Preliminary analysis of sedimentary characteristics and facies model of M-Ⅱ layer in Kazakhstan Oilfield A

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Abstract. The lithologic melange accumulation of areskum formation in akshabluk area is one of the key strata in exploration. Its basement inheritance controls the whole process of Jurassic sedimentation, and the filling and leveling gradually reduces the terrain elevation difference; After the late Jurassic deformation, the flat paleogeomorphology was changed and the deposition of Early Cretaceous strata was controlled. Under the control of marker beds, sedimentary cycles are divided according to the cycle characteristics of logging curves. Under the control of cycle interface (standard layer), according to the cyclicity of logging curve (GR), combined with core and seismic data, it is divided step by step according to the cycle level, from large to small, that is, it is divided step by step according to "oil bearing series → oil reservoir group → small layer → sedimentary unit", and a layered system is established. Vertically, M-I and M-II groups are developed from bottom to top. M-II group is divided into m-ii-1 and m-ii-2. M - II - 1 is subdivided into four sub layers: m - II - 1A, M - II - 1B, M - II - 1c and M - II - 1D. Based on the comprehensive analysis of sedimentary background and paleostructural characteristics, according to the sedimentary location and sedimentary environment of oilfield a, and referring to core data and seismic data, it is determined that oilfield a develops three sedimentary facies: alluvial fan facies, fluvial facies and lacustrine facies. According to the seismic attribute slice and logging data, predict the sandstone thickness contour map of each sedimentary unit, divide the single well logging facies, study and divide the sedimentary subfacies and sedimentary microfacies according to the sedimentary model.

Keywords: Ares Qom Formation,Sequence, Standard layer, sedimentary facies.

1. Introduction

Oilfield A was discovered in 1986. With the continuous deepening of oilfield development and the commissioning of new wells, in order to improve the development effect, the requirements for fine reservoir description have become higher and higher. The previous understanding can no longer meet the needs of current development and production. He started a deeper understanding of the reservoir, and put forward the idea of reconstructing the underground cognition system, and started a new round of detailed description of the reservoir. Among them, sequence division and sedimentary facies prediction are particularly important.

1. Geological background

Oilfield A is located in the south of Ake Chabrac syncline, measured in ares Kum Depression, which is the south of the South Turgai Basin on the northern edge of the North Turan platform. Mesozoic and Cenozoic sediments (from Lower Jurassic to Quaternary) are buried in Kum Basin, ares, which are mainly located on Proterozoic fold basement. The thickness of the platform structure complex of Early Tertiary in Cretaceous can reach 1600m, which forms the Kum Depression in ares and is buried in the Jurassic system complex structure. The succession of basement controlled the whole process of Jurassic sedimentation, and the relief elevation gradually decreased due to filling and filling. After the deformation in the late Jurassic, the flat paleogeomorphic shape was changed, and the deposition of the early Cretaceous strata was controlled (Figure 1).

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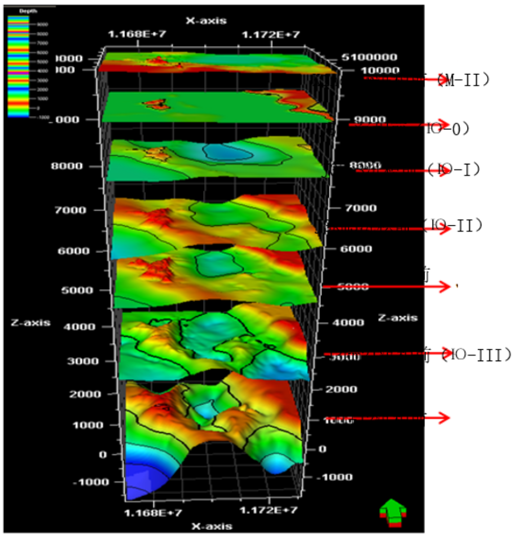

Fig. 1 Research results of paleogeomorphology

2. The establishment of the 2-layer sequence lattice

Based on the comprehensive analysis of sedimentary background and paleostructural characteristics, sedimentary cycles are divided according to the sedimentary location and sedimentary environment of oilfield a, core data and seismic data, and under the control of marker bed, according to the cycle characteristics of logging curve.

The unconformity surface at the top of Jurassic system → the cycle transition surface at the top of Qom, ares, is a normal cycle, and the lithology is alluvial fan sand body → mudstone deposit. With the continuous decline of the crust, alluvial fan facies reservoirs were deposited on the unconformity surface, and thick mudstone was deposited in the later period. On the basis of the division of third-order cycles, fourth-order cycles and fifth-order cycles are further divided (Figure 2). The top surface of ares Kum Formation (the top of M layer) is a cycle transition surface, which can be traced continuously on seismic profile and has obvious characteristics on logging curves, and can be used as a marker layer to control the division and correlation of sedimentary cycles in the study area.

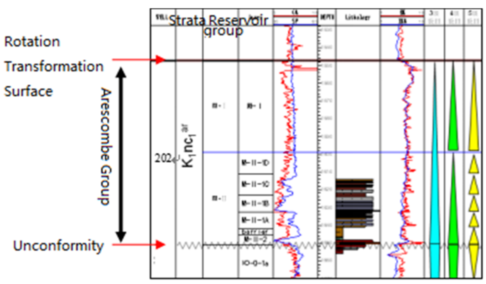

Fig. 2 A Division of sedimentary cycles of Kum Formation in ares Oilfield

2.1 Sequence interface features

2.1.1 Characteristics of primary marker layer

Seismic reflection characteristics and logging curve characteristics are obvious, which can be traced in the whole area, and control the division of oil-bearing strata (m, f) [1]. This time, three first-class marker beds that can guide stratigraphic division and correlation in the study area were identified, namely M top, f top and basement PZ.

The top marker layer of the M layer: the mudstone with a thickness of about 50m deposited above the Arescum Formation, the GR value is generally lower than that of the overlying mudstone, the overall resistivity is lower than that of the overlying mudstone, and the earthquake has strong amplitude and wave crest.

Top of level I marker layer m IO The top features are obvious, and the plane distribution in the study area is stable, which can control the division of M-series of oil-bearing series (Figure 3)

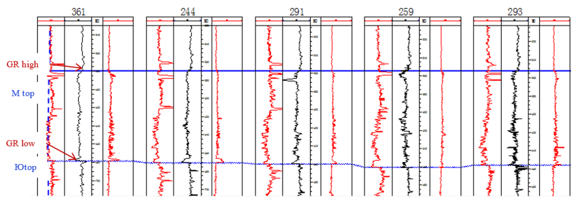

Fig. 3 Division of oil-bearing strata controlled by primary marker layer

2.1.2 Sub-layer division standard

The 176 well log curves (GR) cycle characteristics of A oilfield were analyzed, the log cycle characteristics were summarized, and the standard wells for the division of sedimentary units were selected.

Standard wells for sedimentary unit division of layer M: referring to the cyclical characteristics of the curve, layered standard wells are preferred. 228 and 251 wells are selected for the North dome of the middle block, 246 and 355 wells are selected for the South dome, 40 wells are selected for the east block and 38 wells are selected for the south block. The m-layer is divided into M-I and M-II groups, and the M-II group is divided into m-ii-1 and m-ii-2. M - II - 1 is subdivided into four sub layers: m - II - 1A, M - II - 1B, M - II - 1c and M - II - 1D.

3. Provenance and sedimentary facies

The alluvial fan is a fan-shaped accumulation formed by the sudden drop in the slope of the river after the river exits the mountain mouth and enters the plain [2]. It can be divided into three subfacies of fan root, fan middle and fan margin, including three sedimentary microfacies of channel sand, flood sand and mud (Figure 4). Akshabulak M-II is an alluvial fan deposition. The source of the sediments is adjacent to the southern highlands. In the larger mountain passes and valleys, the sediments are dominated by gravity flow, and the braided channel

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deposits of traction flow are developed on the fan surface[3].

3.1 Provenance characteristics

After the structural deformation and denudation at the end of Jurassic in the M layer of A Oilfield, the sedimentary paleogeomorphology has undergone tremendous changes [4].

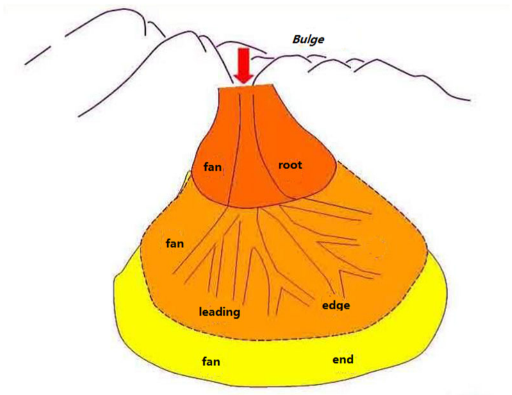

Fig. 4 Alluvial fan model

3.1.1 Petrological features

The petrological characteristics of the reservoir in the Middle East South Block of the study area are similar [5] [6]: the lithology is mainly lithic arkose and feldspathic debris, followed by lithic sandstone and arkose. The reservoir reflecting the deposition has undergone relatively long-distance transportation (Figure 5).

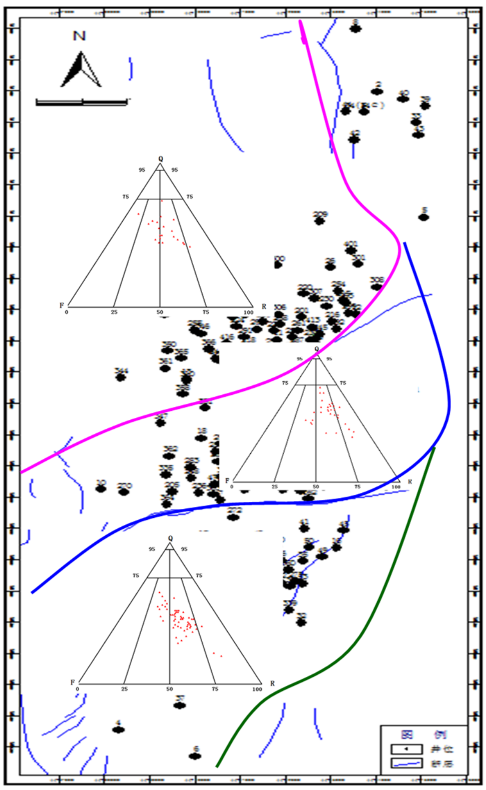

Fig. 5 Plane division of sandstone components in 5 M layer

3.1.2 Particle size characteristics

M-II-1 is mainly composed of fine sand and fine silt, rich in mud, and is a sediment in a weak hydrodynamic sedimentary environment. According to the statistical results of the channel sandstone particle size in the M-II-1 layer, the sandstone is mostly silt-fine sandstone, with few gravel grade and coarse sand components, and a small amount of medium sand components. Gravel, coarse sand and medium sand are generally not higher than 11%, with an average of 6.05%. It generally contains mud-grade components, ranging from 9.34 to 39.6, with an average of 18.37% (Figure 6).

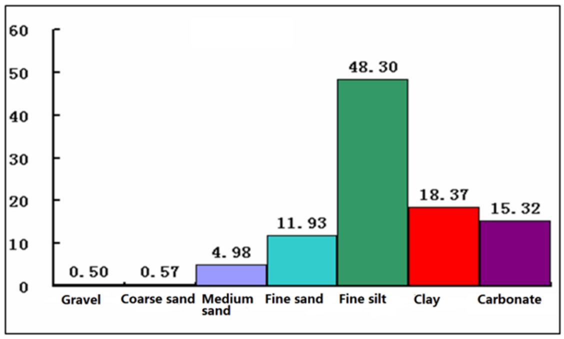

Fig. 6 Average Grain Size Distribution of Channel Sandstone in Layer M-II-1

M - II - 2 deposit is characterized by the mixed accumulation of gravel, sand and mudstone. The reservoir is poorly sorted and the sandy conglomerate is poorly rounded, which is angular and sub angular. Mudstone is reddish in color (Figure 7).

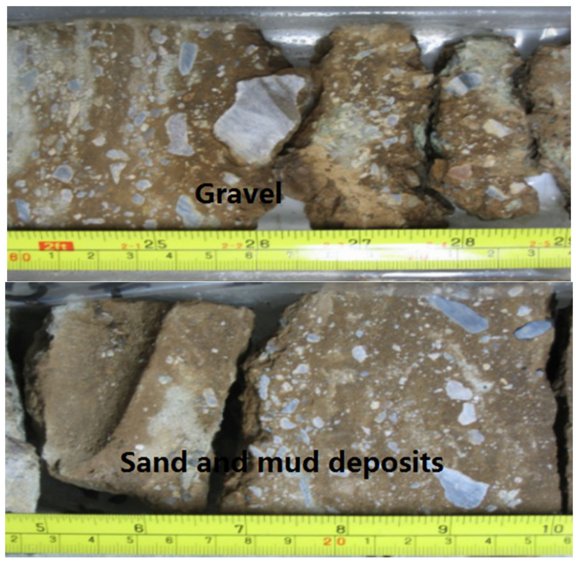

Fig. 7 Core Characteristics of M-II Layer in Well 36

3.1.3 Color characteristics of mudstone

The mudstones of the 5 units in the M-II layer are mainly brown and reddish brown. Reflecting that this period was dominated by terrestrial sediments.

3.2 Analysis of sedimentary facies

3.2.1 Sedimentary microfacies features

Layer m - II includes three sedimentary microfacies: channel sand, overflow sand and mud. The characteristics of each microfacies are as follows:

（1） Channel sand

Sedimentary characteristics of channel sand in m-ii-2 layer;

The M-II-2 layer is dominated by conglomerate sediments, with moderate to poor sorting, rounded and sub-edge to angular (Figure 8). The average sedimentary thickness of the middle and southern blocks is 6.5m. The logging curve is characterized by a bell-shaped or round-headed shape, and the resistivity curve has obvious positive cycle characteristics, low GR and high resistivity (Figure 9). Light gray to light brown glutenite. Among them, the east block M-II-2 is mainly composed of thick layers of coarse sand and conglomerate, with moderate to poor sorting, rounded and sub-angular. The deposition thickness is more than 35 m. The shape of the logging curve is mainly characterized by a thicker box shape.

Fig. 8 Core characteristics of 1652~1656m in Well 201

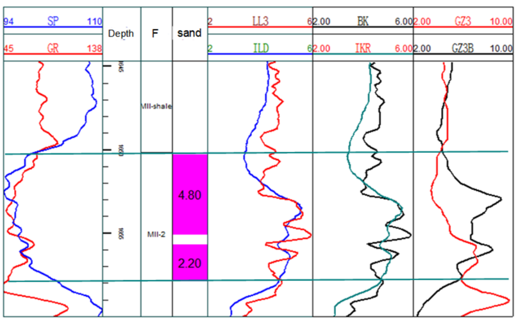

Fig. 9 Characteristics of Well M-II-2 Logging Curve in Well 201

Sedimentary characteristics of channel sand in layer M-II-1:

The channel sand deposition characteristics of the four units in the M-II-1 layer were further analyzed: among them, the M-II-1B unit had typical channel sand deposition characteristics. The channel sand has positive cycle characteristics: light gray-brown siltstone in the upper part; light gray-brown oil-bearing sandstone in the middle; and brown oil-bearing glutenite at the bottom. The log curve is box-shaped or bell-shaped, and the resistivity curve has obvious positive cycle characteristics, low GR and high resistivity (Figure 9).

Table 1 Characteristics of vertical deposition change of M layer

Sedimentary unit	Lacustrine facies	Alluvial fan	Mudstone color	Sandstone grain size	Sedimentary microfacies	Average thickness
M-I				Silt, Mud	River, Flood sand, Mud	1.4 m
M-II-1D			Red-brown, Purple-black	Fine sand, Silt	River, Flood sand, Mud	3.2 m
M-II-1C			Red brown, Dark brown	Fine sand, Silt	River, Flood sand, Mud	3.4 m
M-II-1B			Reddish brown	Fine sand, Silt few conglomerates	River, Flood sand	6.1 m
M-II-1A			Sepia	Fine sand, Silt few conglomerates	River, Flood sand, Mud	5.4 m
M-II-2			Puce	Conglomerate, Sandstone	River course	4.5 m
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Based on the analysis of the scale and particle size of channel sand bodies in each unit during the M-ii-1 sedimentary period, it is considered that from bottom to top, the sedimentary particle size gradually becomes smaller, the content of sandstone gradually decreases and the thickness of typical channel sand bodies in each layer becomes smaller. (Table 1). The environment gradually changed from the alluvial fan of M-II-2, M-II-1A and M-II-1B layers to the middle-fan margin deposit of M-II-1C and M-II-1D alluvial fans.

(2) Floating sand

It is mainly fine sandstone siltstone. SP and GR curves are serrated, with low and medium GR and sp. For example, three layers of fine sandstone siltstone with thickness of 0.7m, 0.9m and 1.2m are developed in well 202 (Figure 10).

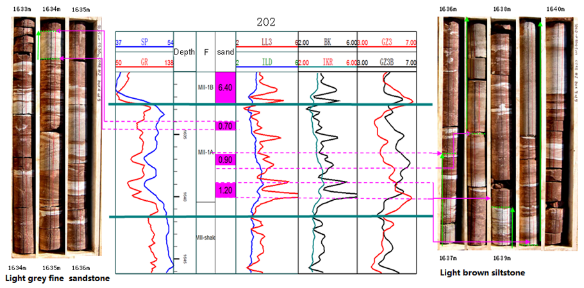


Fig. 10 Logging curve and core characteristics of Well 202

(3) Plaster

The mud developed in the M layer is mixed with thin layers of siltstone; the logging curve shows that the GR curve is high, and the SP curve is close to the baseline. Such as Well 201, 1644.1-1645m, light brown red mudstone; 1645-1646m, light brown red argillaceous siltstone; 1646-1648.8m, brown red mudstone, containing irregular thin layers of siltstone; 1648.8-1649.5m, light green to Grey-green mudstone.

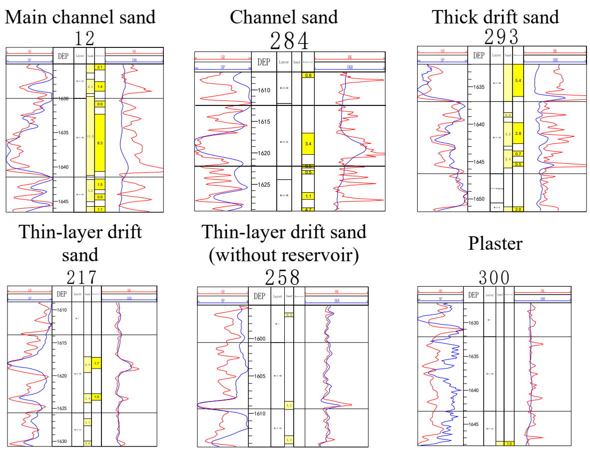


Fig. 11 Log facies model diagram of alluvial fan facies

Combined with the sedimentary environment, coring well, logging data and logging curve characteristics, through petroelectric analysis, the logging facies models of sedimentary microfacies of six logging facies of alluvial fan facies are established [7] [8] (Figure 11).

3.3 Plane phase description method

Single-well sedimentary facies discrimination: After the depositional environment is determined, the sedimentary microfacies types of each sedimentary unit are firstly discriminated according to the characteristics of the log curve shape and grain size (Fig. 11). If there are two types of facies in the same unit, the facies in this unit are dominated by the dominant facies type, and the order of the dominant facies is channel sand→flooding sand→mud.

Drawing of plane sedimentary facies map: judge the maximum possible distribution and combination mode of sand body according to the sedimentary environment and sedimentary mode of this unit, and infer and predict the reservoir according to the continuity, directionality and mutual configuration relationship of various sand bodies under this mode. The framework sand body of layer m - II mainly develops narrow channel sand body and large-area composite channel sand body [9]. The description method is as follows:

(1) Description of narrow channel sand body: this type of channel sand body is developed in the middle-edge position of alluvial fan, which is a channel sand body formed in weak hydrodynamic environment.

The width of the channel is narrow, ranging from 230 to 410 m. The cross section of the sand body is lenticular, and it is elongated along the provenance direction. The thickness of the channel sand body is about 3 m. Interchannel sand bodies with multiple periods of unstable horizons develop on both sides of the channel. When this type of channel is described, the sand bodies are reasonably combined according to the single well logging facies identification results and the sedimentary facies model. The M-II-1C and M-II-1D units developed this type of channel (Figure 12).

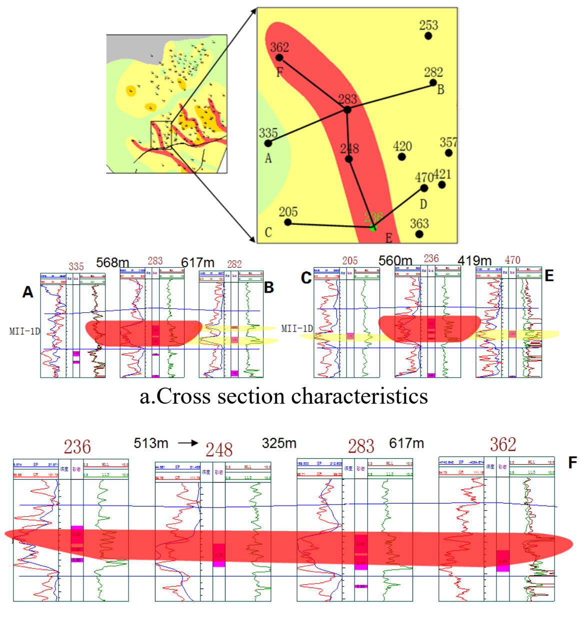
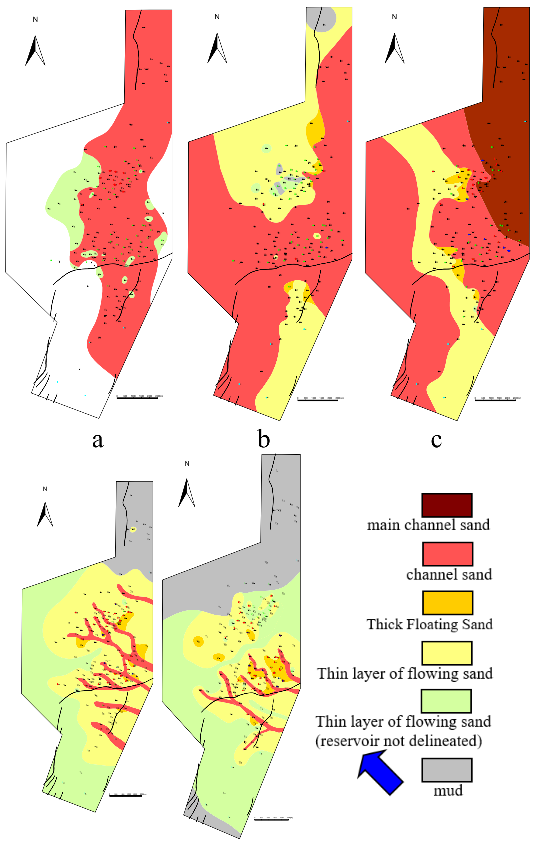


Fig. 12 M-II-1D Description and characteristics of narrow channel sand body

Description of large-area composite channel sand body: this type of channel is developed in the alluvial fan, which is a channel sand body formed under strong hydrodynamic environment. The width of channel sand body is large, more than 2000m; Overflow sand bodies are developed between channels. When depicting this type of sand body, the drawing direction of sand body is guided by the trend of sandstone thickness and sand ground ratio, and the location of large-area channel sand body and inter river sand body is drawn according to the sedimentary model based on the identification of well point logging facies. According to the curve shape and thickness of channel sand body, it is divided into main channel sand and non main channel sand (Figure 13).

4. Reservoir plane facies characteristics

According to the sedimentary model of alluvial fan facies, the distribution of sand bodies is described mainly by logging data. A plan view of the deposited microphases for each layer is drawn (Figure 18). M-II-2, M-II-1A, M-II-1B developed at the root of the partial fan in the alluvial fan, and mainly developed a large area of composite channel sand; M-II-1C, M-II-1D developed alluvial fan At the mid-fan-fan edge, narrow channel and flood sand deposits are mainly developed.



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a.M-II-2 sedimentary phase diagram
b.M-II-1A sedimentary phase diagram
c.M-II-1B sedimentary phase diagram
d.M-II-1C sedimentary phase diagram
e.M-II-1D sedimentary facies diagram

Fig. 13 The depositional phase diagram of M-II layer

The sedimentary characteristics of each unit are as follows:

(1) Plane characteristics of sedimentary facies in M-ii-2 unit

The M-Ⅱ-2 layer is located in the middle of the alluvial fan when it is deposited. Channel sands with a wide width from south to north are developed, with a channel width of more than 2900m and an average thickness of 4.5m (Figure 14).

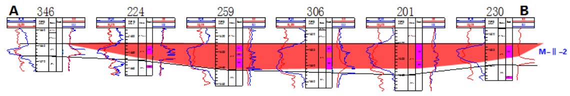

Fig. 14 Section Characteristics of Unit M-II-2

(2) Plane characteristics of sedimentary facies of layer m - II - 1A

M-Ⅱ-1A layer was located in the middle of alluvial fan when it was deposited. There are two rivers from south to north, with a width of about 1700m, which meet at the south dome. The average thickness of river sand is 5.4m (Figure 15).

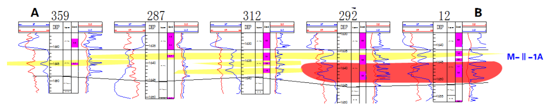

Fig. 15 M-II-1A Layer Profile Characteristics

(3) Plane characteristics of sedimentary facies of M-II-1B layer

M - Ⅱ - 1B layer was developed in the middle fan edge of alluvial fan during deposition. Two river channels are developed from the south to the north, the width of river channel 1 (left) is 3000m, and the average thickness of channel sand is 4.2m; The widest part of channel 2 (right side) is 3602 ~ 6344m, and the average thickness of channel sand is 6.1m. Close to the east of the work area, the main part of channel sand is developed, and the average thickness of channel sand is 8.7m (Figure 16).

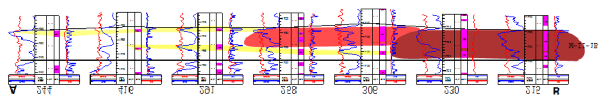

Fig. 16 M-II-1B Layer Profile Characteristics

(4) Plane characteristics of sedimentary facies in M-ii-1C layer

The M-Ⅱ-1C layer was developed in the middle-fan edge of the alluvial fan when it was deposited. Developed from the alluvial fan mid-fan edge channel and flood sand deposits in the southeast direction. The channel width is 231m~980m, and the average thickness of the channel sand is 3.4m (Figure 17).

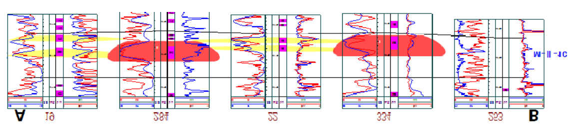

Fig. 17 M-II-1C Layer Profile Characteristics

(5) Plane features of sedimentary facies of M-II-1D layer

M - Ⅱ - 1D layer is developed in the middle fan edge of alluvial fan during deposition. The river channel and overflow sand from the middle fan edge of the alluvial fan in the southeast direction are developed. The river is 191m ~ 320m wide and the average thickness of river sand is 3.5m 2m。 The alluvial fan end overflow sand developed between the north and South domes in the middle is not connected due to the later water body transformation (Figure 18).

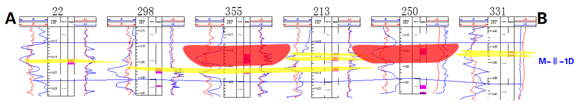

Fig. 18 M-II-1D Layer Profile Characteristics

5. Conclusions

On the basis of comprehensive analysis of the sedimentary background and paleo-structural characteristics, the core data, logging curve data and seismic data were used to study the reservoir sedimentary facies and oil (gas) water distribution characteristics, and the following understandings were obtained:

1) The sequence framework system of Akshabulak Oilfield was established, which unified the stratification boundaries of oilfield sedimentary units;

2) Three sedimentary facies models of alluvial fan facies, fluvial facies and lacustrine facies were determined, and logging facies models of each sedimentary microfacies were established;

3) Predict the distribution characteristics of sand bodies, draw sedimentary facies map, and give the vertical sequence and sedimentary facies evolution characteristics.

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