

Sedimentary Characteristics of Denglouku third member in the south of Shuangcheng area, Songliao Basin

Yuefeng Du^{1, a}, Wenwen Yan^{2, b}, Xu Tong^{2, c}, Zhao Jun^{2, d}, Huinan Liu^{1, e},
Sihan Li^{2, f}, Tingting Li^{1, *}

¹School of Geosciences, Northeast Petroleum University, Daqing, China

²Tenth Oil Production Plant of Daqing Oilfield, Daqing, China

*Corresponding author e-mail: litingting@nepu.edu.cn

Abstract. Based on sedimentary theory and high-resolution sequence stratigraphic theory, Denglouku third member in the south of Shuangcheng area is finely divided into a long-term reference surface cycle, 3 medium-term reference surface cycles and 20 short-term reference surface cycles. Denglouku third member is divided into three sand groups from top to bottom according to the medium-term reference surface cycles, and 6 layers, 6 layers, 8 layers in the groups respectively. Through fine observation of rock cores and data analysis of nearly one hundred wells, it is believed that alluvial fan facies, fluvial facies and delta facies are developed in the study area, which can be further divided into 6 subfacies and 12 microfacies. After the analysis to the plane distribution and vertical evolution characteristics of sedimentary facies, it is found that Denglouku third member in the south of Shuangcheng area shows a water-transgression sedimentary cycle from bottom to top which reflects the sedimentary process of water body gradually deepening.

Keywords: Sedimentary characteristics, Denglouku third member, Songliao Basin.

1. Introduction

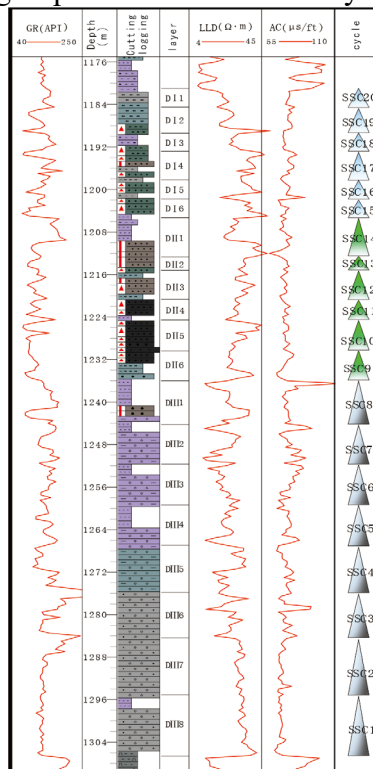
The exploration degree of Songliao Basin is very uneven. The main exploration area represented by Daqing Changyuan has entered the late development stage, petroliferous exploration is becoming more and more difficult. The small fault depression groups and deep strata around the basin are still in the petroliferous primary exploration stage [1]. The reservoir of Denglouku Formation in Shuangcheng area is small, fast changing and deep buried, high-yield industrial oil flow was not obtained until 2018 for the deep exploration well X2 in the south of Shuangcheng depression [2, 3]. The previous studies in Shuangcheng area mainly focused on hydrocarbon source rock analysis [4, 5], study of accumulation characteristics [6, 7]. There was no systematic study on sedimentary system of Denglouku Formation. In this paper, a unified and overall fine correlation was carried out in the study area, and the high-resolution sequence framework of Denglouku third member formation was established. The distribution characteristics of sedimentary microfacies were clarified, which provided a solid and powerful basis for the identification of single sand body, the study of single reservoir heterogeneity, the tapping of remaining oil, and the adjustment of development program in Denglouku third member formation of southern Shuangcheng area.

2. Overview of the study area

South of Shuangcheng area is located in the south of Shuangcheng depression in the southeast fault depression area of northern Songliao basin. Denglouku formation, the main oil-bearing strata, was deposited in the stage of fault-depression transition in Songliao basin. The depression entered a large stable settlement on the basis of the fault depression. Several NNE-trending depression-controlling faults were developed in the area. The sedimentary thickness in the central area of the depression was large and gradually decreased eastward. The depression rose and denuded after the lakeshore deposition of the second member of Denglouku, so the strata of the first and second members of Denglouku were generally absent in the study area, and then subsided again at the

3. Stratigraphic division and comparison in Denglouku third member

According to the above method, Denglouku third member strata in the study area were divided into 1 long-term reference surface cycle, 3 medium-term reference surface cycles and 20 short-term cycles. According to the middle reference surface cycle, Denglouku reservoir can be divided into three sand groups from top to bottom. I sand group can be further divided into 6 layers, II sand group was divided into 6 layers, III sand group was divided into 8 layers. As show in Fig. 1.



4. Sedimentary facies type, characteristics and logging facies mode establishment

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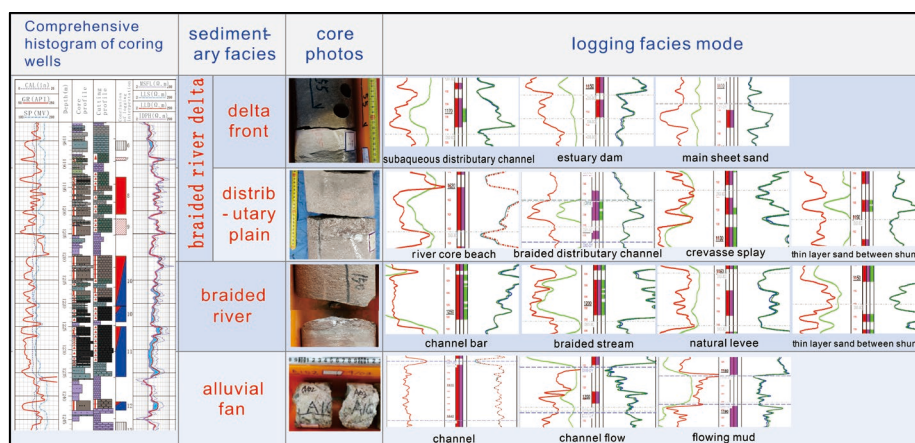


Figure 2. Sedimentation pattern map of the study area.

4.1 Alluvial fan facies

The lithology of this facies in the study area is mainly purplish-gray conglomerate, particle support, argillaceous cementation, overall sorting grinding round difference, massive structure, the overall performance of normal grain order change characteristics, the composition of gravel is mainly rhyolite, andesite, particle size in 10 mm-30 mm. Based on the above rock core characteristics and referring to the curve shape, the alluvial fan facies were further divided into two subfacies of fan end and fan middle, and three microfacies of debris flow, river channel and overcurrent deposition. The logging curves of debris flow and river channel deposition have high amplitude, and are mainly box-shaped. Logging curve amplitude of diffuse sedimentary is low, mainly finger shape.

4.2 fluvial facies

The fluvial facies in the study area is mainly composed of purple-red massive mudstone deposits. The distribution of calcareous nodules is massive and layered, and the dripping acid is strongly foaming, which is the product of strong evaporation environment, the purple-grey silty mudstone is contained in the mudstone, and the logging curve is finger-shaped or linear. The river channel is gray-brown oil-immersed siltstone-fine sandstone, which is a positive cycle deposition, develops interlaced bedding, and develops strong erosion surface at the bottom, the logging curve is mainly bell-shaped and box-shaped. According to the above rock core characteristics and referring to the logging curve shape, it can be divided into two subfacies types of riverbed subfacies and dike subfacies, and three microfacies types of river channel deposition, crevasse channel deposition and inter-channel argillaceous deposition.

4.3 Delta facies

It can be divided into two subfacies types of delta distributary plain and delta front, and six microfacies types of (underwater) distributary channel, (underwater) interdistributary mud, overbank sand and sheet sand. Among them, the delta distributary plain subfacies interdistributary to shallow purple red massive mudstone deposition, occasionally variegated mudstone, development of biological disturbance structure and wormhole. The river channel is gray-brown oil-immersed fine-siltstone, developed interlaced bedding, and the bottom scour is strong, The logging curve is bell-box type. delta front subfacies interdistributary to gray, gray green mudstone, layered distribution, development of horizontal bedding and deformation laminating bedding. The channel is gray-brown oil-immersed fine siltstone with small cross bedding, and the bottom erosion is strong, The logging curve is mainly bell-shaped.

5. Sedimentary facies distribution characteristics

Based on the study of rock core facies types and logging microfacies model, the plane distribution map of sedimentary facies in the study area was drawn by logging microfacies identification of nearly 100 wells drilled. As show in Fig. 3.

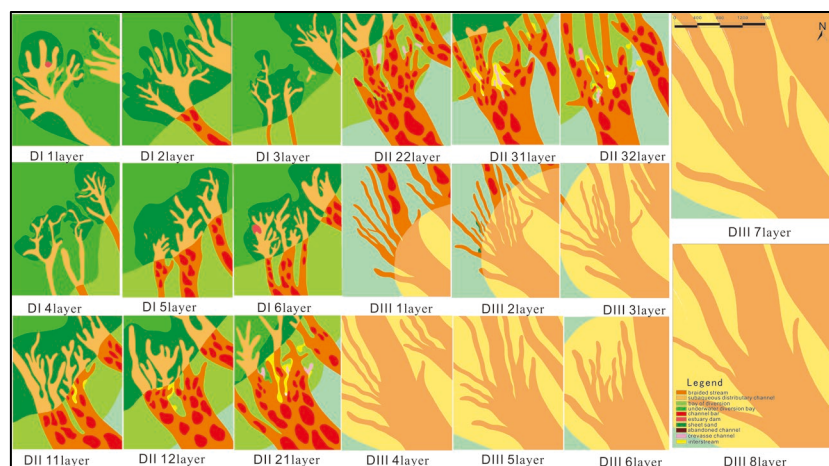


Figure 3. Depositional facies-belt chart.

The DI sand group is the delta front subfacies of oxidized shallow sandy braided river. Taking the DI2 layer as an example, the southeast of the DI 2 layer is the delta front subfacies mainly derived from the braided distributary channel with the width of 1500 ~ 2000 m in the southeast, and the development zone in the northeast is the delta front subfacies mainly derived from the underwater braided channel with the width of 300 ~ 900 m and thin sand, which is 2 main and 16 branch underwater braided channels.

The DII sand group is the oxidized shallow water sandy braided river delta plain subfacies. Taking the DII22 layer as an example, the southeast of the DII22 layer is the delta plain subfacies mainly composed of braided distributary channels with the width of 1500 ~ 2000 m from the southeast, and the development zone in the northeast is mainly composed of branch braided channels with the width of 300 ~ 1000 m and thin sand, which are bifurcated into the flood plain northwest, and are 2 main 19 branch channels.

6. Vertical evolution characteristics of sedimentary system

Denglouku third member formation from bottom to top, gradually transition from alluvial fan facies to braided river–braided river delta plain subfacies–shallow water braided river delta front subfacies–shallow water oxidation lake facies.

Taking well X1 as an example, through the observation of its rock core, it can be seen that DI1-5 layer is mainly composed of gray-green siltstone and fine sandstone with dark purple mudstone, Sandstone is dominated by medium plate and groove cross bedding, Mudstone is mostly horizontal wave and massive structure, On the whole, the formation is mainly 0.5-2 m sand-mud thin interbed, and the bottom is slightly unsmooth erosion surface. It belongs to underwater braided channel microfacies. Purple mudstone can be seen on the rock core of DII11 layer, showing massive structure, about 5 m thick, belonging to interdistributary microfacies. DII12-DII22 is mainly composed of purple fine-medium sand (pebbled) 2-5 m superimposed thick sand, which is a large plate and groove cross bedding. At the bottom, a typical unsmooth scour surface is visible, belonging to the braided distributary channel microfacies. As show in Fig. 4.

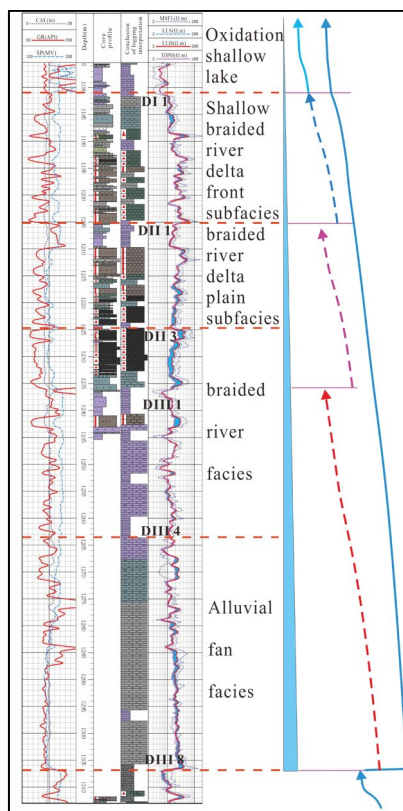


Figure 4. Vertical sedimentary evolution diagram.

7. Conclusion

The high resolution isochronous stratigraphic framework of 20 sedimentary units in 17 layers of Dengloulou Formation 3 sand group in south of the Shuangcheng area was established for the first time. Three sedimentary facies types, braided river facies, shallow braided river delta facies and alluvial fan facies, were identified in Dengloulou Formation in the south of Shuangcheng area, and further divided into 6 subfacies and 12 microfacies.

In the plane of Dengloulou Formation in south of the Shuangcheng area, the river channel is distributed in the direction of southeast-northwest, the southeast is dominated by braided distributary channel, and the northeast is dominated by branched braided channel and thin sand. The main sand body is banded along the source direction and extends long. Vertically, it gradually transits from alluvial fan facies to braided river facies—braided river delta plain subfacies—shallow water braided river delta front subfacies—shallow water oxidation lacustrine facies.

Acknowledgments

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