, such as primary encryption, secondary encryption, and triple encryption well patterns. Some new knowledge can be obtained on the distribution of the body. In order to improve the development effect of the oil field and further increase the recoverable reserves, in 2015, the reservoir was encrypted in the Beizhong block, and 163 wells were supplemented. The prediction accuracy and the analysis of the changes have made clear the changing laws of different types of sand bodies, and improved the understanding of the sand bodies.

Key words. Narrow diversion channel, North Central Block West, Law of change, Sedimentary facies diagram.

1. Geological Overview
The west of the North Central Block is located in the Sazhong Development Zone of Changyuan, Daqing, between the middle 1-1 row and the middle 1-3 row in the Zhongyi District, and the west is connected to the wells 1-1-1-P14 and Zhong 1-330-P12. Line, east to Zhong 1-1-40 well and Zhong 1-3-40 well, with three sets of oil layers including Sartu, Putaohua and Gaotaizi, with an oil-bearing area of 7.7km² and a well pattern density of 92 wells / km².

2. Types and distribution characteristics of sand bodies in S II reservoir group
In order to study the variation law of sand bodies in each sedimentary unit of S II oil layer group, we first need to understand the distribution characteristics of sand bodies. The S II reservoir group belongs to the delta distributary plain and the inner front subfacies of the delta. The developed channel types are high, low and wide, narrow and small distributary channel sand bodies and underwater distributary channel sand bodies. And shape, divided into two types:
2.1. Divergent channel sand bodies with wide channel, with or without main zone (Fig. 1a). Units of this type are SII1, SII2a, SII2b, SII3, SII7, SII8a, SII8b, SII10, SII11, SII14, SII15 + 16a, SII15 Unit + 16b, the channel sand is more developed, the channel width is mostly 400-950m, this type of sand body is well developed, the thickness is thick, the well pattern controls the sand body to a high degree, it is a diversion plain or delta of Zhituo transitional delta The sedimentary environment of the inner leading edge.

2.2. Straight and narrow underwater distributary channel sand bodies with narrow channels (Figure 1b). Units of this type include SII4, SII5 + 6a, SII5 + 6b, SII9, SII12, and SII13 units, and the channel sand is straight around 150-250m Narrow and small rivers have poor continuity. Some rivers can only be continued through interwell predictions. The well pattern controls the sand body to a low degree and belongs to the sedimentary environment of the front edge in the delta.

![Figure 1. Sedimentary facies diagram of S II 2a and S II 5 + 6a units in the Xinjing encryption area in the west of the North Central Block](image)

**Figure 1.** Sedimentary facies diagram of S II 2a and S II 5 + 6a units in the Xinjing encryption area in the west of the North Central Block

3. Analysis of sand body change law after infill drilling

3.1. Analysis of the degree of coincidence of different microfacies in SII oil layer after infill drilling

After supplementing the drilling, we drilled the thickness of the new drilling and identified the type of microfacies on the sedimentary facies of 18 sedimentary units in the SII oil layer group. Through the analysis of layer by layer and layer by layer analysis (see Table 1), channel sand drilling The coincidence rate was 62.2%, the coincidence rate between river sand drills was 70.7%, and the coincidence rate was 50.0% in the extinction zone. The following points are summarized:

3.1.1. The channel sands described so far basically control the channel sands, but the width of the narrow underwater distributary channel sand bodies tends to be further narrowed to about 100m, and the channel sands are encountered in river sands and sharp extinction areas. Has a low probability.

3.1.2. The inter-river sand bodies are well developed, the infill wells have a high degree of compliance, and the larger the distribution area, the higher the degree of compliance.

3.1.3. The area of the extinction zone has a tendency to become smaller. 45.2% of the sharpened areas encountered river sand in new drilling and excavation, mainly developed on the sides of the channel or the edge of the local continuous distribution of the river sand. The reduction in area proves that the SII reservoir is significantly enhanced by the transformation of the lake and the river sand is more developed.
Table 1. Statistics table of microphase changes before and after encryption in SⅡ oil layer group

| Microphase before encryption | Sand body type | Consistent before and after encryption | Consistent before and after proportion (%) | total |
|-----------------------------|----------------|----------------------------------------|---------------------------------------------|-------|
| River                        | Encrypted microphase |                                        |                                             |       |
| River                        | River           | 470                                    | 62.2                                        | 755   |
|                              | Between rivers  | 264                                    | 35.0                                        |       |
|                              | Extinguish      | 21                                     | 2.8                                         |       |
| Between rivers               | River           | 142                                    | 14.6                                        | 972   |
|                              | Between rivers  | 687                                    | 70.7                                        |       |
|                              | Extinguish      | 143                                    | 14.7                                        |       |
| Extinguish                   | River           | 4                                      | 4.8                                         | 84    |
|                              | Between rivers  | 38                                     | 45.2                                        |       |
|                              | Extinguish      | 42                                     | 50.0                                        |       |

3.2. Analysis of the reason why the prediction result of river sand body in SⅡ oil layer group after infill drilling is inconsistent with the actual drilling result

After the well pattern was encrypted in the study area, we compared the predicted results of the SⅡ reservoir channel sand bodies with the actual drilling results after the intensified drilling (Table 1). The changes were mainly concentrated in the straight and narrow small distributary channels. as follows:

3.2.1. Unable to control well pattern, resulting in un-drilled river sand bodies. Since most of the channel width is around a well spacing, the channel curvature and boundary position can only be predicted by parameters such as inter-sand sand and the thickness of adjacent wells. It is difficult to accurately control this type of sand body. There are many migration phenomena. Take the S1-213 deposition unit Z1-202-525 as an example (Figure 2a). As shown in the figure, there are two new wells Z1-202-525 and Z1-211-S525 that should be drilled in the infill well. After the actual drilling, the Z1-202-525 well is encountered in the river, and the Z1-211-S525 well is encountered. This means that the scale of the channel is narrow, and it is difficult to accurately control the boundary of the channel when passing through the extinction zone.

3.2.2. The predicted distance is far away, and the channel sand body is hollow. For narrow and straight channel sand bodies, when the predicted distance of the channel in the longitudinal direction is greater than two well distances, the actual encounter rate of channel sand decreases. When predicting channel sand bodies, specific analysis should be made according to the sedimentary environment and sand body type. For narrow and small rivers, if the prediction distance is too far, there will be discontinuous channels in the predicted parts, or although there are channels, but the direction and channel boundaries cannot be controlled, such as the ZⅡ5 + 6b deposition unit Z1-212-S523 well area (Figure 2b).

3.2.3. At the upper and lower openings of the channel, there is no well point control in one direction and the channel sand is hollow. Mainly refers to the first row or the last row of the study area, because there is no well point control in one direction, and the direction prediction of the river channel. After drilling, sometimes the direction changes or drifts. When drawing, for a wide channel with a channel width greater than two well spacings, there is a greater chance of encountering channel sand above the channel. For a channel controlled by a single well spacing, the drilling risk increases. For example, SⅡ13 deposition unit Z1-11-SF537 well area (Figure 2c).

3.2.4. At the bifurcation or merging of the river channel, the sand of the river channel is hollow because the scale of the sand body is too wide. Straight and narrow small channel sand bodies have a narrow width. Therefore, when determining the boundary of the channel, the sedimentary law of the channel
should be followed, that is, the center of the channel is thick sand body, and the sand body becomes thinner towards the sides of the channel. At the merger, the channel boundary should be close to a thin sand body or a sand body with river-toothed features, so that the prediction of the channel boundary is more reasonable. For example, the well S1-25-6b deposition unit Z1-211-532 (Figure 2d).

4. Cognition and improvement of prediction method of sand body in narrow and small distributary channel

By studying the conformity rate of the underwater distributary channel sandbody drilling in the study area, a certain understanding has been obtained in the prediction method, and the drawing method of narrow and small channel sandbody has been improved.

4.1. Understanding of prediction methods of sand bodies in narrow and small distributary channels

4.1.1. The channel sand bodies in the inner and outer leading edge transitional zones are intermittent and sporadic, no continuity prediction is required in reservoir description. With the continuous intensification of the well pattern, the width of the channel is small and the continuity is very poor in the sedimentary unit of the underwater distributary channel. The two banks are slightly curved. The sand body type belongs to the residual underwater distributary channel sand body. It is an ancient river channel that has been transformed into a large area of matte sand by the leveling transformation of lakes and waves. Only a few low-recessed and thick sedimentary channel sand bodies are retained Down, the
distribution shape is intermittent, generally coexisting with the main sheet sand, so no continuity prediction is needed in the reservoir description. The thick channel sand body often forms a continuous water channel network with the strip main sheet sand.

4.1.2. *The sand bodies in the inner frontal facies are relatively continuous, narrowing in width and increasing in curvature.* After drilling, it was confirmed that the straight underwater distributary channel in the front edge of the delta is continuously distributed in sediment, but the width is narrow. It was originally believed that the channel width of the river was 150m-250m, some wells encountered the channel, and some wells encountered the river, indicating that there is indeed channel sand in the predicted well area, and the sand body is continuously distributed, but the width is narrow and reduced to 100m about. Moreover, from the perspective of the change of the inner frontal facies channel curvature, it was originally believed that the inner frontal facies channel sand body curvature changed little and the channel boundary was relatively straight, but after drilling, it was found that the river curvature increased (Figure 3).

![Figure 3](image-url). The width of the diversion channel sand body narrows and the curvature increases

4.2. *Improvement of drawing method of sand body in narrow and small distributary channel*

The prediction coincidence rate of the sand body drilling prediction of the submarine distributary channel in the study area is 62.2%, which is low. Through the analysis and summary of the change characteristics of the sand body before and after infill drilling, the following three aspects are improved in the drawing method.

4.2.1. *Prediction of river curvature.* For single wells, the width of the sand body should be controlled within 100 meters, and the curvature can be appropriately increased. The two banks should not be too straight and too parallel. You can connect continuous well points in the river channel and do a "Zigzag" to predict the curvature of the river channel. (See the well zone Z1-202-S530 in Figure 3), and it can be inferred to the areas with low well control.

4.2.2. *Prediction of river curvature.* Prediction of river continuity. The predicted channel should be as close as possible to the sand between the rivers to avoid passing through the sharpened area. For the longitudinal prediction range of the channel is greater than 2 well spacing, the inner front can be moderately continuous prediction of the channel, inner and outer front The transition zone or the outer leading edge can not predict the continuity of the river channel. If it can be disconnected, it can be disconnected. The mat sand can be used to improve the accuracy of depicting the sand body.
5. Conclusion

5.1. After intensified drilling of the Gaotaizi reservoir in the SII reservoir group, it was confirmed that the channel width is expected to narrow further, about 100 meters, and the degree of well pattern control is low.

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5.3. After intensification of the well pattern of SII reservoir group, the channel sands encountered are mainly distributed in wide channel sand bodies with double well spacing, and the continuity is good. In the sand, the prediction result of the channel sand body is not consistent with the actual drilling result, which is mainly concentrated in the straight and narrow small distributary channel.

5.4. The sand bodies in the inner frontal facies are relatively continuously distributed, with narrower width and increased curvature. The sand bodies in the inner and outer front transition zones and outer frontal channels are intermittent and sporadic.

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