

The method of identification of abandoned channel by dense well pattern and its application in A Oilfield

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Abstract: The existence of abandoned channel represents the end of the evolution history of single river channel. Taking the C layer in B area, A oilfield as an example, synthesizing the logging response characteristics, plane distribution pattern and the relative depth map method of sand top of abandoned channels, abandoned channels were identified under the guidance of modern deposition theory. In the three-dimensional window, a multi-angle observation and analysis of connected well profiles was carried out by using the underground dense well pattern data, and a total of 10 parts were identified in the research area, including s-type and pen-moon abandoned channel.

Key words: Meandering stream; abandoned channel; Point bar; Reservoir architecture.

1. Introduction

The C layer in B area belongs to distributary channel deposit in delta plain, where channel bodies of meandering stream are developed. The oil field has entered the high water cut stage, and the reservoir heterogeneity has a great influence on reservoir development. The remaining oil is highly dispersed. abandoned channel is one of the important factors affecting the connectivity of sand body. Due to the difference of lithology and physical properties, the upside of abandoned channel with silt and mud forms an effective occlusion among its surrounding point bars. Therefore, the identification of abandoned channels is of great significance to the study of reservoir heterogeneity and residual oil distribution.

2. The method of identifying abandoned channel in dense well pattern

There are three types of occlusion of abandoned channels, namely: abrupt abandonment, gradual abandonment, transition.

The roof of the dam separate abrupt abandonment channel from the new channel has been higher than the water level of the mainstream river, preventing the water from entering the abandoned channel and making the two completely isolated. Only during the flood season can the floodwater carry fine suspended matter into the abandoned channel. In the still water environment, the deposit is mainly mud-based and silty. finally, a circular enclosed lithologic blocking zone dominated by mud-texture strip is formed on the plane.

The roof of the dam separating the gradually abandoned channel is lower than the water level of the mainstream river. It has been at a low water level. Its internal water body always connects with upper water body of mainstream river channel. Most of the upper reaches flow downstream through new river channel (mainstream channel), and a small number of water will pass through the abandoned channel. The water in the abandoned channel is weak. Due to the semi-occlusion of the dam, middle coarse materials are difficult to move into the abandoned channel, which is dominated by rolling and jumping components at the bottom of the water body of the main river. Abandoned channel constantly receives fine particles deposited from the main river, which are mainly suspended and mixed with a small number of jumping components. Therefore, the sediment particle size of the abandoned channel is smaller than that of the surrounding point bar, and the shale content is higher.

Finally, The physical-lithology shielding strip is formed on the plane, which is dominated by physical property. The transitional abandoned channel has both characteristics and forms the "walled type" occlusion of physical-lithology characteristics.

The above three different types of abandoned channels deposit, form a circular enclosed walled shielding strip on the plane, which separates contiguous meander sand bodies into combination of multiple point bars. The sediment of abandoned channel can play a certain protective effect on the fluid in the sand of the point bars on both sides. Its shielding intensity can be described by the ratio of the thickness of mudstone in the abandoned river to the thickness of the sand at the corresponding point bar [1, 2].

2.1 Logging acquaintance of abandoned channels

The abandoned channel on a single well is shown that the bottom layer should be equal to the bottom layer of the river sand, and the top layer of the abandoned channel should be lower than the top layer of the river sand (Figure 1). The log curve at the bottom of abrupt abandoned channel is represented as Spontaneous Potential and Natural Gamma curve is box or clock shaped, and the upper near baseline. The log curve at the bottom of the gradual abandoned channel is basically the same as the abrupt abandonment, while the filling part of the upper abandoned channel is jagged, which represented as big amplitude difference of the microelectric level curve at the bottom and small amplitude difference on the top. It reflects on interactive filling of sand and mud.

The method of using electrical relationship to identify abandoned channel is widely used, but it is polysolvable. The lithology, structure and electrical characteristics of the mudstone section in the upper part of the abandoned channel are similar to those of the flood plain, natural levee and breach fan, which makes it difficult to accurately identify the abandoned channel. abandoned channels are mostly isolated meniscus in plane, and there are also curved bands, whose continuity in transverse and longitudinal profiles is limited. Even for the late river channels with continuous curved bands, the longitudinal profiles in parallel river flow direction are not continuous, so identifying abandoned channels requires higher well pattern density. It is necessary to use the methods of profile identification, plane prediction and three-dimensional space combination to identify the abandoned channel comprehensively, but the trend and scale of the abandoned channel cannot be accurately judged based on the logging response of a single well.

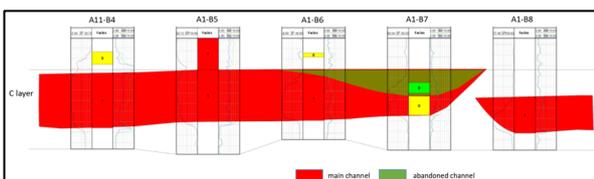


FIG. 1 Abandoned channel microfacies logging response

2.2 Prediction of abandoned river in plane

(1) Sand thickness difference method to identify abandoned channels

The possible distribution locations of abandoned channels can be preliminarily identified through the contour map of sand body thickness. The point dam is relatively thick and in the shape of ring layer, and the abandoned channel adjacent to the river channel is located at the concave bank of the sand body of a single river channel [3, 4]. Because the logging response of abandoned channel is mostly mudstone, the abandoned channel can be roughly identified by the contour map of sand thickness in the data of underground dense well pattern. First, the single stage channel boundary is identified between the point par and the point par (the attribution of the abandoned channel is determined by logging curve or the thin sand bodies between rivers), and the abandoned channel is concave

toward the point bar at the channel boundary and the thinning of the channel sand body.

According to the plane morphology and distribution characteristics of abandoned river, The plane combinations of abandoned channel can be divided into two categories: one is the abandoned river formed by single flow, including serial channel type (C type), neck cut type (O type) and breach diversion type (S type); The other type is the abandoned river formed by multi-flow action, such as the abandoned channel of stream diversion type (X type). On the facies zone diagram, the gradually abandoned channel generally presents a discontinuous meniscus shape with small curvature, and the development scale of point bar sand body is small. However, the abrupt abandoned channel is generally independent, whose curvature is relatively large.

(2) Sand top relative depth method to identify abandoned channels

The sand top relative depth method is to predict the plane position of the abandoned channel according to the sand top relative isodepth map on the plane, and then identify the abandoned channel according to its characteristics on the log curve. The relative depth of the sand top refers to the distance between the top of the structure and the sand top of the channel in the small layer. The relative depth of the sand top of the single well of the abandoned channel can be calculated after the single layer top structure is flattened. The relative depth of the sand top of the single well of the abandoned channel is obviously greater than that of the adjacent well, so the position of the abandoned channel can be initially identified by the relative depth map of the sand top [5].

2.3 3D window multi-angle identification of abandoned river

The identification method of two-dimensional plane and section cannot grasp the scale of abandoned channel from a macro perspective, nor can it well control the combination of abandoned river. The multi-angle grid analysis technology in 3D window uses the representation of grid diagram in 3D window to observe and analyze the connected well section to identify abandoned river. By combining the size, direction and shape of the abandoned channel, this method can overcome the defects of two-dimensional identification of the abandoned channel and identify the abandoned river more accurately.

3. Identification of abandoned channels in the study area

The sand body is widely distributed in the plane, and the sediment thickness is also large. The source direction is near northwest, and it is deposited in distributary channel of delta plain. It belongs to meandering river deposit. Most abandoned channels are S-shaped or meniscus shape on the plane.

According to the difference of effective sandstone thickness, sand thickness contour map of C layer in B area is made, as shown in FIG. 2. The contour map of S-shaped abandoned channel on the sand thickness contour map can be obtained by counting the single cycle sand thickness of

all Wells, using inter-well interpolation to obtain the contour map, and then delineate the maximum sand thickness to form multiple "beading" local sand body enrichment centers. It fits well with the distribution pattern of point bar in meandering river sediments, and the point bar are regularly distributed along the flow direction. Based on the delineation of local sand thickness centers, the tangential method is adopted to connect several sand-rich centers in turn.

Figure 3 is the relative isodepth map of C layer sand top in B area. The low value in the figure indicates that the relative depth of sand top is small, that is, the thickness of sand body is large, and the relative depth of sand top gradually increases after the transition to high value. Therefore, abandoned channel is most likely to develop in the area with high value. Based on well logging response on the profile and relative equidepth map of sand top, the multi-view grid map is combined in the three-dimensional window, and the abandoned channels that may be missed are identified on the multi-view sedimentary profile according to abandoned channel plane morphology. Finally, the well points of the abandoned channels identified on the plane are reasonably combined according to the sedimentary origin to obtain the distribution of the abandoned channels on the plane.

As shown in Figure 4, well A9-31 has a similar log shape to well A9-32, corresponding to the bottom formations. The thickness of well A9-31 is thinner than that of Wells A9-32 and A9-33 on both sides. It is presumed that the channel boundary of a single phase is between A9-33 and well A9-31. The boundary line to well A9-32 is presumed to be abandoned channel deposit, and the abandoned channel is located on the concave bank of the point point on the plane. If the abandoned channel is on the same side and close to the single-stage channel boundary, the abandoned channel can be continuously combined. Well A9-D42 is in the single-stage channel boundary, but belongs to the off-surface reservoir, and is presumed to be the flood plain facies deposit.

With this method, 3 S-shaped and 7 crescent-shaped abandoned channels were identified in the study area (FIG. 5, FIG. 6). In the sand body of C layer composite river channel in the east of B area, the abandoned channels in the east and west are relatively continuous, and the abandoned channels in the west is characterized by high curvature meandering river, which is presumed to be a abrupt abandoned channel. The central and southern abandoned channels show crescent shape and discontinuous distribution, which is presumed to be gradual abandoned channels. Well A9-F38 is located on the concave bank of a continuous abandoned channel and is a breach fan deposit (FIG. 7).

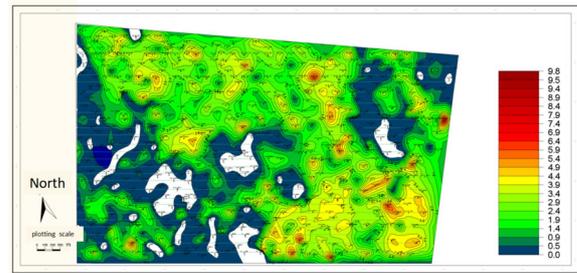


FIG. 2 Effective thickness contour map of C Layer sandstone in B area

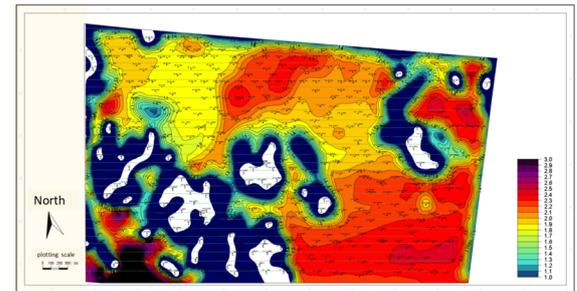


FIG. 3 Relative equal depth map of C layer sand top in B area

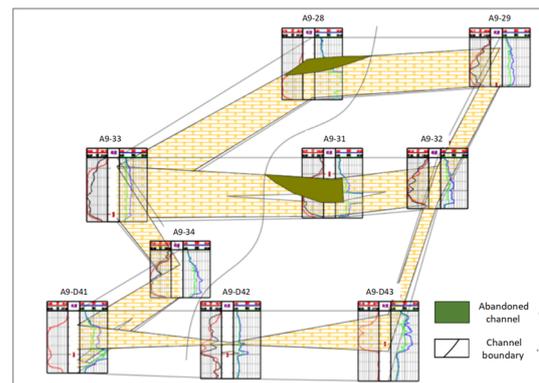


FIG. 4 Three-dimensional grid diagram of C layer in B area

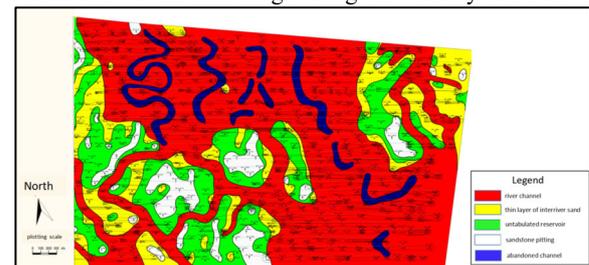


FIG. 5 Sedimentary facies zone of C layer in B area

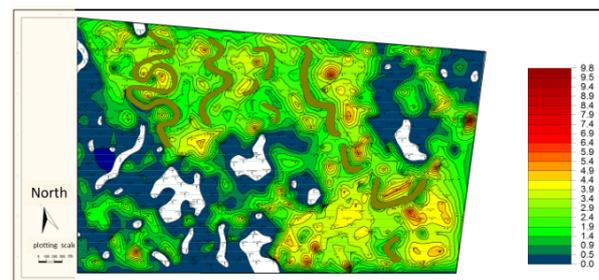


FIG. 6 Abandoned channel distribution in effective thickness contour map of C Layer sandstone in B area

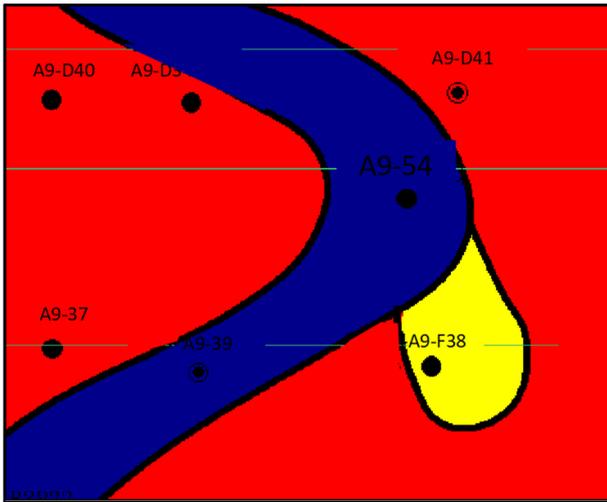


FIG. 7 Well A9-F38 breach fan deposition

4. Conclusions

Under the condition of dense well pattern, the research idea of effectively identifying abandoned channels based on logging data is as follows: guided by the modern meander river sedimentation model, and on the basis of fully analyzing the characteristics of various types of abandoned channels, the method of logging phase identification, effective sandstone thickness method, sand top relative depth method, three-dimensional window grid map and other methods are integrated to cut into and verify each other from multiple angles, and finally identify abandoned channels. Through the application of different methods, three S-type abandoned channels and seven crescent type abandoned channels were identified in the study area, and the western abandoned channels showed the characteristics of continuous and high curvature, so they should be abandoned abruptly. The central and southern abandoned channels show a crescent shape and discontinuous distribution.

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