
Research Methods of Different Levels of Reservoirs Based on Seismic Data

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Abstract: The lack of drilling data is a difficult problem in the study of reservoir configuration under the condition of sparse well pattern. In this paper, the seismic data are fully excavated, and the methods of frequency RGB fusion, small scale river sand attribute fusion and horizontal well data combination are used to study the river level, the level point bar level, and the internal configuration of point bar. The frequency division RGB fusion method has a good effect on the characterization of large-scale channel reservoirs, especially the channel stacking period and channel boundary response. The integrated attributes of river channel and sand body distribution method has a good effect on depicting the small-scale end river channel and abandoned river channel, and on this basis, the research on point bar sand body is consistent with the actual drilling. The high-precision edge detection section and RGB fusion section are superimposed to display the development of lateral volume, and verify with the actual horizontal well. River facies reservoirs of different scales have been verified by drilling with targeted research techniques. The results show that under the condition of sparse well pattern, well-seismic combination is the key to the division of small-scale sedimentary units, multi-attribute fusion under high-resolution seismic data is an important means to identify and depict point bar and abandoned river channels, and the application of horizontal well data is a supplementary means to test results and depict lateral accumulation. The research results have achieved good application results in guiding the actual production of oil field.

Keywords: Reservoir Configuration, Point Bar Sand Body, Abandoned Channel, Seismic Fusion Attribute

1. Introduction

The fine research and characterization of the internal configuration of the reservoir become an important means to tap the potential of the remaining oil in the middle and high water cut stage of the oilfield [1-3]. For fluvial facies oilfield, the reservoir configuration unit in fluvial sand body controls the distribution of remaining oil. Therefore, it is of great significance to clarify the characteristics of each configuration unit of fluvial sand body and to quantitatively characterize it for further potential exploration of oilfield [4-6]. In recent years, there has been a guiding research method of meandering river configuration, but there is no reliable technical means for the study of different levels of reservoir configuration under sparse well pattern [7-9]. In this paper, the configuration level is divided into river level, point dam level and point dam internal configuration level. Three kinds of research methods are used to study the three levels, and

good practical results are achieved.

2. Channel Level Reservoir Study

2.1. Research Method

The key of small-scale reservoir research is the fine division and correlation of strata by well and seismic data, facies control constraint and equal elevation sand control, and the premise is to find out the origin, characteristics and marker layer of reservoir sedimentation [10-12].

The characteristics of meandering river facies single sand body level reservoir can be summarized as follows: 1) from the formation to abandonment of a single channel, the deposited channel sand body is the smallest unit of small-scale correlation; 2) the whole sequence sedimentary thickness of a single channel generally reflects the full bank sedimentary thickness of the river, and its top boundary is an

isochronous surface; 3) the top boundary of channel sand body developed in different sedimentary periods is different, but the channel sand body developed in the same period is different. The body should have basically the same elevation difference as the surrounding standard layer; 4) the channel is usually fine-grained deposition, which is characterized by thick, thin and thick deposition [13]. Therefore, the river level is the minimum scale of two-dimensional contrast and division. Based on this, under the principle of cycle comparison and hierarchical control, and on the basis of fine cycle division, the composite channel is incorporated into a single cycle, and the single channel is identified and divided through the difference of elevation, thickness change, lithology change, etc., and the single channel division result is verified and modified by using high-resolution seismic inversion data, so as to realize the channel layer. 2-D identification and division of sub configuration units.

2.2. Research Technology

Frequency division RGB fusion technology is realized in two steps: frequency division and fusion. Firstly, the seismic data volume is divided into discrete tuned frequency volume by using generalized S-transform, and three tuned frequency volume combinations are optimized according to the thickness of the target sand body. Then, the three frequency bodies are given red, green and blue basic colors respectively, and the sedimentary evolution law of the sand body is demonstrated by using the stratigraphic slice technology. The brightness of color code on the fusion section reflects the change of lithology, and the chroma reflects the thickness and channel period (Figure 1).

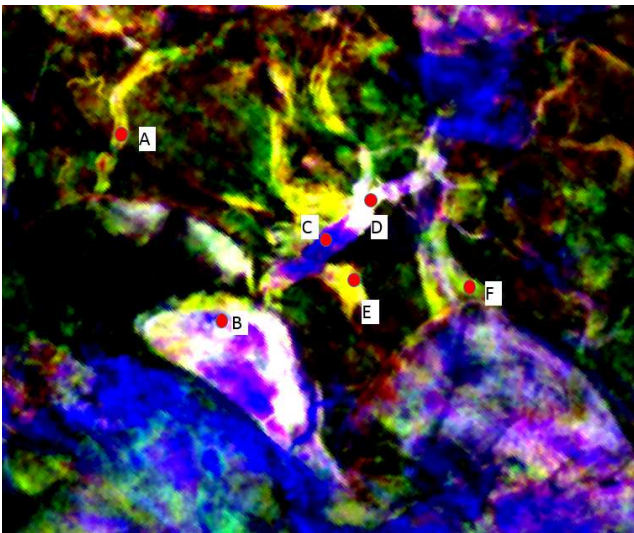


Figure 1. RGB fusion attribute.

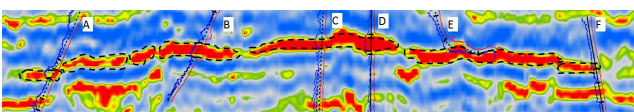


Figure 2. Well-tie seismic profile.

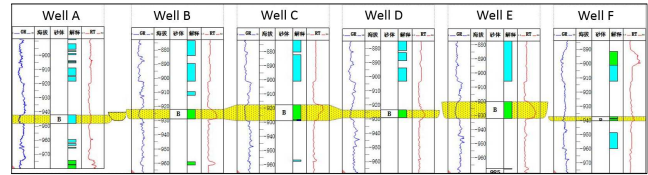


Figure 3. Well-tie section.

Seismic profile facies reflect the change of lithology, sand body thickness and elevation of different river channels (as shown in Figure 2). The energy intensity and continuity of the reflection axis reflect the physical properties and continuity of the sand body, the interruption of the reflection axis reflects the deposition mud or abandoned river channel between the rivers, the vertical thickness of the reflection axis reflects the thickness of the sand body, and the elevation difference of the reflection axis reflects the deposition period of the river channel. Well A and well F drilled early river sedimentary sand, well E drilled middle river sedimentary sand, and well B, C and D encountered late river channel sedimentary sand. This conclusion is consistent with the attribute displayed in Figure 1. The well-tie section shows that the channel period and sand body thickness are consistent with the conclusion of fusion attribute. (Figure 3).

3. Study on Point Bar Level Reservoir

3.1. Research Methods

For the composite sand body, the key is to analyze its internal separation. Under the sedimentary background of meandering river, the key point is the residual river channel in the "contiguous" sand body. Under the condition of sparse well pattern, it is difficult to show the change of configuration elements and their sedimentary evolution [14]. In this study, the research method of channel and point sand dam of "searching for river by discarding sand" is put forward. Based on the principle of sedimentology, sand is found along the river, and the flaky sand is dissected.

3.2. Research Technology

The original seismic data are processed by keeping the dip angle guided filtering, high-precision small-scale coherence technology, river sand attribute fusion technology, and three-dimensional visual display technology of stratum slice. From the fusion attribute slice (Figure 4), the distribution of river channel at the end of the period can be clearly depicted, and the distribution of point bar can be clearly seen. Figure 5 shows the actual drilling location and sand body thickness. Well Y drilled the middle of the point bar and the thickness of the sand body is 11.7m. Well X and P drilled the edge of the point bar and the thickness of the sand body is 5.7m and 9.9m. Well Q drilled in the abandoned river and the thickness of the sand body is 1.2m. The location of well point is very consistent with the thickness of sand body, which proves that the fusion attribute is reliable.

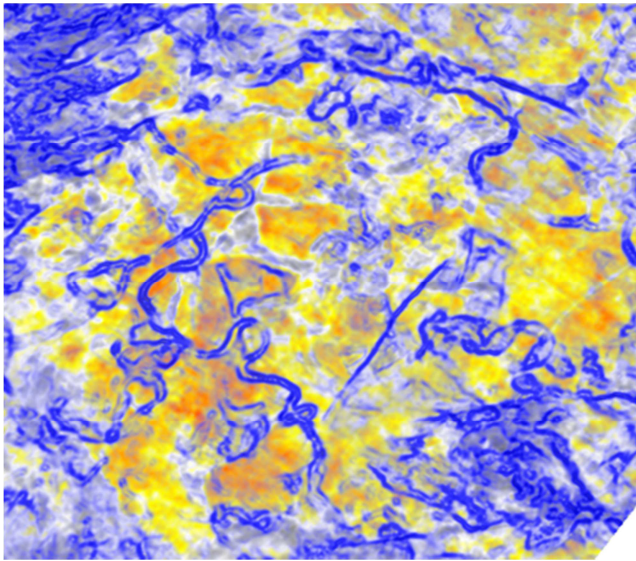


Figure 4. River channel and sand fusion attribute.

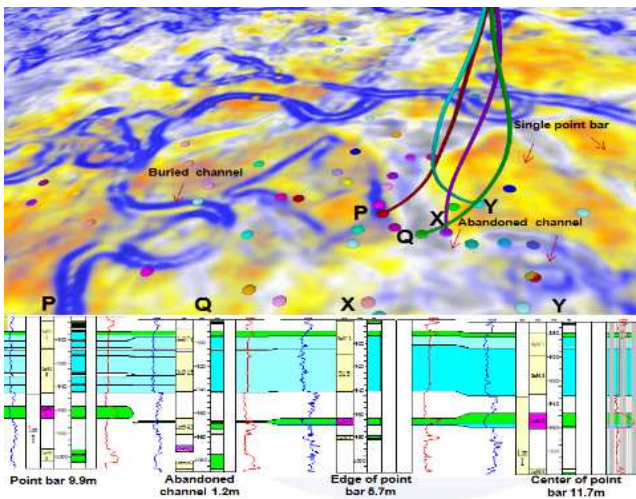


Figure 5. Well data confirm fusion attribute.

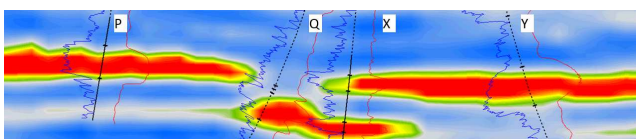


Figure 6. Well data confirm fusion attribute.

Well-tie seismic profile (as shown in Figure 6), well X and well Y drilled early point bar, well P drilled late point bar, and well Q encountered abandoned river channel. The thickness of sand body drilled in the well is basically consistent with the thickness of seismic reflection axis. The physical properties of sand body filled with abandoned river channel are poor, and there is no obvious reflection axis, and the two stage point bar sand bodies are separated. Further study shows that the two stages of point bar sand are deposited in different periods of the same river swing process.

4. Study on Lateral Accumulation Level Reservoir

4.1. Research Methods

The key to the study of lateral accumulation level reservoir is to identify the abandoned channel and the intercalation of lateral accumulation mudstone in the point bar [15]. However, the abandoned channel has been changed and overlapped many times by the channel, and the thickness and extension length of lateral accumulation mudstone are limited, so it is difficult to describe it with conventional methods due to the limitation of seismic data quality. In this study, small-scale channel technology and RGB fusion technology are used to depict the well-developed side accumulation bar, which can directly show the development of side accumulation. For the sand body which is difficult to depict, the GR range of horizontal well is used to depict.

4.2. Research Technology

When the frequency division RGB fusion attribute is decomposed into low, medium and high frequency single frequency bodies, the small-scale geological information is blurred, which is not conducive to the characterization of abandoned river channels or lateral mudstones, but its rich color can reflect the different thickness and different sedimentary periods of the sand body. Only weak response to lateral point bar (Figure 7). The small-scale edge detection attribute superimposed on the frequency division RGB fusion attribute can enhance the response to lateral accumulation or mudstone. In this study, this method is used to study the lateral accumulation level reservoir of sand body (Figure 8).

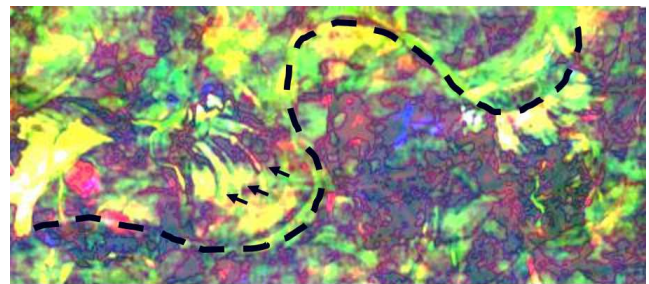


Figure 7. RGB fusion attribute depict lateral mudstone.

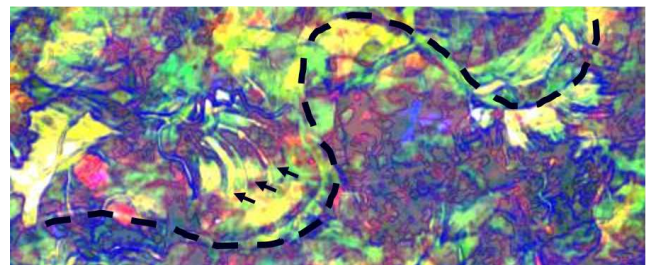


Figure 8. RGB fusion attribute superimposed small scale river attribute depict lateral mudstone.

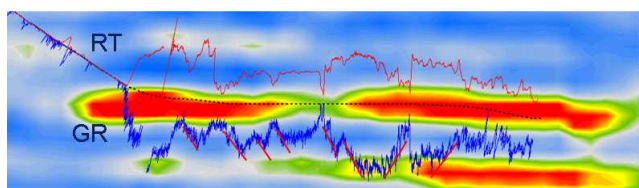


Figure 9. Well data confirm fusion attribute.

Single side accumulation layer can not be identified on seismic section, but it can be identified by combining the location of horizontal well plane attribute and the change of GR curve characteristics of actual horizontal section. The development process of the lateral deposit is formed by the erosion of the concave bank, the deposition of the convex bank and the continuous migration of the main channel. According to modern sedimentary research, the bottom of the lateral deposit is coarse sandstone, the top is fine sandstone, and there is argillaceous interlayer between the lateral deposit. Therefore, when the horizontal well passes through multiple lateral deposits, the GR curve characteristics should be cyclical. As shown in Figure 9, the RG curve of horizontal well shows multi-stage cycle characteristics. Combined with the plane attribute of the well location, it can be determined that the horizontal well encounters multi-stage lateral accumulation.

5. Conclusions

Different seismic research methods are used for different levels of reservoirs, which is very helpful for fine characterization of reservoir structure. In the reservoir study of channel level, the frequency division RGB fusion method can effectively describe the channel stage and channel superposition relationship, which is in good agreement with the actual drilling data. Small scale river sand fusion method is used to study the reservoir at point dam level. This method can clearly depict point bar sand body, the last stage of river channel and abandoned river channel, which is consistent with the actual drilling data. In the study of single lateral deposit level reservoir, multi-attribute fusion combined with actual horizontal well data is used. The research results have been confirmed by actual drilling data, which has a good guiding significance for the prediction of high-quality reservoir.

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Biography



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