

PS Architecture of Underwater Distributary Channel Reservoir in Member 3 of Qingshankou Formation in QianAn District, South of Songliao Basin*

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Abstract

The QianAn district is located in the south of Songliao basin, and it has experienced 30 years of oil exploration and development process since first developed in 1985. As the oilfield gradually enters in its late stage of high water contained development, the main production contradiction has transferred from interformational to intraformational, so understanding the internal architecture of the underwater distributary channel sand body reservoir in the study area becomes meaningful to the enhancement oil recovery. Therefore, this study uses the theory of reservoir layer upon layer analysis method as guide, combining with the modern shallow water delta depositional model, integrating with the core and log data of dense well pattern area of block 3 in QianAn district, processes a detailed study on the internal architecture of underwater distributary channel reservoir in the study area.

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Architecture of underwater distributary channel reservoir in member 3 of Qingshankou formation in QianAn district, South of Songliao Basin

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Abstract

The intercalations and internal structures with sandbody play a more and more important role in remain oil generation. Based on the method of hierarchical structure analysis of reservoir, we established the level 3-5 architecture models of underwater distributary river channel reservoir using data of well logs and core, and described the distribution pattern and scale of each architecture element level by level. The results may objectively reveal a three dimensional distribution mode of basic units with underwater distributary river channels and veritably reflect internal structures of subaqueous distributary channel sands in the fluvial-dominated delta.

Geological Setting

The study area QianAn district is tectonically located at south of central depression of Songliao basin, with a total area of 62.9 Km², it has more than 7 coring wells and 400 oil production wells (figure 1).

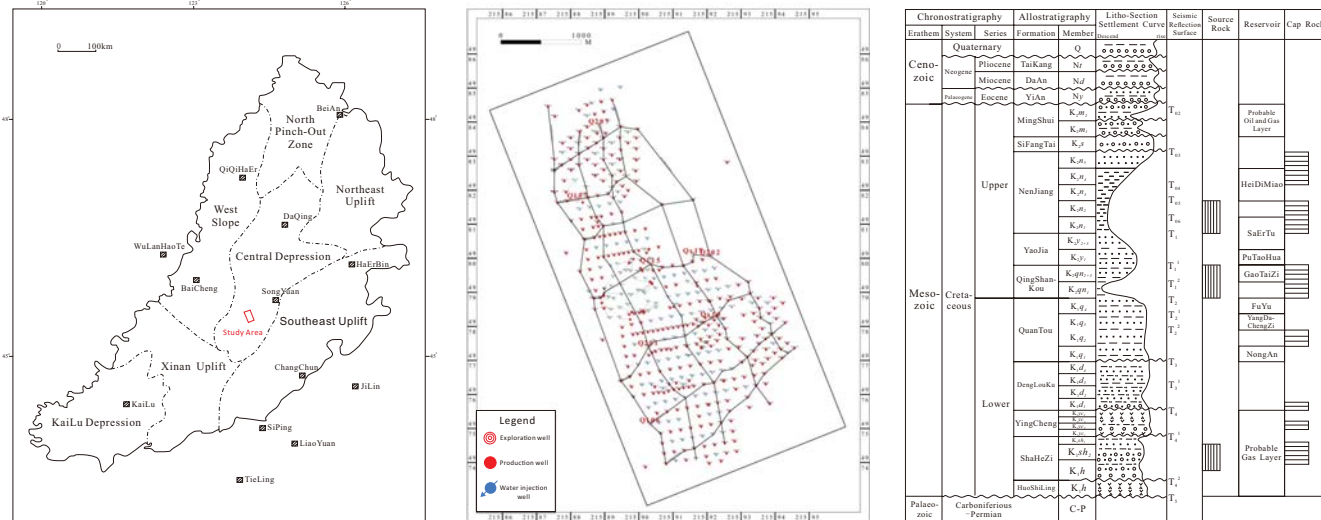


Fig.1 Location and geological setting of study area

The stratum of the study area is mainly composed of two sets of Mesozoic-Cenozoic strata which is syn-rift sediment rocks and post-rift depression sedimentary rocks, and the syn-rift sedimentary rocks are deposited in Middle-Upper Jurassic period, the post rift sedimentary rocks are mainly deposited in Cretaceous. The strata of Cretaceous system can be divided into two parts, the Lower stage is mainly contained by HuoShiLing formation, ShaHeZi formation, YingCheng formation, DengLouKu formation, QuanTou formation, the Upper stage is mainly contained by QingShanKou formation, YaoJia formation, NenJiang formation, SiFangTai formation and MingShui formation from bottom to top. The target layer Member 3 of QingShanKou formation is belong to the GaoTaiZi oil layer which is the main production layer in the south of Songliao basin. In previous studies, the sedimentary environment of the target layer is considered to be shallow water delta, by the characteristics of a relatively dry climate, flat terrain, gentle slope, shallow water, abundant source supply.

Architecture model

With the study of the paleogeography, hydrodynamic condition, depositional model and discipline under the circumstances of deposition of underwater distributary river channel reservoir in the study area, based on the result of core observation, a interpretation model of I-V level architecture surface of the reservoir has been built (figure 2).

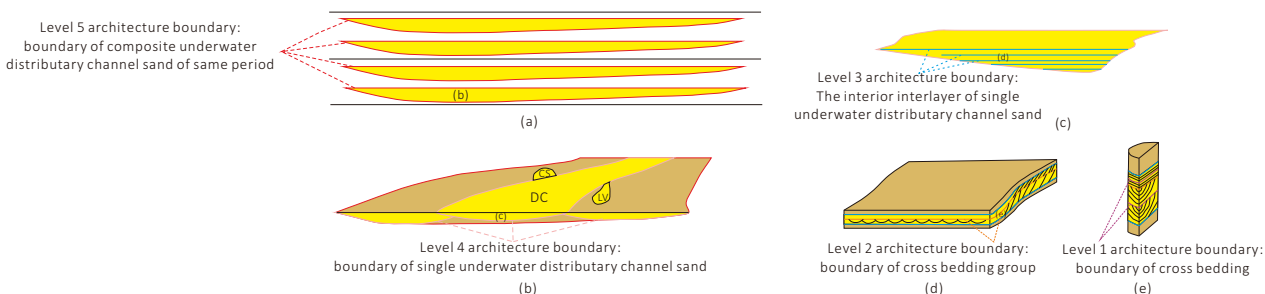


Fig.2 Architecture boundary of underwater distributary river channel reservoir

We can see from figure 2, the level 5 unit is the composite subaqueous distributary channel sandbodies and the boundaries between them, and is coincidence with the microfacies underwater distributary river channel of subfacies delta front. The Level 4 unit is the single subaqueous distributary channel sandbodies and their boundary. The level 3 unit is the interlayers in the single subaqueous distributary channel sandbody and the accretion bodies refined by them.

Level 5 reservoir architecture

Take the sedimentary profile from the study area as example, we found that the level 5 composite underwater distributary river channel sandbody developed well at VII-VIII sand group, the connectivity is better, and distributes in almost equal-thickness stripped shape and becomes thinner from east to west. The Level 5 unit in the rest sand group are not developed that well, the connectivity is poor, and the sandbody distributes in lenticular shape (figure 3).

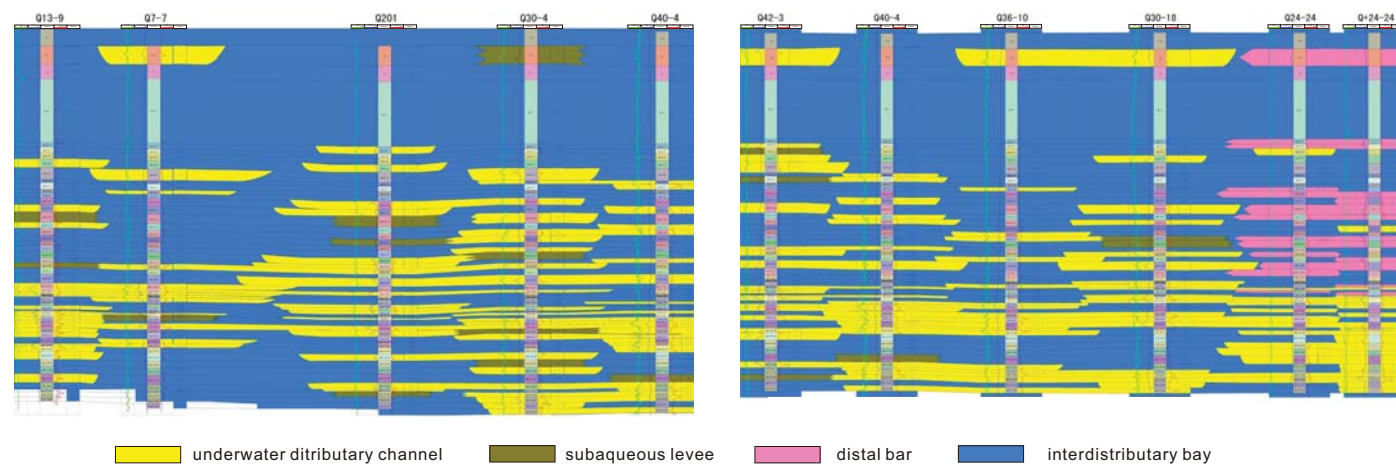


Fig.3 The sedimentary profile of Member 3 of QingShankou formation

The main microfacies of VIII sand group are subaqueous distributary channel, subaqueous levee, interdistributary bay of shallow water delta front. During that period of sedimentary circle, the lake level rise first and then fall, this indicates a local regression in the entire aggressive background. The 28~27 section channel sandbody is relatively thin and narrow (figure 4a&b). The 26 section channel sandbody is thicker, wider and larger as the lake level falls (figure 4c). In general, the sandbody of VIII sand group is large-scale, and almost covers 60% of the study area.

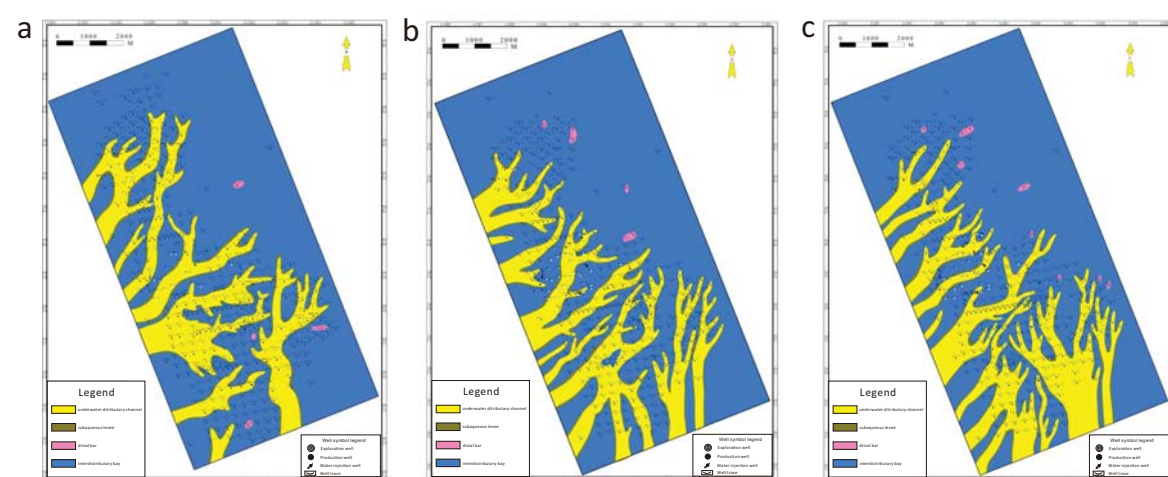


Fig.4 The sedimentary microfacies map of VIII sand group of Member 3 of QingShankou formation

Level 4 reservoir architecture

On the basis of level 5 architecture unit characterization, we analyses the level 4 architecture unit the single channel in the composite channel, and quantitatively characterizes its boundary, distribution and scale.

The boundary of single channel sandbody can be summarized into 5 types, the inter-channel deposit, elevation diversity, thickness diversity, lateral overlay and thick-thin-thick variation (figure 5).

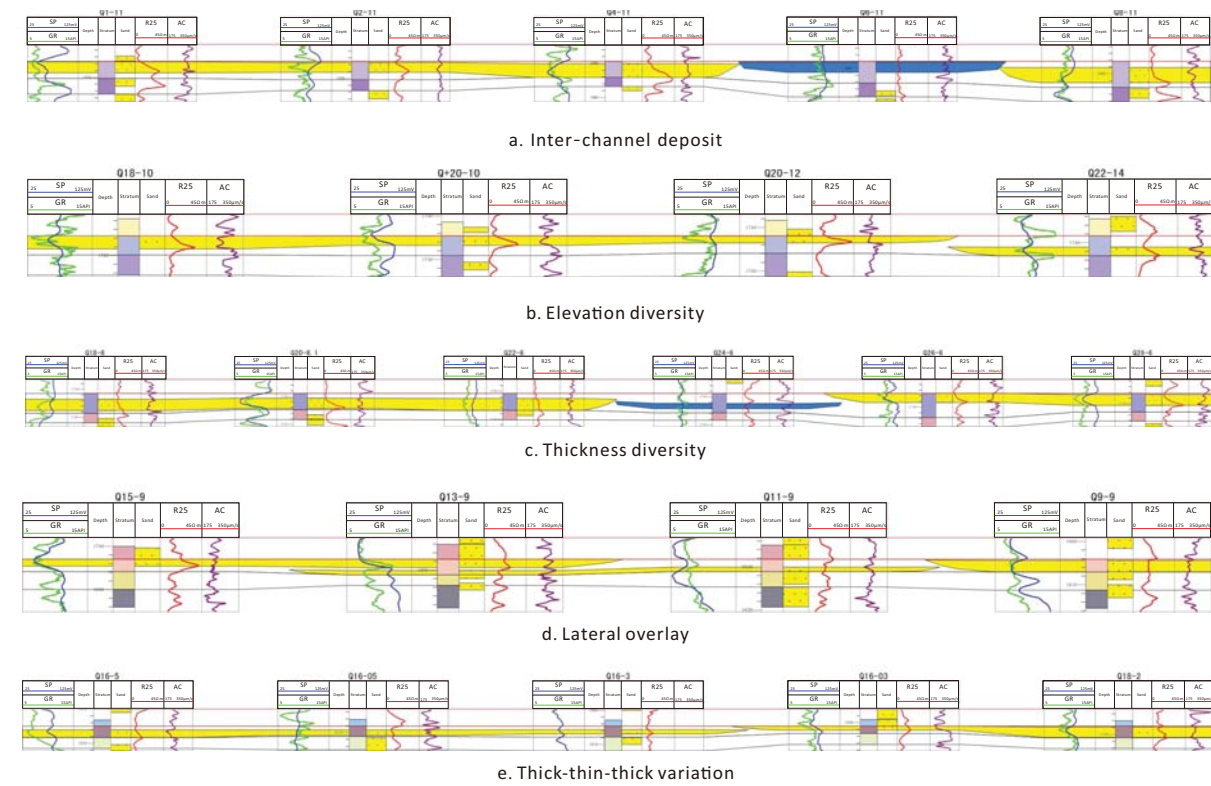


Fig.5 5 types of architecture boundary of single channel sand in the study area

The 28-27 single channel sand can be found almost in entire study area, and it distributes in branch shape in plane, the flex degree is not high, the middle and downstream of the single channel sand overlays into schistose shape composite channel sandbodies. The orientation of the single channel sand is controlled by the source supply, and distributes in SW-NE stripe shape (figure 6a&b). The sand bifurcates obviously in the front, and the single channel of this period is not wide, the ratio of width/thickness is 331.9/2.0.

The 26 single sand body distributes in a large area of schistose shape as the lake level decreases gradually. Incision and overlay obviously existed between the single sand bodies, formed relatively large-scale composite channel sand. This section can recognize 10 single channel sand bodies, and each of it is mainly distributes in SW-NE stripe shape (figure 6c). The sand bifurcates obviously in the front, and the single channel of this period is wide, the ratio of width/thickness can reach 466.8/2.0.

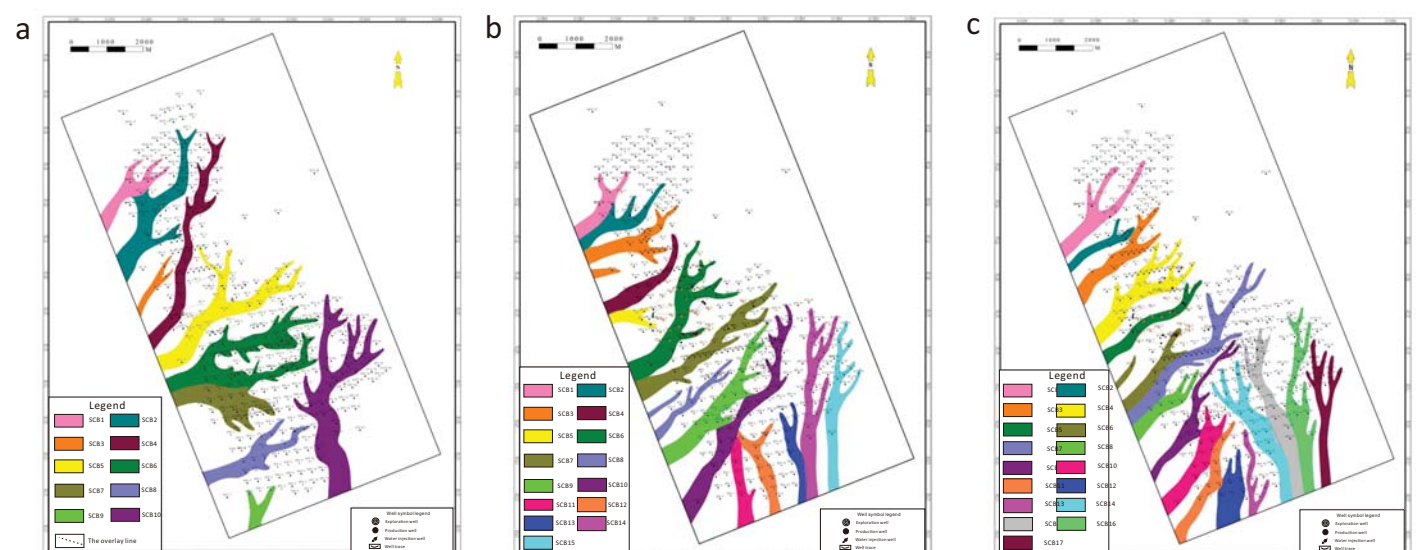


Fig.6 The distribution map of single channel sand of VIII sand group of Member 3 of QingShankou formation

By the fitting of width/thickness ratio of single channel sand, we find that both the width and thickness have a tendency to decrease as the lake level rises (figure 7). The ratio of the width of single channel between 200-800m can reach 72.7%, the ratio of thickness between 0-4m can reach 84.8%, the ratio of width/thickness between 40-200 can reach 88.1%.

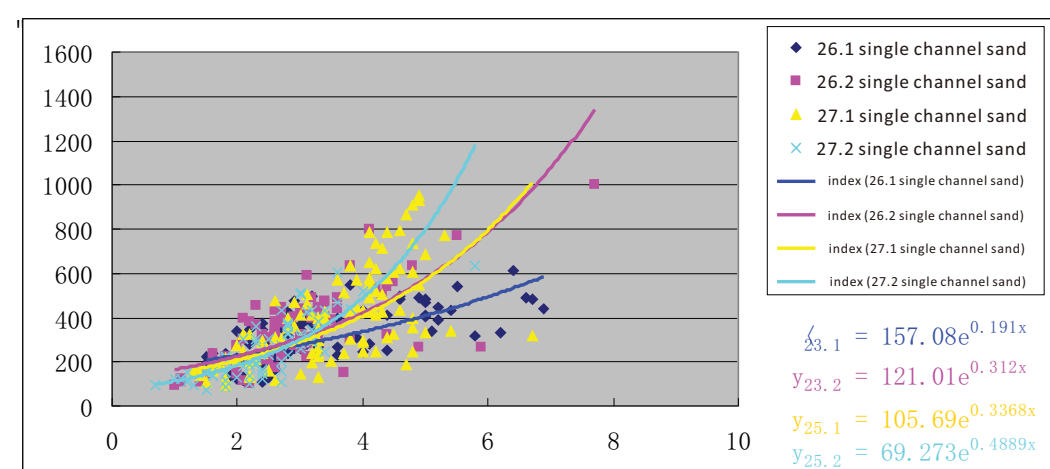


Fig.7 The prediction model of width/thickness ratio of Member 3 of QingShankou formation in the study area

Level 3 reservoir architecture

This part of the research is ongoing.

Result

An architecture model of level 1-5 underwater distributary channel sand reservoir of the purpose layer in the study area has been built. Level 4-5 architecture unit are the key points of this presentation, characterization of the level 3 architecture unit is under research now.

The level 5 architecture unit is the composite subaqueous distributary channels and its boundary. The level 5 unit develops best in the VII-VIII sand group period, it distributes in branch and sheeted shape, the sand is thick, and the channel is wide, and it also extends relatively long in the source supply direction.

The level 4 architecture unit is the single subaqueous distributary channel and its boundary. 5 types of architecture unit boundary has been recognized in the study area. After statistics, we find that the scale of the single channel enlarges as the lake level falls, the width of the single channel is mainly between 100-500m, the ratio of width/thickness is mainly between 90-130.

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