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## Fluvial-delta Sand Types and Its Controlling Reservoir Effect of the Second and Third Members

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# Fluvial-delta Sand Types and Its Controlling Reservoir Effect of the Second and Third Members

**Huaye Liu**

Exploration and Development Research Institute, Daqing Oilfield Company Limited,  
Daqing 163712, China

\*E-mail: liuhuaye@ petrochina.com.cn

**Abstract.** The second and third members of Yaojia Formation is major formation of exploration and development of Daqing oilfield, but the scale of the oilfield that have been found in this formation is small, and the distribution of oil and gas is complicated and scattered. In order to figure out the relationship between the reservoir bed and reservoir. We study on basis of cores, well logs, seismic data, chemical testing and so on, analysis about the styles of sedimentary faces, depositional characteristics and distribution rules, researching the beneficial sand body, sand distribution, sand connectivity and its controlling on reservoir types. By research we find that the delta system is the most important depositional system. It reveals a kind of characteristic which possesses multi-provenance, multi-sedimentary-system and half-circle-faces-belt-distribution. The feature of sand body distribution, width of sand body, thickness of sand body, connectivity of sand body is different for different sedimentary faces, there are five types sand body types. Sand body type is the basis of reservoir zonality, and controlling the four reservoir accumulation zone. Establish the controlling model of reservoir sand body type, is for the theory and reality significance for the exploration of the second and third members of Yaojia Formation.

## 1. Introduction

Songliao basin is a large continental depression basin, the hydrocarbon accumulation and other areas of the continental petroleum geological research domain have made great progress since the Daqing oil field was discovered[1-3].The member Yaojia 1 formation is presented with the sag-wide oil-bearing, but the member Yaojia 2 and 3 formation oilfield has discovered in Qijia-Gulong depression, but the oilfield is small and distribution is more scattered except in Daqing Anticline, there still has certain potential. This paper carried out comprehensive and careful study of sequence stratigraphy and sedimentary system research, analysis of favorable reservoir sand body types, spatial distribution, lateral connectivity and its control effect on reservoir type, establish the reservoir control models of sedimentary facies of sand body type, there is a certain theoretical and practical significance for further exploration in the member Yaojia 2 and 3 formation in Songliao basin.

## 2. Geological Setting

Songliao basin is located in the northeast China, east-north distribution as a whole, covers an area of about  $26 \times 10^4$  km<sup>2</sup>, is a large Cenozoic continental depression basin, and is one of the most abundant oil and gas resources the non-marine sedimentary basin that have been found in the world [4-7]. Yaojia formation is a sedimentary strata when the whole lake basin uplift turn into a gradual subsidence after the late Qingshankou formation deposition. The member Yaojia 1 formation development the lower water stand deposition. The lake basin expanded in the member Yaojia 2 and 3 formation sedimentary period, the water depth is deeper in central lake basin, the sediment faces is



fluvial, delta, shore-shallow lake faces from the edge to the center of basin. From the edge to center of the river delta-shore and shallow lake facies.

### 3. Sedimentary Sand Body Types and Features

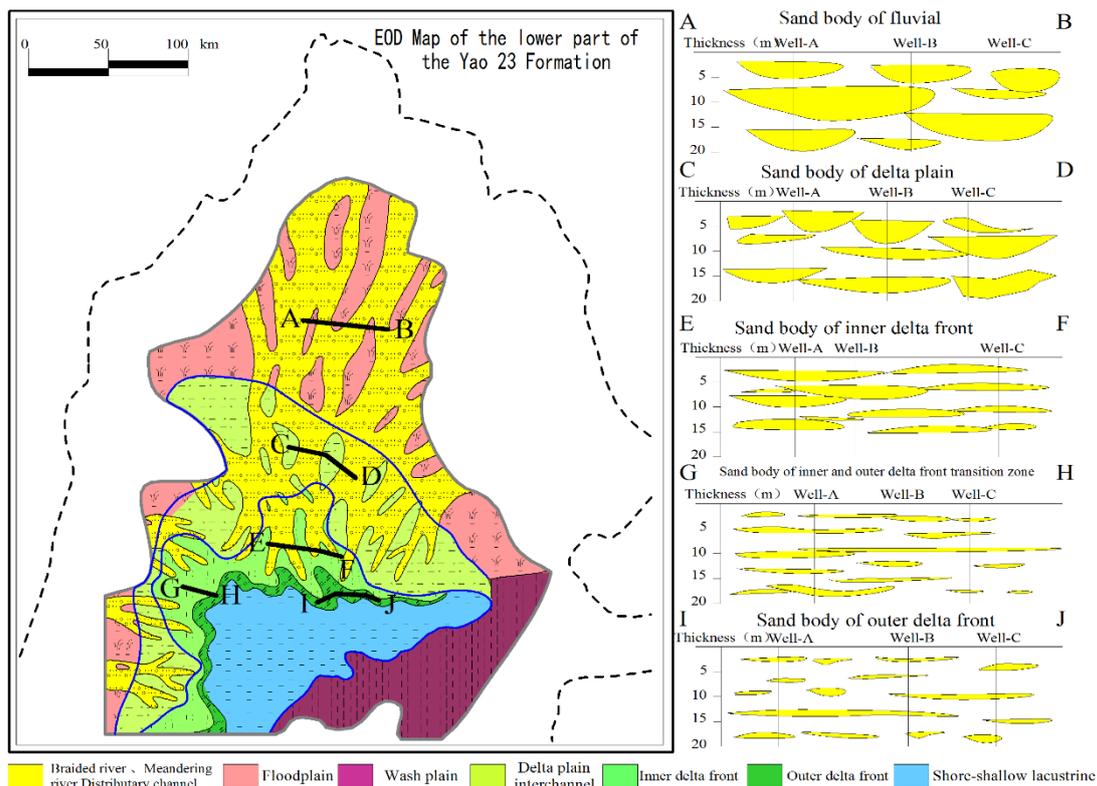
Fluvial sedimentary sand body including braided river channel sand body and meandering river channel sand body. The thickness of single layer of fluvial sedimentary sand body is 5-30m, due to the migration of rivers, the major sand body is unstable variable thick ribbon sand body, sand body vertical superimposed each other and average sand-shale ratio is more than 50%, the porosity is generally 20-35%, average 29.2%, permeability is generally 5-1350mD, average 620mD, good connectivity (Fig.1)

The main delta plain sand body is above water distributary sand body. The thickness of single layer of delta plain sedimentary sand body is 3- 15m, mostly stripped sand body, the distribution is not stable, but the amount is numerous, the vertical superimposed each other and average sand-shale ratio is more than 50%, the porosity is generally 20 -35%, average 29.2%, permeability is generally 5-1700mD, average 1224mD, well connectivity.

Inner delta front sedimentary sand body is mainly composed of underwater distributary channel sand body and mouth bar sand body. The single layer thickness of inner delta front sedimentary sand body is 2-10 m, due to the change of lake level, the vertical form the multiple transgression and regression cycles, turning back, between underwater distributary channel, mouth bar sand body mix a small amount of delta front sheet sand , the sand body vertical superimposed layers sand body, forming a continuous sheet in horizontal, the average sand-shale ratio is generally greater than 50%, the porosity is 15-35%, average 24.6%, permeability is generally 2 - 800mD, average 519.4mD, connectivity is better.

The transition sedimentary sand body between inner and outer of the delta front mainly mouth bar, sheet sand sand body, distal bar sand body. The single layer thickness transition Sedimentary sand body inner and outer delta front is 1-5m, because of the underwater distributary channel sand bodies are rarely able to drive to this area, the scale of sand bodies is smaller , the longitudinal mouth bar, distal bar, frontal sheet sand are superimposed, mixed with a certain thickness of mud sediment, the sand-shale ratio is commonly 20%-50%, the porosity generally is 10-30%, average 18.3%, permeability generally is 1-500mD, averaging 133.7mD and connectivity generally.

The outer delta front sedimentary sand body is mainly the distal bar, sheet sand sand body. The single layer thickness is 0.5-3 m, vertical thin layer sand body superimposed, intermediate mix thickness is thicker, though the distribution range in horizontal is wide, but the longitudinal mostly isolated sand body, the average sand-shale ratio is less than 20%, porosity is generally 5-25%, average 16.5%, permeability generally is 1- 175mD, average,36.4mD, poor connectivity.



**Figure 1.** The EOD map and sand body shapes of lower Yao23 formation

#### 4. Control Action of Sand Body Type to the Reservoir

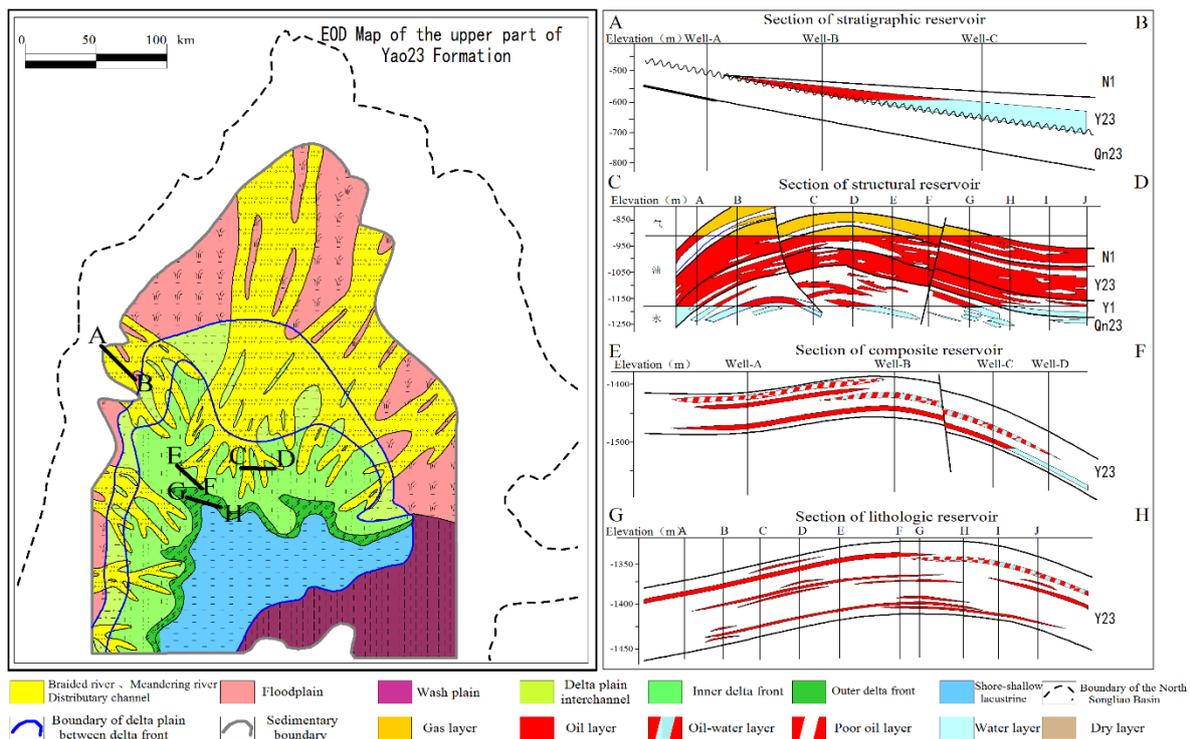
Zone of stratigraphic overlap is generally distributed in the margin of the basin slope or edge of basin inside large uplift, is favorable zones for forming large-scale stratigraphic on lap reservoir. Most of the stratigraphic overlap area appear in the western slope of Songliao basin. With the growing lake water, fluvial, delta plain sedimentary sand body retrograde to source area, stepwise overlap the member Qingshankou 1 mudstone, overlying mudstone cap rock, so as to form large-scale oil and gas accumulation along the overlap belt, stratigraphic on lap reservoir formed. Such as, Fulaerji reservoir area and Tangchi area (Fig.2).

Central depression area in the Northern Songliao basin is covered with large areas of delta front deposition, the Daqing Anticline structure matching with the delta front sand body, it is easy to form structural reservoir. Reservoirs that have been found are mainly distributed in structural trap background region, such as Taikang uplift belt that has the micro structure of Alaxin, Erzhan gas reservoir, the big structural reservoir of La-Sa-Xing in northern Daqing Anticline.

With sedimentary faces belt carry forward to the center of basin, the transition sand body of inner and outer delta front match with the slope tectonic background or part anticline structure, the frequent lake level changes result in the form of transgressions and regressions cycles. In the regression cycle the scale of sand body is small and isolate, reservoir physical property and sand body connectivity is bad, easy to form structure-lithologic reservoir, fault-lithologic reservoir, lithologic reservoir types, constitute composite reservoir zone.

Reservoirs that have been found that are mainly distributed in the nose structure or slope parts of the Qijia-Gulong region, such as the Aogula reservoir, Longhupao reservoir, Haerwen reservoir, Talaha reservoir, Yingtai area.

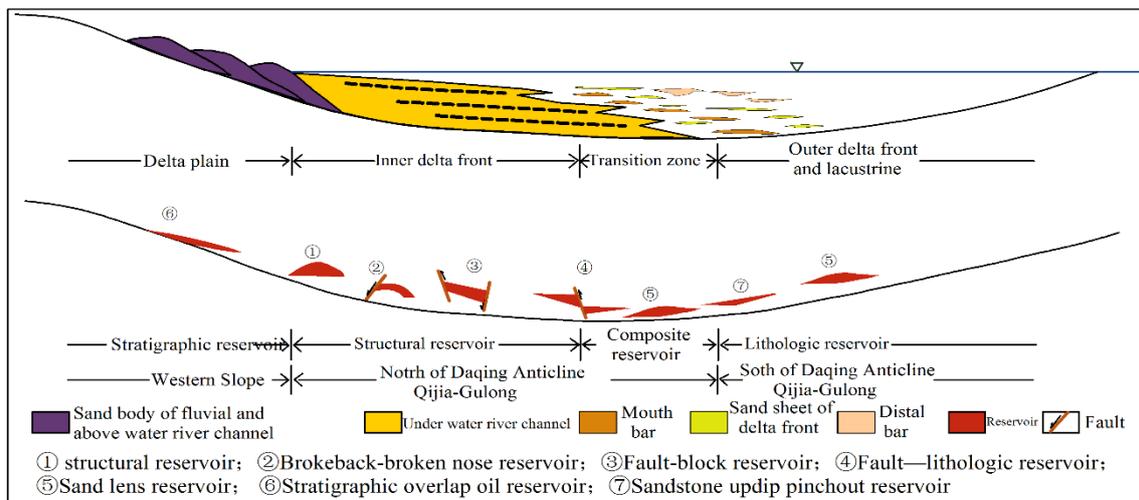
The sand body of outer delta front is relatively isolated, easily form pinchout sand body because the change of the faces, easily forming lithologic reservoir in the sag of syncline area, slope area. The reservoirs that have been found that are mainly distributed near the sag of syncline area, slope area of the Qijia-Gulong region.



**Figure 2.** The EOD map of upper Yao23 formation and typical oil and gas reservoir sections

### 5. Oil and Gas Reservoir Distribution Pattern

The types and characteristics of Sedimentary faces distribution, reservoir sand body control the distribution of the reservoir type regular(Fig.3). Fluvial faces sand body and delta plain sand body development in the basin edge, at the background of stratigraphic overlap, the scale of sand body is big and reservoir property is good, good connectivity, match the overlying a certain size of cap rock, favorable to forming stratigraphic trap, is stratigraphic reservoir accumulation zone; Inner delta front sand body often deposited in the depression, sand body size is big, reservoir property is good, connectivity is good, and allocate efficiently with anticline, fault nose and fault block structure type, is structural reservoir accumulation zone; The sand body scale of Delta front transition zone changes is bigger, reservoir physical properties and connectivity has a certain difference, so the types of traps of reservoir are various, is the composite reservoir accumulation zone; The sand body scale of outer delta front is small, distribute with lenticular or sheet, the sand body is lithologic trap itself, is lithologic reservoir accumulation zone.



**Figure 3.** The Control Model of Sedimentary sand body on oil and gas reservoir of Yao23 Formation

## 6. Conclusion

On the whole the member of Yaojia 2 and formation contain fluvial sand body, delta plain sand body, inner side delta front sand body the transition of inner and outer delta front sand body and outer delta front sand body five types of sand body types. The member of Yaojia 2 and 3 formation can be divided into four oil-gas accumulation zone. Fluvial faces sand body and delta plain sand bodies control the distribution of stratigraphic reservoir accumulation zone; Inner delta front sand bodies control the distribution of the distribution of structural reservoir accumulation zone; Transition zone of inner between outer delta front sand bodies control the distribution of the composite reservoir accumulation zone; Outer delta front sand bodies control the distribution of lithologic reservoir accumulation zone.

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