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Study on the Fine Configuration of Reservoir in River Facies Oilfield in Bohai Sea Area

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Abstract

The geological conditions of offshore shallow water delta oil reservoirs were complex, with limited well data and large well spacing. Taking A Oilfield in the Bohai Sea Area, China as an example, the target sand body was formed in a shallow water delta sedimentary environment, with well-developed underwater distributary channels and frequent branching and diversion. The reservoir was strong non-uniformity and uneven plane water cut pressure. To this end, based on the existing work of predecessors, combined with seismic, logging, and production dynamics data, and based on the genesis mechanism of shallow water delta reservoirs, the boundary of composite river channels was identified through seismic facies, and logging facies were used to subdivide them into single river levels within the composite river channels. Then, seismic waveform characteristics were applied to track and characterize the plane distribution of single river channels, guiding the efficient development of offshore shallow water delta oil fields and achieving increased storage and production in Bohai Oilfield, China.

Keywords

Shallow Water Delta, Reservoir Configuration, Seismic Facies, Single Channel, Dominant Channel

1. Introduction

The Bozhong A Oilfield is located in the Bohai Sea area, which belongs to the sea area of the Bohai Bay Basin in terms of regional structure. Rich oil geological re-serves have been obtained in the fluvial sandstone of the Neogene Minghuazhen Formation, making it one of the main exploration and development layers for increasing reserves and production in the Bohai Oilfield. However, the geological conditions of the complex river facies oilfield in the Neogene Minghuazhen Formation of the Bohai Oilfield are complex. Under the control of rivers, sand bodies are mostly distributed in narrow strips, bands, and branches on the plane, with large horizontal variations and complex oil-gas-water relationships [1]. The study of the fine reservoir configuration of such reservoirs has always constrained the efficient development of the oilfield [2].

Scholars have conducted corresponding fine reservoir configuration studies on the geological conditions of river facies reservoirs with diverse internal structures and complex reservoir distribution patterns of sand bodies. This is of great significance for tapping the remaining oil potential and improving oil and gas recovery in high water cut and tertiary oil recovery stages of oil fields [3]. However, for offshore oil fields with high investment and risk, there are few research methods for reservoir configuration rules under large well spacing conditions, This seriously restricts the comprehensive adjustment and efficient development of offshore oil fields [4] [5]. This article finely dissects the internal configuration of shallow water deltas by depicting the filling and evolution periods of underwater distributary channels, providing strong support for solving the prominent contradictions in the production of the sand body and the comprehensive adjustment of the oilfield in the later stage.

2. Geological Setting

The oilfield is located on the southern slope of the Huanghekou depression in the southern Bohai Sea, adjacent to the Huanghekou oil generation depression, and has good conditions for oil and gas accumulation and accumulation [6]. The strata revealed by oilfield drilling are the Quaternary Plain Formation, the Neogene Minghuazhen Formation, the Guantao Formation, and the Paleogene Dongying Formation and Shahejie Formation from top to bottom [7]. The main oil bearing strata in the oilfield are developed in the lower section of the Minghuazhen Formation and Guantao Formation of the Neogene, followed by the Dongying Formation and Shahejie Formation. The sand body in the lower section of the Minghuazhen Formation in the oilfield is a shallow water delta distributary channel sand body, with the main driving force of sedimentation being traction and drainage. The wave action of lake water is weak, and the sedimentary microfacies are mainly distributary channel sedimentation [8]. The mouth and far sand bars are relatively undeveloped, and the source direction mainly comes from the southwest direction. Research suggests that the lower section of the Minghua Town Formation is formed by filling multiple underwater distributary channels.The underwater distributary channels frequently migrate laterally on the plane and overlap vertically. Although the distribution range of sand bodies is wide, there are differences in lateral connectivity. The reservoir in the lower Ming section is mainly composed of medium to fine-grained lithic feldspar sandstone, with low maturity in rock composition and good particle selection, presenting a sub angular to sub circular shape. The rock pores are well-developed and have good connectivity, mainly intergranular pores. The reservoir has reservoir physical characteristics of medium to high porosity and permeability.

3. Research on Reservoir Configuration

The lower section of the Neogene Minghuazhen Formation in the Bohai Sea is a set of shallow lake basin sand mudstone interbedded sediments, with a relatively low sand to land ratio overall [9]. The sand body can be well identified during earthquakes. In the target layer of the oilfield, seismic data has good continuity in the same phase axis, high signal-to-noise ratio and resolution, and clear faults. During the implementation of development wells, the predicted elevation depth of the target layer encountered by each well using seismic attributes is generally less than 3 meters compared to the actual drilling error, indicating good seismic data quality [10]. Therefore, tracking reservoirs through seismic attribute data can effectively characterize the stacking relationship of sand bodies and delineate the boundary of distributary channels. The author takes the main sand body of the first small layer of the second oil group in the Minghuazhen Formation of the Bozhong A Oilfield as an example to elaborate in detail on the reservoir configuration research method used in this study.

3.1. Identification and Characterization of Composite River Channels

This configuration study mainly uses seismic inversion data, taking the S sand body as an example, and summarizes five seismic contact styles for identifying river channels through the corresponding relationship between seismic facies and river channel morphology (**Figure 1**).

1) Separated underwater distributary channel: On the profile, it appears that two channels do not intersect, but the evolutionary order of the two channels cannot be determined;

2) Cutting and separating underwater distributary channels: The seismic facies profile features the left channel being cut by the later right channel, but the two channels are not connected, with a thick mudstone layer in the middle;

3) Unidirectional natural embankment connected underwater distributary channel: On the profile, it is shown that the left channel has developed a natural embankment, and the two channels are connected through this natural embankment;

4) A bidirectional natural embankment connected underwater distributary channel: On the profile, it is shown that both channels have developed natural embankments, and the natural embankments are connected together;

5) Cutting and contact underwater distributary channels: The profile shows that the left channel is cut by the later right channel, and mudstone interlayers are developed between the two channels.

On the seismic profile along the river channel, the river channel exhibits obvious features of flat top and convex bottom, while on the logging facies, it presents a positive rhythmic binary structural feature. By combining well and

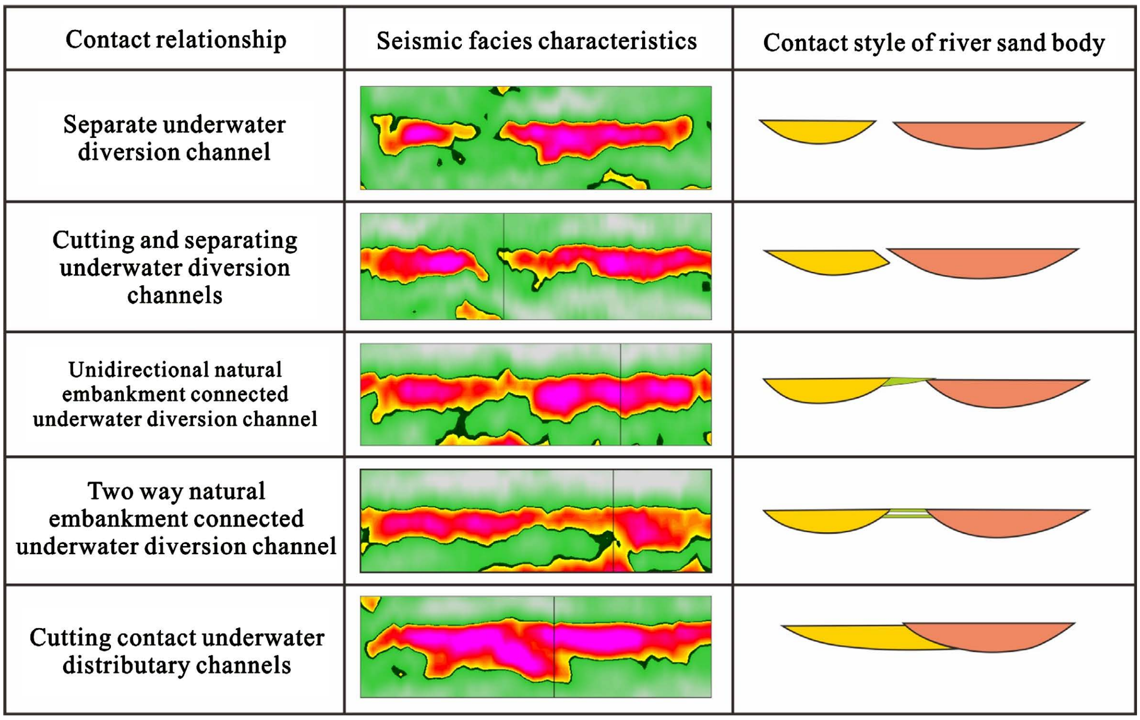

Figure 1. Channel recognition pattern of seismic facies.

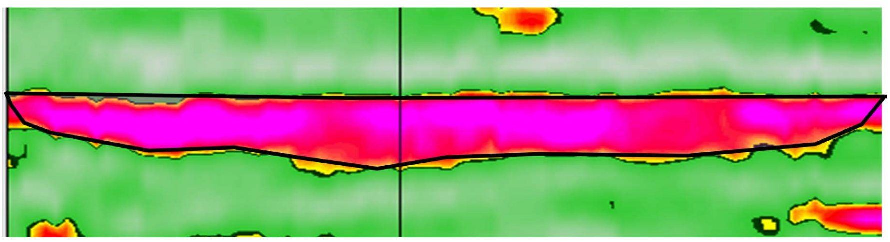

Figure 2. Reservoir section along the direction of the main channel.

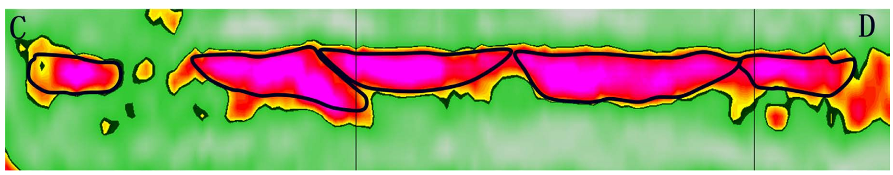

Figure 3. Cross-sectional view of the river reservoir direction.

seismic data, the boundary of the composite river channel can be effectively distinguished (**Figure 2**). Cross cutting the direction of the river channel, the boundaries of each river channel are clear, and the overlapping relationship is also very obvious, and even the evolutionary sequence of the river channel can be distinguished (**Figure 3**).

Based on the seismic facies identification template mentioned above, combined with the characteristics of logging facies, interpretation and tracking were carried out on the seismic profile, and the planar distribution pattern of the composite river channel of the target sand body was finally characterized (**Figure 4**).

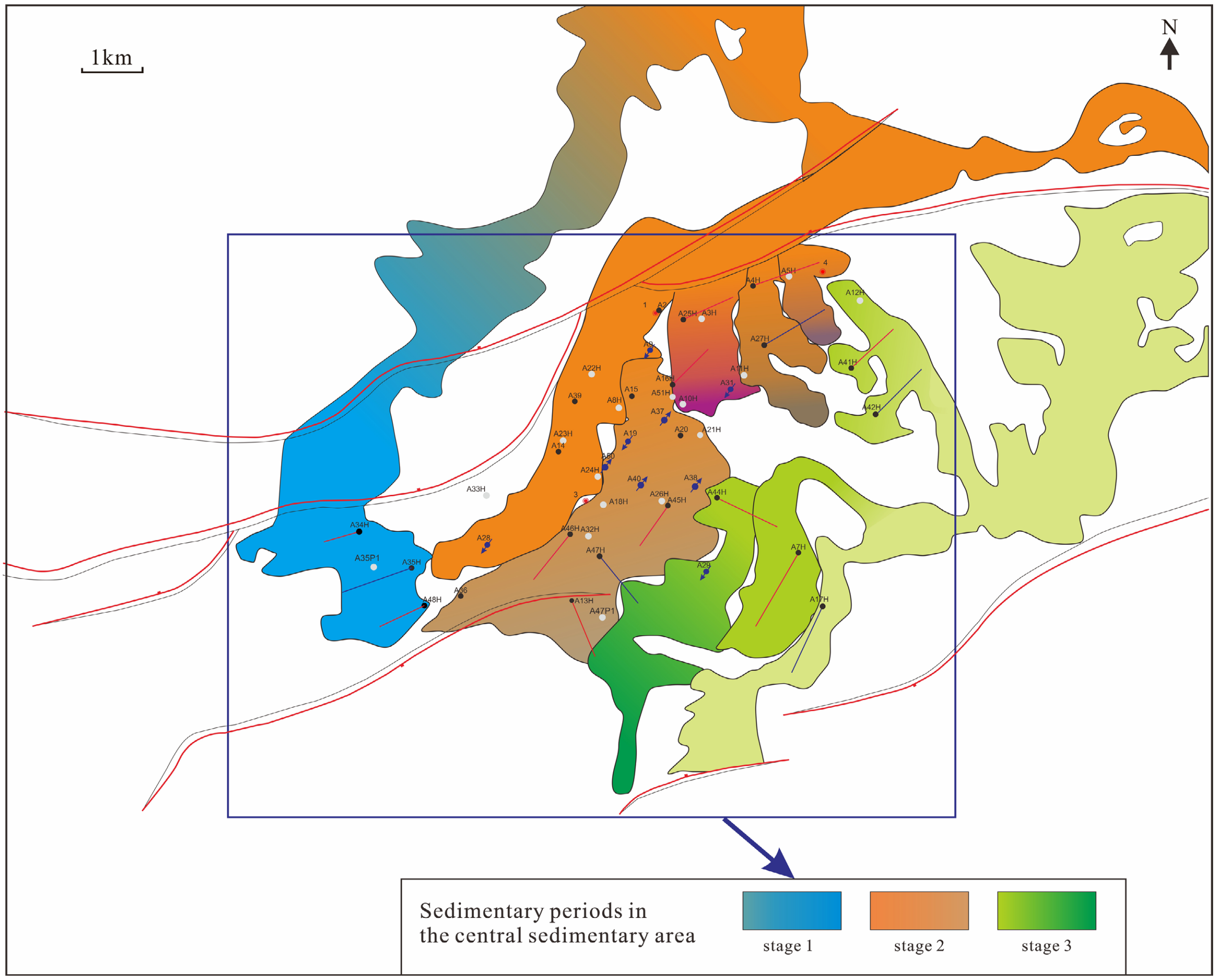

Figure 4. The main reservoir of S sand bodies composite channel plane distribution map.

3.2. Fine Characterization of Single River Channels

The internal reservoir structure of the sand body studied in this article is complex, mainly manifested by the lateral migration of multiple river channels on the plane to form large-area distributed composite sand bodies, and the vertical stacking of sand bodies from different stages of distributary channels.

The composite river channel exhibits multiple positive rhythmic features vertically, and there is a sedimentary interval, which is a characteristic lithology formed between the end of one period of continuous stable sedimentation and the beginning of the next period of continuous stable sedimentation in the vertical sedimentary sequence, which is different from the upper and lower adjacent layers. The logging curve mainly shows platform changes or mud response characteristics.

Figure 5 depicts the planar distribution characteristics of two single river channels. And it also delineated the distribution range of interlayer between these two periods of single river channels. The brown area shown in the lower right figure is the mudstone interlayer, and the purple area is the physical interlayer.

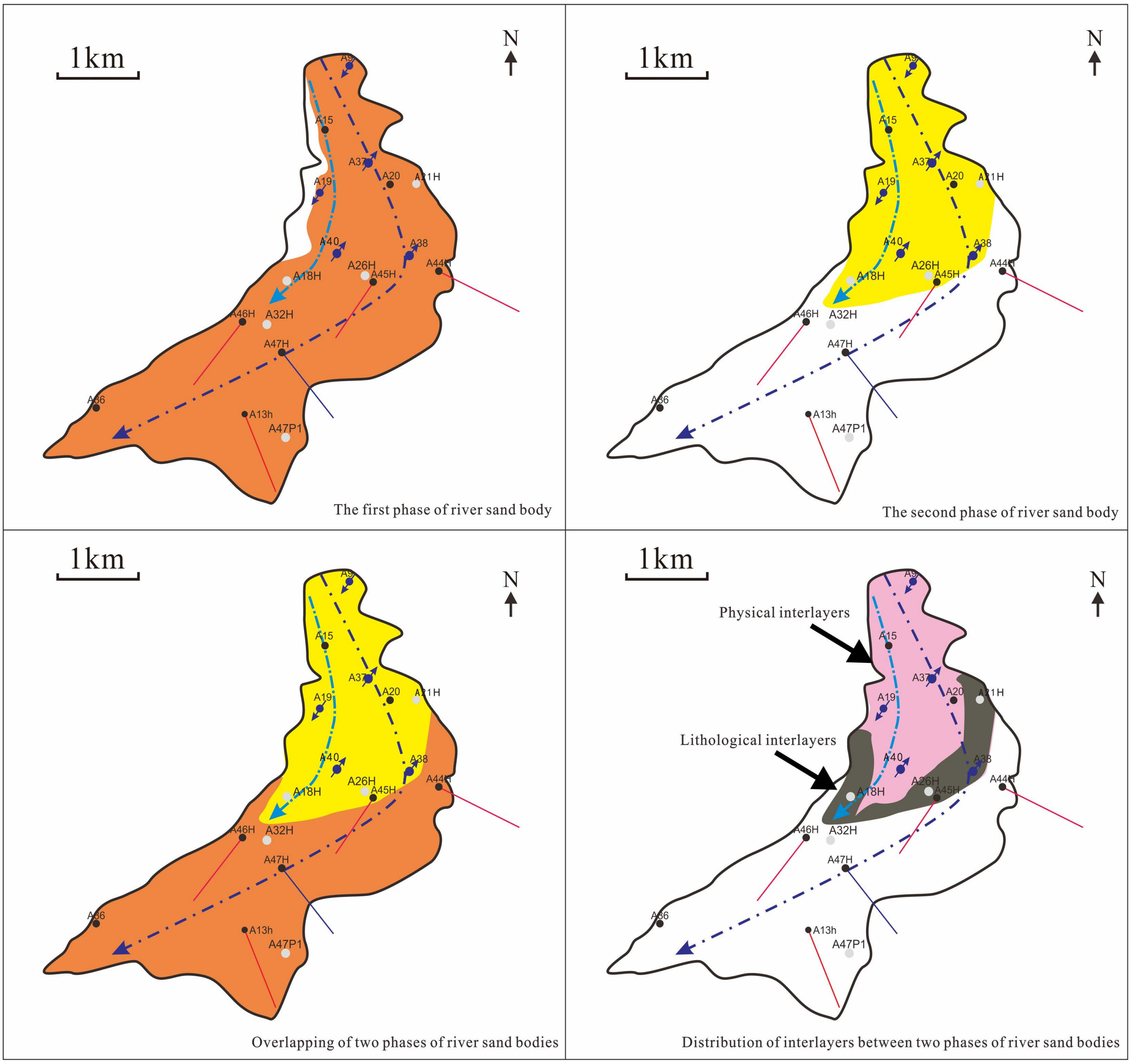

Figure 5. Spatial distribution map of two single river channels.

4. Conclusions

1) Using seismic facies characteristics to identify five contact modes of underwater distributary channels, namely separated underwater distributary channels, cut separated underwater distributary channels, unidirectional natural embankment connected underwater distributary channels, bidirectional natural embankment connected underwater distributary channels, and cut contact underwater distributary channels.

2) By studying the fine reservoir configuration of the S sand body, the fine characterization of the reservoir was achieved before drilling the development well, which guided the optimization of the development well position and was of great significance for guiding the rational and efficient development of the oilfield.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Wang, Z., Zhang, G., Zhou, X., *et al.* (2012) Reservoir Configuration Analysis and Its Significance in Oilfield Development. *Xinjiang Petroleum Geology*, **33**, 61-64.

[2] Miall, A.D. (1985) Architectural-Element Analysis a New Method of Facies Analysis Applied to Fluvial Deposits. *Earth Science Reviews*, **22**, 261-308. https://doi.org/10.1016/0012-8252(85)90001-7

[3] Wu, S., Yue, D., Liou, J., *et al.* (2008) A Study on Reservoir Geological Modeling of Underground Paleochannel Reservoir. *Science in China*: *Series D*, **38**, 111-121.

[4] Liu, Y., Hou, J., Wang, L., *et al.* (2009) Architecture Analysis of Braided River Reservoir. *Journal of China University of Petroleum*, **33**, 7-11.

[5] Lu, H., Lin, C., Cheng, Q., *et al.* (2013) Deltaic Reservoir Architecture and Remaining Oil Distribution Study of Es2 Member in Yonganzhen Oilfield, Dongying Sag. *Journal of Northeast Petroleum University*, **37**, 40-47.

[6] Deng, Y., Wang, Y. (2012) New Recognition of Shallow Oil and Gas Reservoir Forming Mode and Exploration Achievements in Huanghekou Sag-Enlightenment from Exploration Process of BZ28-2S Oilfield. *China Petroleum Exploration*, No.1, 25-29.

[7] Peng, W., Sun, H., Zhang, R., *et al.* (2009) Late-Stage Near-Rource Preponderant Hydrocarbon Pooling Pattern in the Huanghekou Sag of Bohai Sea Waters. *Oil & Gas Geology*, **30**, 510-518.

[8] Yu, H., Li, J., Peng, W., *et al.* (2009) Shallow-Water Delta Deposition and Exploration Significance of Lower Minghuazhen Member in Huanghekou Sag. *Petroleum Geology and Oilfield Development in Daqing*, **28**, 1-6.

[9] Zhang, C., Yin, T., Zhu, Y., *et al.* (2010) Shallow-Water Deltas and Models. *Acta Sedimentologica Sinica*, **28**, 933-944.

[10] He, Y. and Yu, K. (2005) Recognition and Its Effect Analysis of Single River Channel in Composite Sand Body with Distributary Plain Facies. *Petroleum Geology & Oilfield Development in Daqing*, **24**, 17-19.