

Study on Sedimentary Microfacies of X Section of Jiufotang Formation in Block A

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Abstract: Block A is located in the Mesozoic half-graben faulted basin, and the Lower Cretaceous Jiufotang Formation constitutes the main oil-bearing series. Years of exploration and development practice shows that sedimentary microfacies are the key factors controlling the spatial configuration and reservoir performance of reservoir sand bodies. Therefore, based on the results of core observation, logging response and logging interpretation, this paper carried out a systematic study on the sedimentary microfacies of Jiufotang Formation in Block A. The results of the study show that the X section of the Jiufotang Formation in the A block mainly identifies two types of sedimentary facies : fan delta and lake, which are subdivided into four sedimentary microfacies : underwater distributary channel, sheet sand, underwater interdistributary bay and lacustrine mud. Restricted by the differential activity of boundary faults, the sedimentary system shows obvious zoning-the nearshore subaqueous fan-fan delta system is developed in the steep slope zone, the gentle slope zone is the fan delta front deposit, and the center of the sag accumulates semi-deep lake-deep lake mudstone and clamps turbidite sand body. Comprehensive evaluation shows that underwater distributary channel and interdistributary microfacies are the optimal reservoir facies belts in the study area. The above results can lay a geological foundation for fine reservoir prediction and remaining oil potential tapping in Block A.

Keywords: Jiufotang Group; Sedimentary Microfacies; Delta Deposition.

1. Introduction

The Mesozoic fault basin group in the southwestern margin of the Songliao Basin is composed of several secondary half graben fault depressions, and Block A is located in one of the first-order depressions. The Lower Cretaceous Jiufotang Formation, as the main strata in the rifting period, has the dual attributes of source rock and reservoir, and is the core target layer for oil and gas exploration and development in this area. After several rounds of exploration, many wells have been drilled in the area, and good oil and gas shows are generally seen in the Jiufotang Formation. However, the overall exploration degree of the block is low, the distribution of well patterns is uneven, the lateral variation of sand bodies is fast, and the reservoir heterogeneity is strong, which has become a key bottleneck restricting the efficient development of oil and gas. The sedimentary system in the faulted lake basin is controlled by the boundary fault activity, paleogeomorphology and provenance supply, resulting in significant differences in thickness, physical properties and connectivity of sand bodies in different sedimentary microfacies. The spatial distribution of favorable reservoir sand bodies is strictly controlled by sedimentary microfacies. [1,2]

Taking the fine description of the sedimentary microfacies of Jiufotang Formation in Block A as the core, the types of sedimentary facies, subfacies and microfacies are systematically determined, the electrical response characteristics and spatial distribution rules of different microfacies are revealed, and the sedimentary evolution model suitable for the geological background of this area is constructed. The research results can provide a solid geological basis for the fine anatomy of reservoir architecture, the prediction of favorable reservoir facies belt and the optimal deployment of development wells. At the same time,

it has important reference significance for the sedimentary research of similar fault depression blocks. [3, 4]

2. Sedimentary Characteristics

2.1. Sedimentary Microfacies Characteristics

The X section of A1 well is selected to carry out single well facies analysis. The lower section is dominated by semi-deep lake-deep lake mud; the upper section of the water body fluctuates frequently, and the sheet sand is interbedded with the underwater distributary channel and the interdistributary bay. Multiple sets of ' sand-mud ' cycles are developed vertically, reflecting the lake level rise and fall and the change of provenance supply.

The well profile shows that from A1 to A3, it is a transition from near source to far source, shallow water to deep water. Well A1 is dominated by underwater distributary channels, GR and SP are toothed box / bell-shaped, with large sand body thickness and coarse grain size, sandwiched by thin layers of interdistributary bays, representing the high-energy environment of delta front. Wells A2 and A3 are dominated by semi-deep lake argillaceous deposits, and GR and SP are low and straight, reflecting a quiet reducing environment. The thin sheet sand is the distal redistribution product of the front sand after lake water transformation. Horizontal comparison shows that the A1 multi-stage channel sand is rapidly pinched out in the direction of the lake basin, and the semi-deep lake facies is expanded from the interlayer to the absolute main body, and the sheet sand is horizontally stable but thin. The provenance comes from the A1 direction, and the sedimentary system is characterized by front advance. The differentiation of this facies belt is of great significance to oil and gas exploration : the channel sand of well A1 is a high-quality reservoir, which can form lithologic traps; the semi-deep lacustrine mudstones in Wells A2 and A3 can be used as

regional cap rocks and source rocks to form a good reservoir-cap assemblage.[5]

The lake basin of the X section of the Jiufotang Formation continues to evolve and the lake level fluctuates. Four microfacies of underwater distributary channel, interdistributary bay, sheet sand and semi-deep lake facies are developed. The underwater distributary channel is banded from land to lake, forming a leaf-like sand body skeleton. The interdistributary bay is filled between the river channels, the sheet sand is draped on the outer edge of the lobed body, and the semi-deep lake facies is distributed in the outermost periphery, which is in the finger-lobe shape advancing towards the lake basin as a whole.

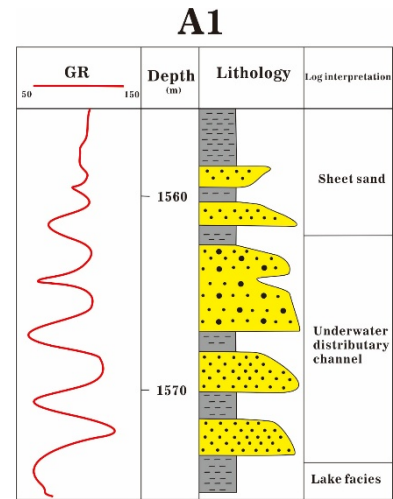


Figure 1. Single well sedimentary facies diagram of A1 well

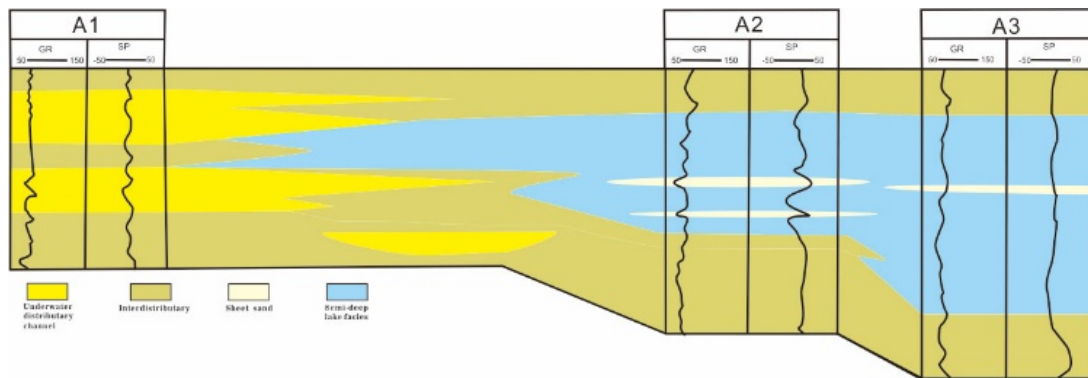


Figure 2. The cross section of A1-A3 wells

During the sedimentary period of the X section, the boundary fault activity was strong and the sedimentation rate was large. The coupling of the source supply dominated by river action and the hydrodynamic force of the lake basin (lake water jacking) : after the strong river power carries debris into the lake, the flow velocity slows down and the water flow bifurcates due to the lake water jacking, forming the bifurcated channel and the leaf-like sand body distribution, while the relatively weak lake wave transformation makes the sheet sand distributed in a narrow ring edge, reflecting the sedimentary characteristics of the river-controlled delta front.

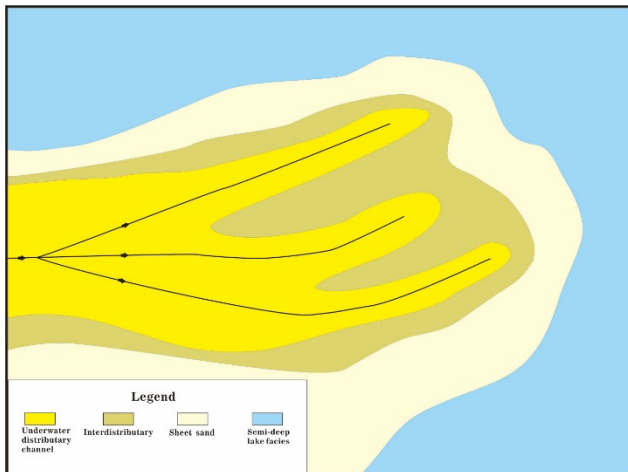


Figure 3. X section sedimentary microfacies plane diagram

2.2. Analysis of Main Controlling Factors of Deposition

The deposition of Jiufotang Formation in Block A is mainly controlled by three factors. First, the syndepositional boundary fault activity controls the paleogeomorphology of the basin. The west steep and east gentle pattern determines the type of sedimentary system. The steep slope develops nearshore subaqueous fan, and the gentle slope develops fan delta. The change of fault subsidence rate controls the change of water depth in lake basin. Second, the source supply conditions, the western near-source coarse debris, the eastern far-source relatively fine debris, source supply strength control sand body size. Third, the lake level changes, controlling the migration of sedimentary facies, the lake mudstone expands during the lake level rising period, and the fan body retreats to the land; during the decline period of the lake level, the fan delta progradated towards the lake basin, and the sand body advanced towards the depression.[4,6]

3. Depositional Model

The eastern part of the block belongs to the fault depression gentle slope zone, the terrain slope is gentle, the clastic material is transported over a long distance, and a large-scale fan delta sedimentary system is developed. The fan delta front subfacies is the main body, and the plain subfacies is not developed. The underwater distributary channel, as a skeleton sand body, advances to the center of the lake basin in a leafy shape, and the channel sand bodies are superimposed in multiple stages to form a thick composite sand body. The

mouth bar is developed at the front end of the river channel, and the mudstone between the two sides and the river channel is the interdistributary bay, which forms the sheet sand after the transformation of the lake wave. The fan delta front sand body has a large distribution range and is the most important reservoir development facies belt in Block A.[7]

The sedimentary model reveals that the favorable reservoir sand bodies in Block A mainly come from the underwater distributary channel and estuary dam microfacies of the eastern gentle slope fan delta front. The physical properties of braided channel sand bodies in the nearshore subaqueous fan of the western steep slope change greatly, and there are local favorable reservoirs. The thin turbidite sand body in the sag is small in scale, but it is surrounded by source rocks and has the exploration potential of lithologic oil and gas reservoirs.[8]

4. Conclusion

(1) Block A is a western steep and eastern gentle half graben-like fault depression, which is controlled by concave faults. The paleogeomorphology is divided into western steep slope zone, central sag zone and eastern gentle slope zone. The west is the main source system.

(2) Two sedimentary facies of fan delta and lake are identified in Jiufotang Formation of Block A, which mainly develop sedimentary microfacies such as underwater distributary channel, sheet sand, interdistributary bay and lacustrine mud. The eastern gentle slope is dominated by fan delta front; nearshore subaqueous fan developed in the western steep slope; semi-deep lake deep lake facies and slump turbidite sand bodies are developed in the central sag.

(3) Sedimentary microfacies control the spatial distribution of sand bodies and reservoir heterogeneity. The follow-up development should focus on the favorable facies belt of fan delta front to carry out reservoir prediction, and take into account the exploration of turbidite lithologic traps in the sag

zone.

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