



Sedimentary facies and model of gentle slope shallow-water braided river delta in the Jurassic Sangonghe Formation, Yanqi Basin, China

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Abstract

The Jurassic Sangonghe Formation of Yanqi basin develops a set of shallow braided river delta deposits, and it is of great significance for the exploration and development of Baolang oilfield to study its sedimentary characteristics. Based on the core data and wire-line log data in the study area with a highly dense well pattern, this work aims to provide the sedimentary features and sedimentary petrofacies distribution of this deposit, and present a sedimentary model for this study area. By analyzing characteristics of lithology–electricity responses, the wire-line log responses of different sedimentary petrofacies in the study area are summarized and the electrofacies recognition template is established. Meanwhile, the planar and profile sedimentary petrofacies distribution is further examined in detail. The results demonstrate that the study area develops coarse clastic sediments, and the sediments are dominated by conglomerate, sandstone, and mudstone, with a characteristic of “rich in sandstone and poor in mudstone”. Sedimentary petrofacies are primarily the subaqueous distributary channel facies, with vertically stacked and laterally extensive sandstone bodies. The sedimentary model of shallow-water braided river delta in the study area is characterized by gentle slope, strong current, lacustrine level rising and falling frequently and the thick and wide sandstone bodies.

Keywords Baolang oilfield · Shallow-water braided river delta · Gentle slope · Sedimentary characteristics · Sedimentary model

Introduction

The sedimentary characteristics of shallow-water braided river delta deposits have received great attention over the past several years, with a vast number of reservoirs demonstrated to arise from this kind of depositional environment. Fisk (1954) first defined the term “shallow-water delta”, and Donaldson (1974) and Postma (1990) proposed classification systems according to different controlling factors, respectively. Recently, the study of shallow-water delta mainly focuses on formation dynamics, petrofacies architecture, and internal structure (Reading 2013; Lemons and Chan 1999; Plint 2000; Zelilidis and Kontopoulos 2002; Overeem et al. 2003; Leckie et al. 2004; Fielding et al. 2006;

Gani and Bhattacharya 2007; Lee et al. 2015; Howell et al. 2008; Zeng et al. 2015). In China, Gong (1986) first applied the concept of shallow-water delta in the study of Permian deposits in Yu County, Henan Province in the 1980s. Currently, formation conditions, sedimentary models, reservoir characteristics are the main concerns of shallow-water delta research in China (Han et al. 2000; Li et al. 1995; Lou and Cai 1999; He et al. 2001; Zou et al. 2008; Zhu et al. 2008a, b, 2012; Liu et al. 2015; Sun et al. 2016). The reservoirs of shallow-water braided river delta deposit are widely distributed, such as Ordos basin, Bohai bay basin, Songliao basin, Sichuan basin in China (Zhu et al. 2008a, b, 2012; Zou et al. 2008) and Piceance Creek Basin and North Appleby Field in the USA (Bridge and Tye 2000). Most publications, however, focus on the features of the steep slope shallow-water braided river delta deposits and little effort has been made on the gentle slope shallow-water braided river delta deposits.

The Sangonghe Formation in Baobei district of Baolang oilfield provides ideal conditions for a detailed research of gentle slope shallow-water braided river delta. The paucity of study on the sedimentary characteristics and model in

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this area prompts the need for careful efforts to satisfy the acquirement of fine development.

By analyzing the core data and wire-line log data in the study area with a highly dense well pattern, this study discusses the sedimentary characteristics and model and identifies the relationship between its lithology and wire-line log, which can provide a guidance for later field-development and well-completion strategies.

Data sets and methods

This study is chiefly based on the core data and wire-line log data. Seven coring wells are attained in the study area, including six conventional cores and one sealed core. About 561.12 m of cores from these seven wells that distributed evenly in the study area have been observed and described, which can provide the necessary basis for the wire-line log data interpretation.

There are 134 wells totally in the study area, including production wells and injection wells, among which 97 wells run into the objective layer. All wells have wire-line log data which are composed of spontaneous potential log (SP), Gamma ray log (GR), resistivity log [including deep investigate double lateral resistivity (RD), shallow investigate double lateral resistivity (RS) and microspherically focused logging (RMSL)] and acoustic log (AC). The well-spacing density of the objective layer is up to 0.01 km²/well, which provides a basis for research on characteristics of sedimentary petrofacies using wire-line log data.

By locating the core, core data and wire-line log data are matched, which contributes to clarify the geological meanings of wire-line log data. Then, electrofacies recognition template is established according to the analyzing outcome. Later, wire-line log data are applied to identify lithology and ascertain the thickness of the sand body for every single well. On the vertical cross-section, the sand body of adjacent wells is correlated and the profile sedimentary petrofacies distribution is analyzed. On the horizontal plane, planar sedimentary petrofacies distribution is displayed based on the electrofacies recognition template. Finally, the sedimentary model of the study area is established according to sedimentary characteristics.

Geological setting

Basin evolution

The Yanqi basin is situated in the Southern Tianshan folded belt, which is among the Tarim, Junggar, and Tuha basins. As a Mesozoic and Cenozoic superimposed basin, the basin looks like a NW trend rhombus on morphology, and the

length is about 160 km from nearly east to west, while the width is around 60–90 km from north to south, over an area of 13,000 km² (Hu et al. 2006).

The Jurassic palaeogeographic settings of Baobei district were characterized by gentle slope (Wang et al. 2001). The provenance orientation is from the northwest to southeast (Guo et al. 2012). The evolution of Yanqi basin is divided into five stages: (1) triassic foreland basin stage in Yanqi–Kuche area. (2) Jurassic extensive basin stage after the orogenic epoch. (3) Cretaceous uplift and erosion stage caused by compression. (4) Eocene regional subsidence stage caused by breakdown and extension. (5) Quaternary broken intracontinental foreland basin stage.

The Yanqi basin began to receive sediment in the Mesozoic period and was dominated by lacustrine deposits. In the late Triassic, the first lake transgression occurred in the Yanqi basin with the warm and humid paleoclimate, when coal seam deposited in the study area. In the early middle Jurassic, the lake area in the Yanqi basin expanded continuously, depositing the Jurassic Badaowan Formation and Sangonghe Formation, the objective layer of this research. During the period of middle Jurassic Xishanyao Formation, the paleoclimate was humid and attained the maximum flooding surface. Although the paleoclimate turned into dry in the late Jurassic, the basin was characterized by lacustrine sedimentation (Chen 2003). The overall uplift of the late Cretaceous caused the entire Cretaceous strata to be eroded and thus lost. In the Cenozoic era, the Yanqi basin formed a series of anticlines and fractures caused by the Yanshan Orogeny (Yang 2004).

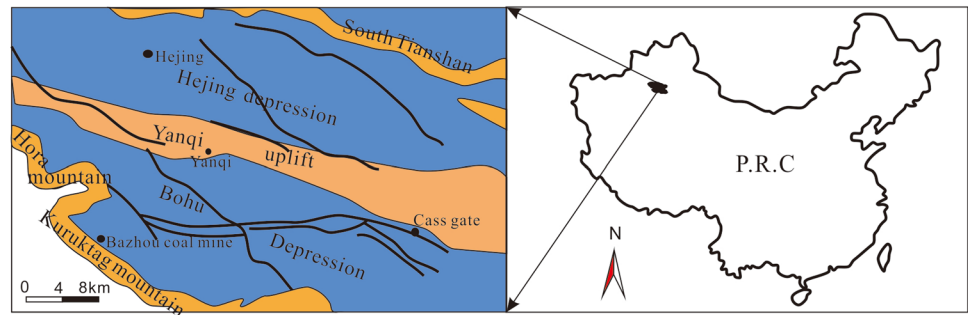
Nowadays, the Yanqi basin is composed of three secondary building units, including Bohu depression, Yanqi uplift and Hejing depression, and the Bohu depression can be subdivided into northern sag, central uplift tectonic belt and southern sag (Fig. 1). The Baobei district is located at the northwest end of the Sumu structural belt, the middle of the northern sag (Du et al. 2012).

Stratigraphy

The Mesozoic sediments in Yanqi basin covered on the Hercynian fold basement, the subsidence in Yanqi basin began at mid-late Triassic, and ended at the main episode of Yanshan orogeny, the late Jurassic. Namely, the Yanqi basin experienced a complete sedimentary cycle. The episodic tectonic movement formed four third-order sequences, and led to the absence of part stratum (Qiu et al. 2001).

Jurassic strata formed three third-order sequences, including sequence II, sequence III, and sequence IV (Fig. 2). Sequence II developed in the stage of initial subsidence, which belongs to the period of transgression. Sequence III formed in the transitional phase of intensive subsidence to slow subsidence, and occurred the largest lacustrine in the

Fig. 1 Geographic location and tectonic subdivision of Yanqi basin



Mesozoic. The development of widely distributed lacustrine mudstone in the upper Jurassic Sangonghe Formation is not only a good regional cap, but also the cap of known oil and gas reservoirs. Sequence IV was the product of basin shrinking, and the transformation of paleoclimate from semiarid to arid conditions which led to the formation of red alluvial deposits.

Jurassic Sangonghe Formation is a part of the sequence III, basically inherits sedimentary framework of Badaowan Formation in the early deposition. Two dustpan-like sags still exist in the south and north, respectively, but the distinction is that the thickness in the north is greater than the south, which demonstrates that depocenter moves to the north. The difference is slightly in the late period of Sangonghe Formation between the south and the north of the basin, and the terrain overall tends to be gentle.

Jurassic Sangonghe Formation represented two depositional system tracts, which are the lowstand system tract and the highstand system tract.

The lowstand system tract: alluvial fan occurs widely in the north of the basin, and extends to the southern part of Baozhong district. The sediments are mainly sandy conglomerate, the thickness of which is more than 20 m, even up to 100 m. The sediments are poorly sorted and sandstone content is generally greater than 60%. Alluvial fan group also emerges along the southern margin of the basin, but on a smaller scale. Braided rivers are widely distributed in the center of the basin, and small shallow-water lakes arise in the late stage. Abundant coarse fragments contribute to the occurrence of a large number of lacustrine deltas and also brings about the outcome that the mudstone thickness is only a few meters.

The highstand system tract: the development of Jurassic lakes enters into heyday in the late period of Jurassic Sangonghe Formation when the basin is dominated by braided rivers, deltas and lakes. Meantime, braided rivers chiefly arise along the northern and southern margin of the basin. The outer edge of the north side develops braided river plain in an arid climate, with thick riverbed glutenite and fuchsia floodplain mudstone. The braided river plain develops in the northern part of Baobei district in a humid climate, which

is characterized by overbank swamps and fluvial overflow lacustrine. The lake is distributed in east–west direction, and the area of it is up to 1600 km².

Sedimentary characteristics

Petrology features

The grain size of the sediment, which is the interbedding of sandy conglomerate and mudstone, is coarse (Fig. 3). Both compositional maturity and textural maturity are low, and the composition is mainly lithic (35–60%), followed by quartz (20–40%) and feldspar (10–20%). The sorting is from moderate to poor, with the sorting coefficient of more than 2, and the roundness is from sub angular to sub rounded, particle-supported.

Sedimentary structures

Sedimentary structures in the study area point to characteristic of strong hydrodynamic, such as massive bedding, graded bedding, cross-bedding, and parallel bedding. Exceptionally, horizontal bedding reflects the weak hydrodynamic.

1. Massive bedding. It is mainly developed in conglomerate and conglomeratic sandstone, reflecting rapid accumulation of coarse sediment influenced by strong hydrodynamics (Fig. 3a). Alternatively, there is also massive bedding in siltstone and claystone, such as the deposition of mudstone layer in flooding period and rapid accumulation of suspended material of the delta front (Fig. 3b).
2. Graded bedding. It is observed in the fine-to-coarse-grained conglomerate. Large amounts of suspended material begin to deposit with the decrease of mobility and water carrying capacity, indicating the abundant supply of provenance and intermittent flow (Fig. 3c, d).
3. Cross-bedding. Different types of cross-bedding reflect the different transport mechanism of the tractional current, which is the result of bedform migration under distinct hydrodynamic conditions. It is difficult to recognize

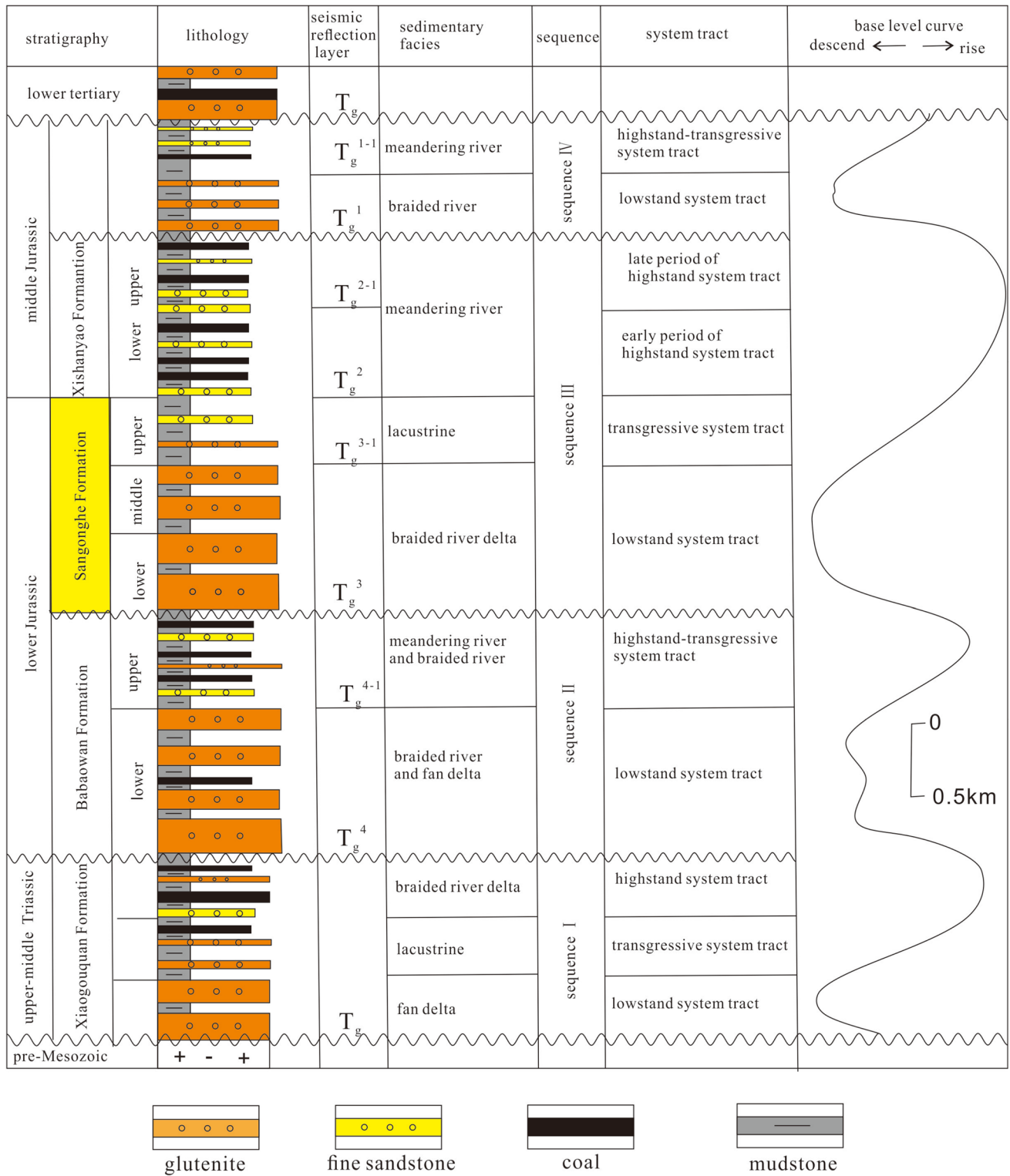
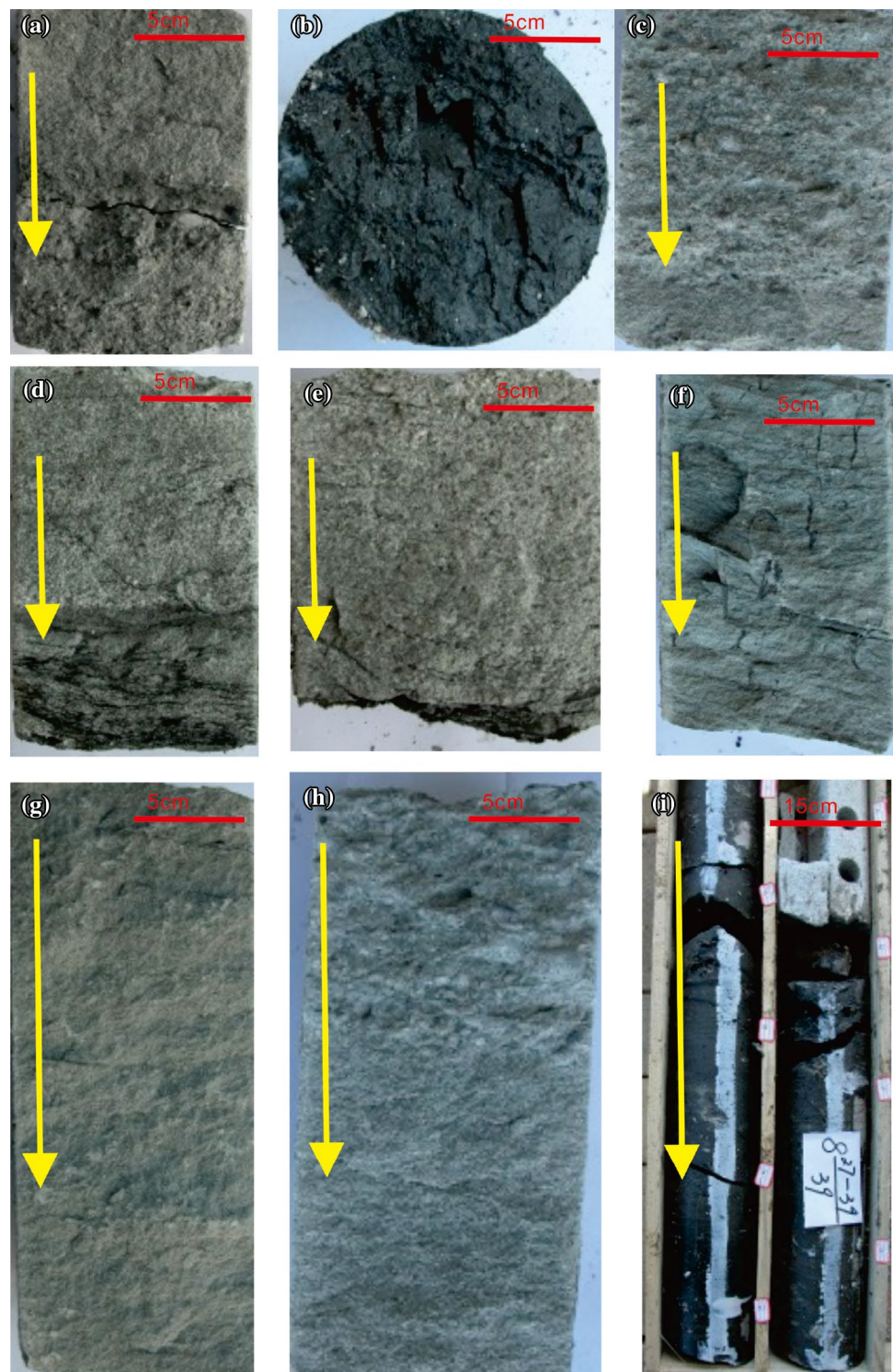


Fig. 2 Mesozoic stratigraphic sequence in the Yanqi basin

the trough cross-bedding because the scale of the core is small. Tabular cross-bedding is more common in gritstone and sandy conglomerate, with more coarsening-

- upward succession and less fining-upward succession, demonstrating the migration of bedform (Fig. 3e, f).
4. Parallel bedding. On the conditions of the strong hydrodynamic, the sand particles move and roll on the flat

Fig. 3 Typical sedimentary structures of shallow-water braided delta in Baobei District, Baolang oilfield. **a** Light grey conglomeratic medium sandstone with massive bedding **b** black carbonaceous shale **c** light grey medium conglomerate with graded bedding **d** light grey gravelly sandstone with parallel bedding **e** light grey sandy conglomerate with plate cross-bedding **f** light grey fine sandstone with cross-bedding **g** light grey fine sandstone with parallel bedding **h** light grey medium conglomerate with graded bedding **i** dark grey mudstone with coal line



river bed, which gives rise to the separation between coarse-grained sediment and fine-grained sediment. It reflects torrents and upper flow regime (Fig. 3g).

- Horizontal bedding. Horizontal bedding usually represents a relatively still and lower flow regime. The siltstone and mudstone in the study area develop massive

bedding primarily, with horizontal bedding occasionally, which can be seen in the interdistributary bay (Fig. 3h).

Grain size distribution

The grain size of sediment depends on transporting medium, transporting mode and sedimentary environment, and grain size analysis is an important method to determine the sedimentary environment (Zhao and Zhu 2001). The probability cumulative curve of the study area is mainly made up of two segments. The figure C–M is dominated by QR, followed by PQ and RS, which indicate the characteristics of strong hydrodynamic and short-distance transportation (Fig. 4). According to Zheng's summary (Zheng and Ming 1989), the sedimentary environment is a braided river.

Lithofacies types

To reflect the changes of the hydrodynamic in the process of deposition and eliminate the uncertainty of the single sedimentary structure, the concept of the lithofacies was introduced (Miall 2006). Lithofacies is the sum of the rock characteristics formed under specific flow regime, which is significant for inferring transporting mode, hydrodynamic condition and sedimentary environment (Chen et al. 2013; Li and Huang 2017).

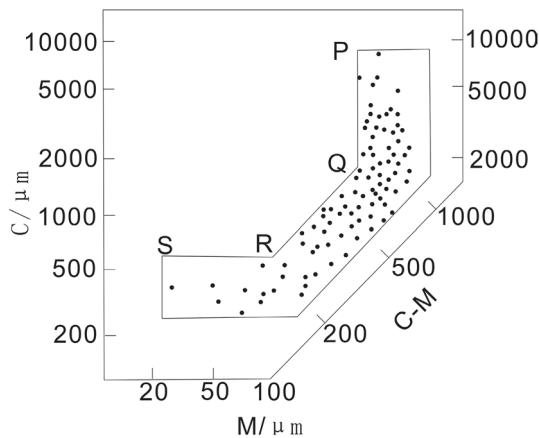


Fig. 4 Figure C–M of sandbody in Baolang oilfield

Based on the coring well data of Bao1252, the analysis of the lithology, granularity, sedimentary structure, and configuration relationship is carried out, and eight types of lithofacies are identified (Table 1).

1. LF1: Massive bedding conglomerate facies

With sandstone and conglomerate mixed and high content of conglomerate in lithic, both the sorting and the roundness of LF1 are poor. The LF1 is characterized by high content of matrix and loose cementation, where coal and mud bricks are common to see. Massive bedding is dominated, and imbricated structures occur occasionally. Scoured base is developed at the bottom of LF1. LF1 indicates abrupt high-energy regime.

2. LF2: Large trough cross-bedding sandy conglomerate facies

The sorting and roundness of sandy conglomerate are medium and poor, respectively. Large trough cross-bedding develop in LF2, but it is difficult to identify it in the core for the small scale. Scoured base is developed at the bottom locally. LF2 reflects a strong tractional current in a high-energy environment.

3. LF3: Large tabular cross-bedding sandy conglomerate facies

Both the sorting and roundness of the sandy conglomerate are medium. LF3 develops unclear tabular cross-bedding, which is manifested by the orientation of conglomerate or laminae. LF3 demonstrates tractional current in high-energy environment.

4. LF4: Graded bedding sandstone facies

LF4 is dominated by mid–fine grained sandstone, with conglomerate at the bottom. The bottom of LF4 exists

Table 1 Lithofacies types and genetic interpretation of III Formation in Baobei block, Baolang oilfield

Types	Code	Genetic interpretation	Types	Code	Genetic interpretation
Massive bedding conglomerate facies	LF1	Abrupt high-energy regime	Parallel bedding sandstone facies	LF5	Medium-energy tractive current
Large trough cross-bedding sandy conglomerate facies	LF2	Tractional current in high-energy environment	Wave bedding fine sandstone facies	LF6	Medium-energy environment with the affection of wave
Large tabular cross-bedding sandy conglomerate facies	LF3	Tractional current in high-energy environment	Mixed bedding sandstone and mudstone facies	LF7	Medium–low energy environment with the affection of wave
Graded bedding sandstone facies	LF4	Abrupt gravity current or high energy environment	Horizontal bedding mudstone facies	LF8	Low-energy environment with a certain depth of water

scouring surface. LF4 points to an abrupt gravity current or high-energy environment.

5. LF5: Parallel bedding sandstone facies

LF5 is mainly composed of fine sandstone, and there exists conglomerate locally. Both the sorting and the roundness are fairly well. LF5 represents medium tractional current.

6. LF6: Wave bedding fine sandstone facies

LF6 is dominated by fine sandstone, with minor conglomerate locally. Both the sorting and the roundness are moderate. LF6 indicates medium-energy environment affected by wave.

7. LF7: Mixed bedding sandstone and mudstone facies

The lithofacies of LF7 are interbedded layers of fine sandstone and mudstone. The mixed bedding mainly includes wavy, flaser, and lenticular bedding. Bioturbation structure and vertical bur are visible in LF7. LF7 represents medium–low energy environment affected by waves.

8. LF8: Horizontal bedding mudstone facies

The color of mudstone is dark grey or black. LF8 develops horizontal bedding and massive bedding locally. It contains animal shell fossil and a small amount of plant stem fossils. LF8 represents low-energy environment with a certain depth of water.

Fossil characteristics

In the study area, the fossils of plant stem and leaf can be seen, which represent the low-energy regime during the intermittent period of the flood. Bioturbation structure is common, and animal shell fossils can be seen occasionally, which primarily exist between the layers, indicating the sedimentary characteristics of interdistributary bay. The characteristics of these fossils imply the humid climatic conditions suitable for plant growth and the frequent changes of the shallow-water body.

Sedimentary facies characteristics

Electrofacies recognition template

According to the rock types, sedimentary structures, grain size characteristics, lithofacies types and palaeontology and other sedimentary facies markers, combined with wire-line

log data, it is considered that Sangonghe Formation in Baobei district, Baolang oilfield mainly develops braided river delta front subfacies. Based on the analysis of coring well data of Bao 1252, four types of petrofacies are identified: subaqueous distributary channel, mid-channel bar, channel lateral margin and interdistributary bay (Fig. 5).

Restored to logging curve elements, including amplitude, shape, contact relationship of the top and the bottom, smoothness, and tooth midline, the GR curve of 97 wells in the study area is analyzed. Eleven types of electrofacies are identified, including the funnel-shape, box-shape, bell-shape, serrated thick logging curve and near-linear thin logging curve and so on (Fig. 6).

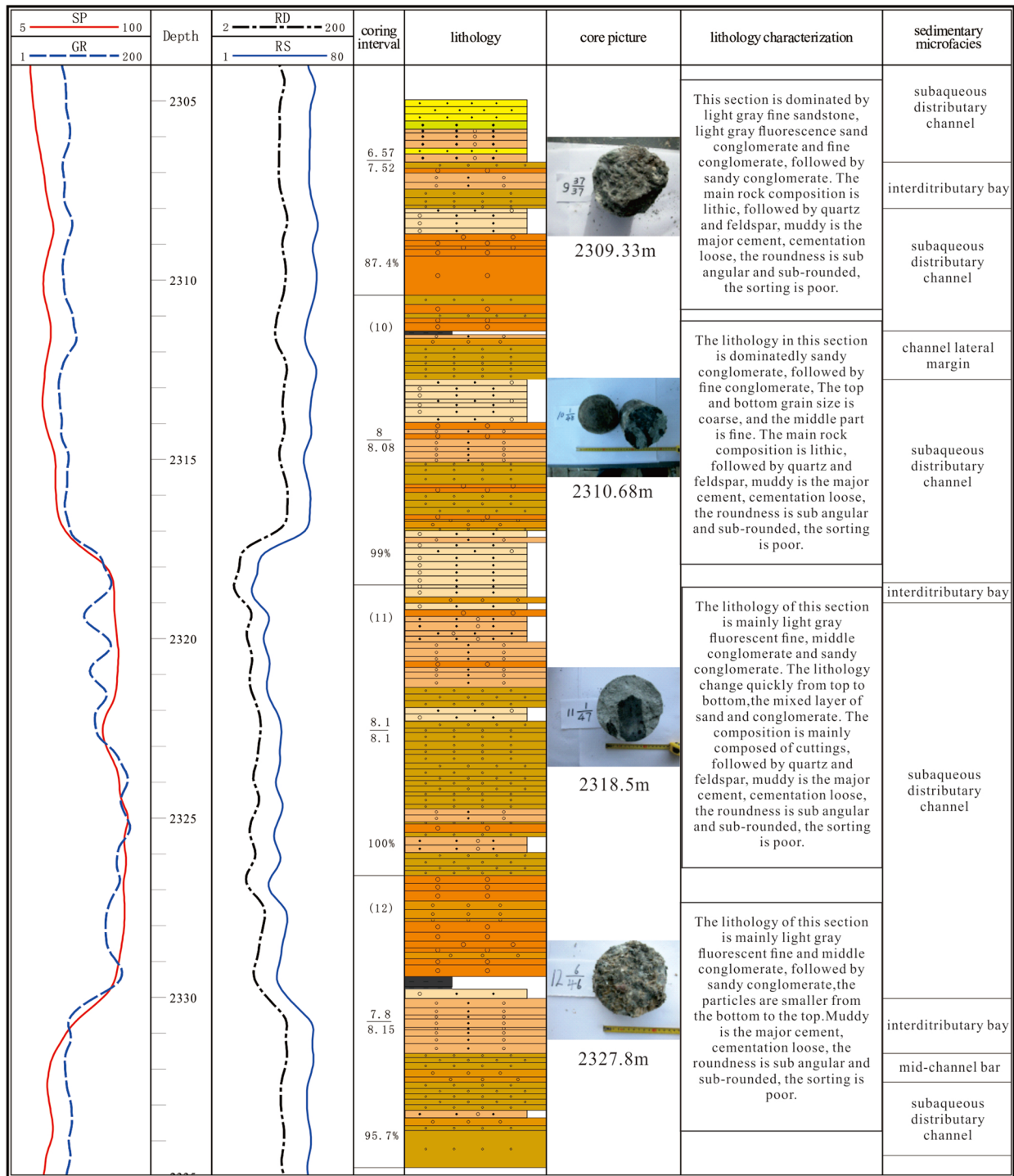
Aided by the data of seven coring wells, the correspondence between the electrofacies and the sedimentary petrofacies is established, and then electrofacies recognition template of III Formation in Baobei District, Baolang Oilfield is summarized.

Sedimentary petrofacies distribution

To study profile sedimentary petrofacies of Sangonghe Formation in Baobei District, Baolang Oilfield precisely, three longitudinal sections that are parallel to the northeast provenance and three longitudinal sections that are perpendicular to the northeast provenance are selected, respectively. Taking two representative longitudinal sections that are perpendicular to the source as an example (Fig. 7), the vertical sedimentary petrofacies distribution is discussed. According to the morphological characteristics of longitudinal sedimentary petrofacies, the sand bodies are divided into four types: large, medium, small channel sand bodies and thin sand sheet.

The outcomes show that sand bodies thickness of Sangonghe Formation changes slightly in the perpendicular direction of the provenance. Alternatively, large and medium-sized channel sand bodies account for more than 90%. Transversely, the lateral extent of the sand body is up to 500 m with good connection. Vertically, sand bodies are stacked, with thick single sand body that is more than 10 m and thin interlayer. Taking the Layer III₂¹⁺² as an example, the distribution of sandbody thickness is shown in the Fig. 8. And the range of sandbody thickness is displayed in Fig. 9. The contact relationship between different sand bodies can be summed up as five types, including vertical superposition, vertical tangency type, lateral superposition, lateral tangency type, and vertical separated (Fig. 10).

In the transverse plane, distribution of sedimentary petrofacies on planar is analyzed, which is based on the distribution of sand body thickness and the response characteristics of wire-line log (Figs. 8, 11). It should be noted that the planar sedimentary facies are the overall characteristics of vertically stacked sand bodies in a certain period of time, and the large



mudstones

fine sandstones

medium sandstones

gravelly sandstones

sandy conglomerates








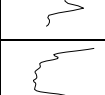
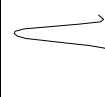
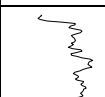
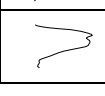
fine conglomerates

medium conglomerates

cobble conglomerate

Fig. 5 Synthesis columnar section of core sedimentary petrofacies of well Bao 1252

Fig. 6 Electrofacies recognition template

Sedimentary facies	Sedimentary microfacies	Electrofacies (GR curve)		Remarks
Channel facies	large channel sand body		Smooth box-shaped logging curve	The amplitude of logging curve is generally low, micro-toothed and toothed curve shape, and the sandstone thickness is large.
			Micro-toothed box-shaped logging curve	
	medium channel sand body		Smooth bell-shaped logging curve	The amplitude of logging curve is generally low, micro-toothed and toothed curve shape, and the sandstone thickness is large.
			Micro-toothed bell-shaped logging curve	
	small channel sand body		Toothed thin box-shaped logging curve	The amplitude of logging curve is generally high, the curve is generally smooth, and the sandstone thickness is small.
			Micro-toothed thin box-shaped logging curve	
			Funnel-shaped thin logging curve	
			Thin bell-shaped logging curve	
Front sheet sand			Single-finger type logging curve	The amplitude of the logging curve is high, the curve is smooth, the thickness is small, and the sandstone distribution is extensive.
Interdistributary bay			Serrated thick logging curve	The amplitude of the logging curve is zero, the curve is smooth or toothed, and the sandstone thickness varies.
			Near-linear thin logging curve	

thickness of sandbody that is wide strip or sheet-like actually represents the lateral migration range of sandbody in the certain period of time, namely, the frequency of sedimentary petrofacies turns up, instead of the single sand body actual thickness. The geological significance is that according to the sand body types, cumulative thickness and the occurrence, we can both determine the continuity of sand bodies and the position of the subaqueous distributary channel facies. The results manifest that there are three rivers in the study area, and the subaqueous distributary channel facies is dominated, followed

by channel lateral margin, and a large number of mid-channel bars exist. The river features of this study area are exhibited in Table 2.

Sedimentary model

Based on the geological background, core data and wire-line log data of III oil-bearing interval of Sangonghe Formation in Baobei district, Baolang oilfield,

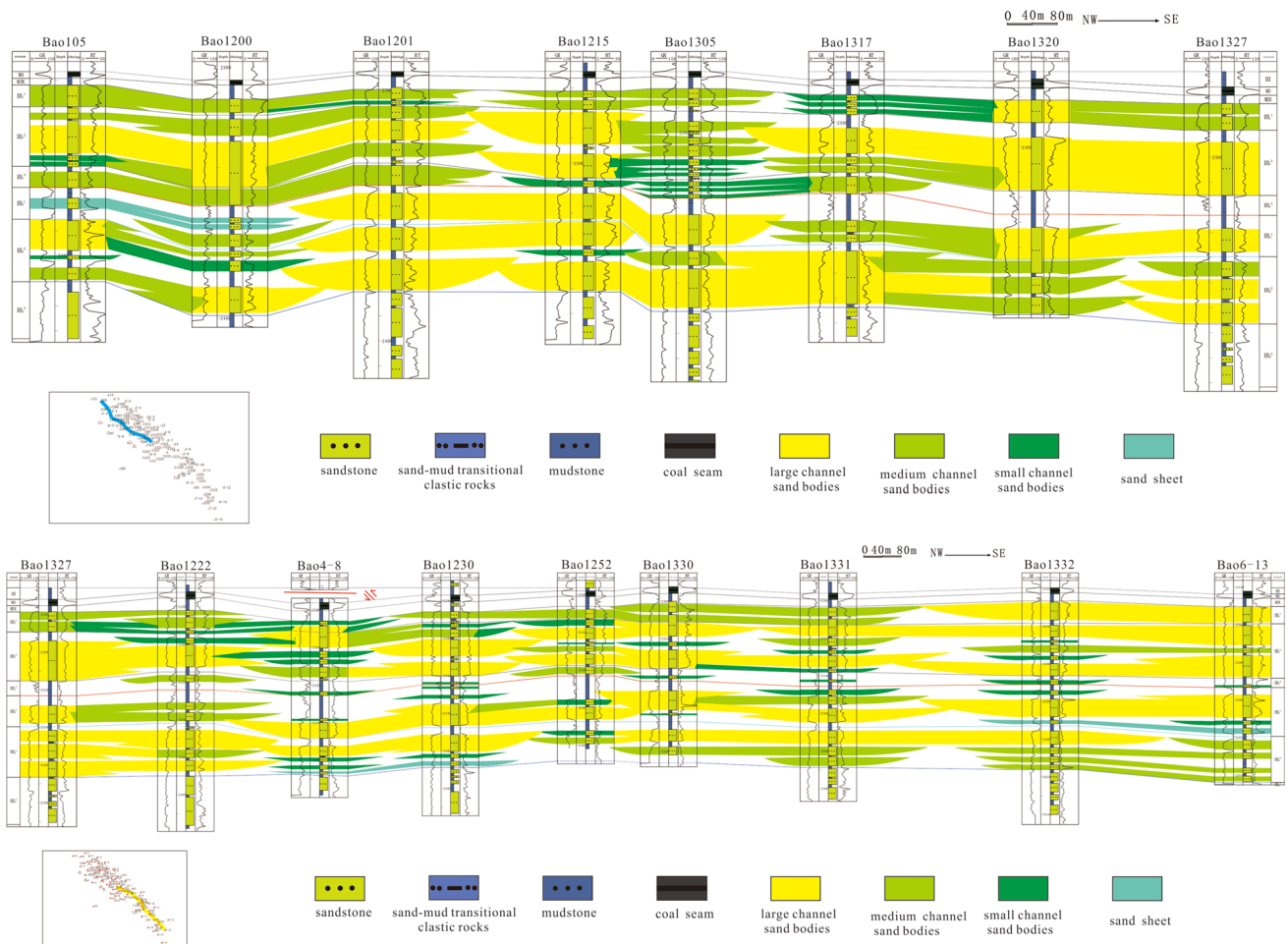


Fig. 7 Vertical section of sedimentary petrofacies of III oil-bearing interval of Sangonghe Formation in Baobei block, Baolang oilfield

the sedimentary model of the study area are reconstructed (Fig. 12).

In the early period of Jurassic Sangonghe Formation, the sedimentary background is regressive systems tract with a wide lake-basin. The study area lies in the gentle slope of the northern part of Yanqi basin, where the lake area changes greatly in response to the slight variation of a shallow-water body. Periodic precipitation occurs in the study area with the influence of the humid climate, causing frequent fluctuation of the lake level. Furthermore, the steady subsidence of the basin provides adequate accommodation for the deposition, and the clastic materials transported from the northern edge of the basin deposit in the lake continuously.

The process of deposition in the study area can be summarized as follows:

In stage of the lake level declines, both the lake area and the river hydrodynamic force descended gradually, causing the movement of the delta front toward the center of the basin. The river gradually formed a relatively fixed river channel. Accommodation is reduced with the accumulation

of sediment, leading to the lateral migration of sandbodies. Thus, the distribution of sandbodies in the study area was continuous. After the river entered the lake, subaqueous distributary channel width suddenly increased significantly due to the flat terrain in the shallow-water. And this was the reason why a large amount of mid-channel bar occurred. In the low water period, the sand body was exposed to air and vegetation grew in the study area, forming the coal sediment in the delta front.

In the flooding period, the fixed channel in the period of low water was submerged by the lake water. The position of the river entering the lake had changed, resulting in formation of new deposition at a new place. The sedimentary area of sand body changed into a deep water environment with the increase of the lake level and began to deposit mudstone, forming the interlayer of the study area.

During the deposition period, the delta front continuously experienced the cycle, “In the low water period, the sandstone deposited, and in the flooding period, the mudstone deposited”. Although the length of the dry season

Fig. 8 Sandbody thickness contour line of Layer III₂¹⁺² in Baobei District, Baolang oilfield

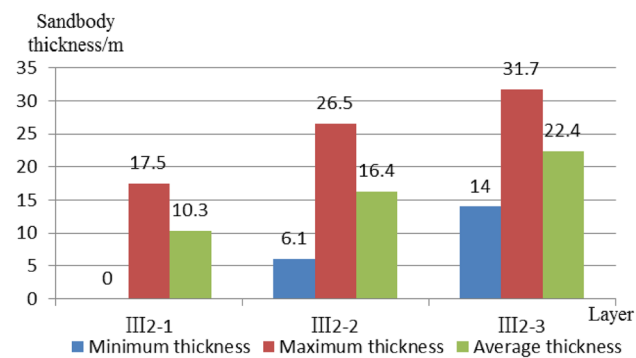
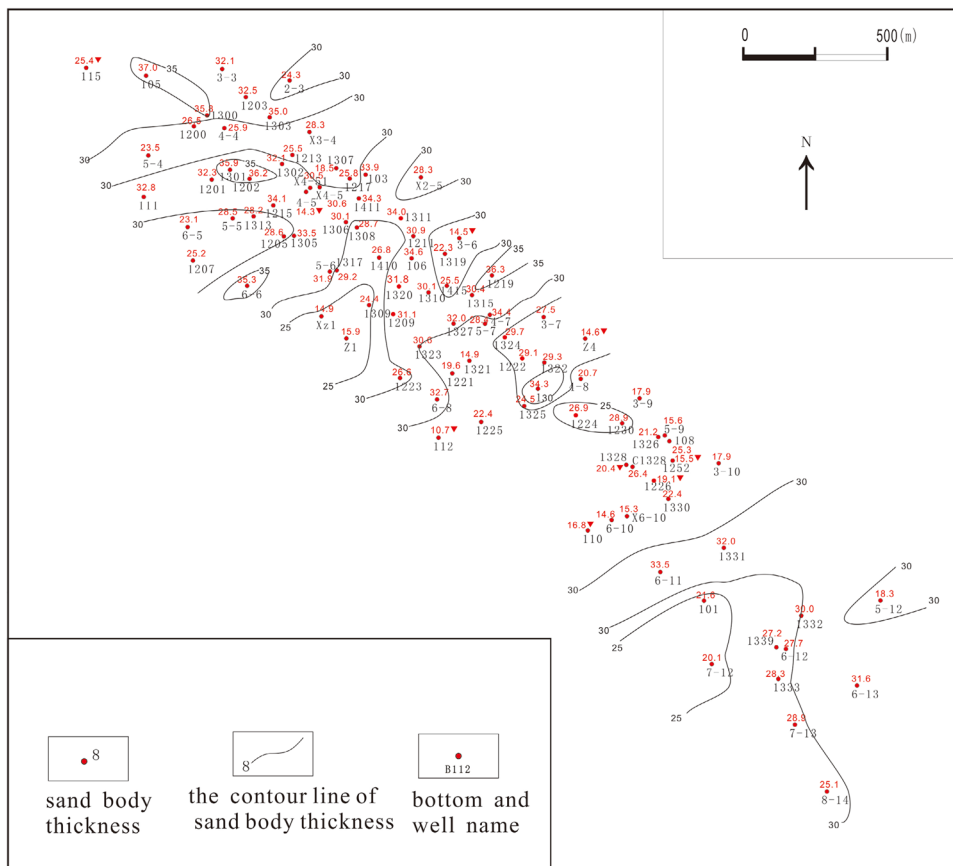


Fig. 9 Sandbody thickness of the different layer in Baobei District, Baolang oilfield

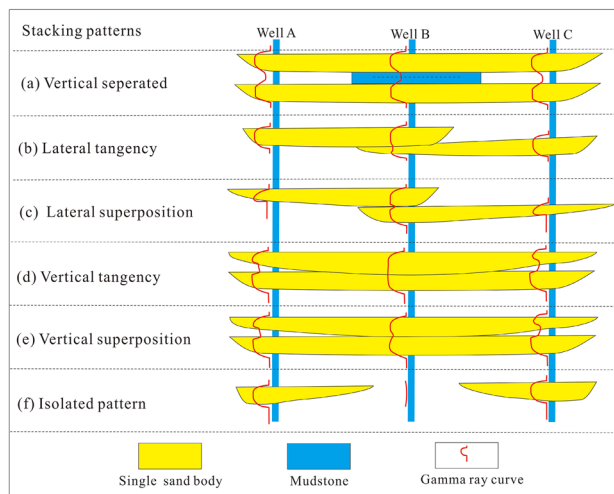


Fig. 10 Sandbodies stacking patterns

and flood period is almost equal, the quicker deposition rate of sand bodies rendered the thickness of sandstone is larger than that of mudstone.

In the prodelta, sand sheet occurred with the influence of the wave action. However, the study area was controlled by the river, thus few sand sheets existed.

Conclusions

The study area deposits under the gentle slope depositional background. The characteristics of short distance to sediment source can be ascertained according to the low

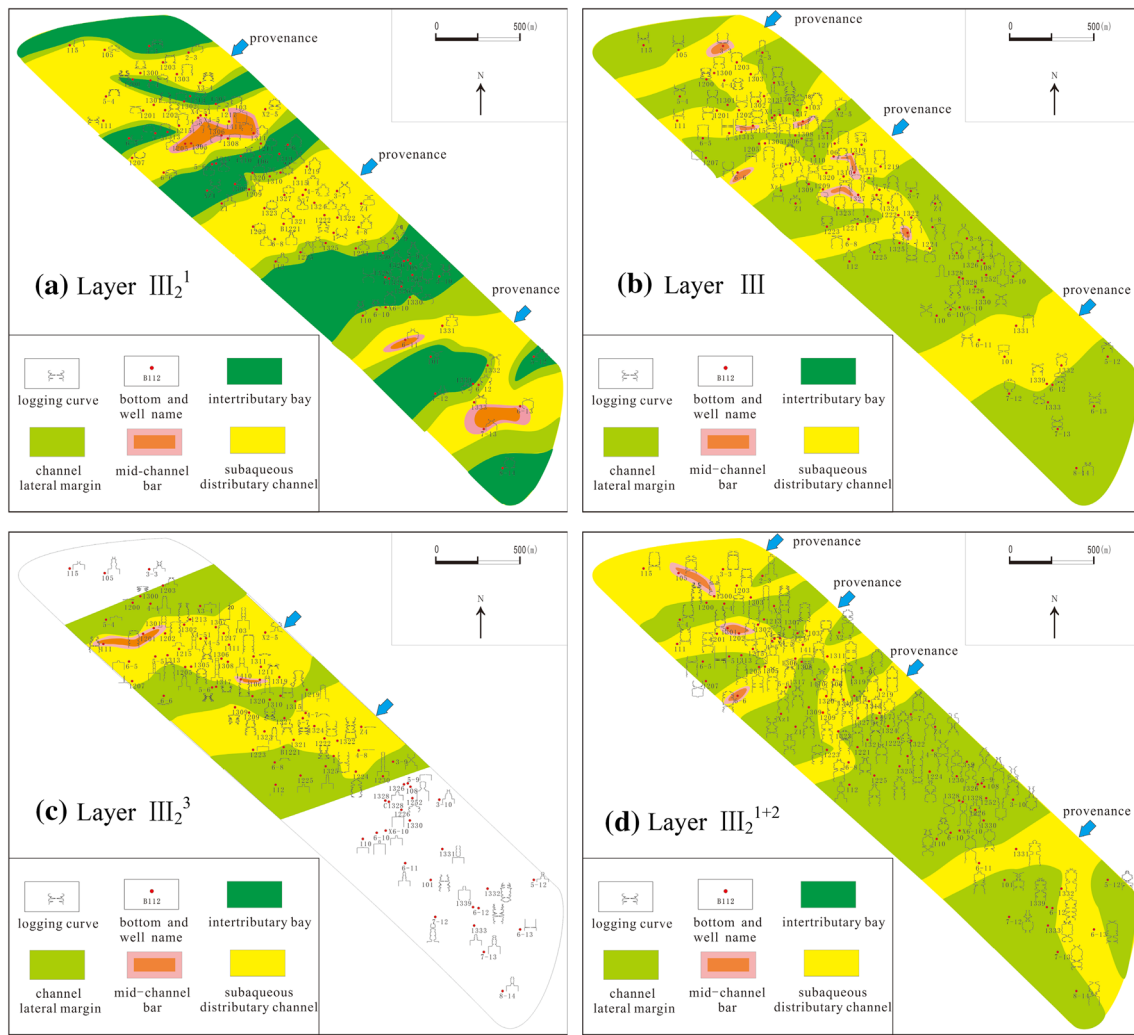


Fig. 11 Planar map of sedimentary petrofacies of III oil-bearing interval of Sanggonghe Formation in Baobei District, Baolang oilfield

Table 2 River feature of III oil-bearing interval of Sanggonghe Formation in Baobei District, Yanqi Basin

Layer	River number	Tributary number	Maximum width	Minimum width	Mid-channel bar
III ₂ ¹	3	5	400	80	3
			550	350	
III ₂ ²	3	5	400	200	7
			360	40	
			400	200	
III ₂ ³	2	2	600	200	2
			520	130	
III ₂ ¹⁺²	3	6	—	60	3
			200	70	
			400	150	

compositional maturity, the low textural maturity and the figure C–M of sandbody. In addition, according to figure C–M of sandbody, continuous distribution and overlapping relationship of the sandbody, and the logging curve which is dominated by box-shaped curve with a minority of bell-shaped curve, it can be confirmed that the study area develops braided river delta. The characteristics of fossil demonstrate the humid climate and the shallow water in the study area. Therefore, the study area develops short-distance gentle slope shallow-water braided river delta.

Based on the core data and wire-line log data, eleven electrofacies are identified, including the funnel-shaped, box-shaped, bell-shaped, serrated thick logging curve and near-linear thin logging curve and so on. Moreover, four horizontal sedimentary petrofacies, including subaqueous distributary channel, mid-channel bar, channel lateral margin, and intertributary bay, and four longitudinal sandbody types, including large, medium, small channel

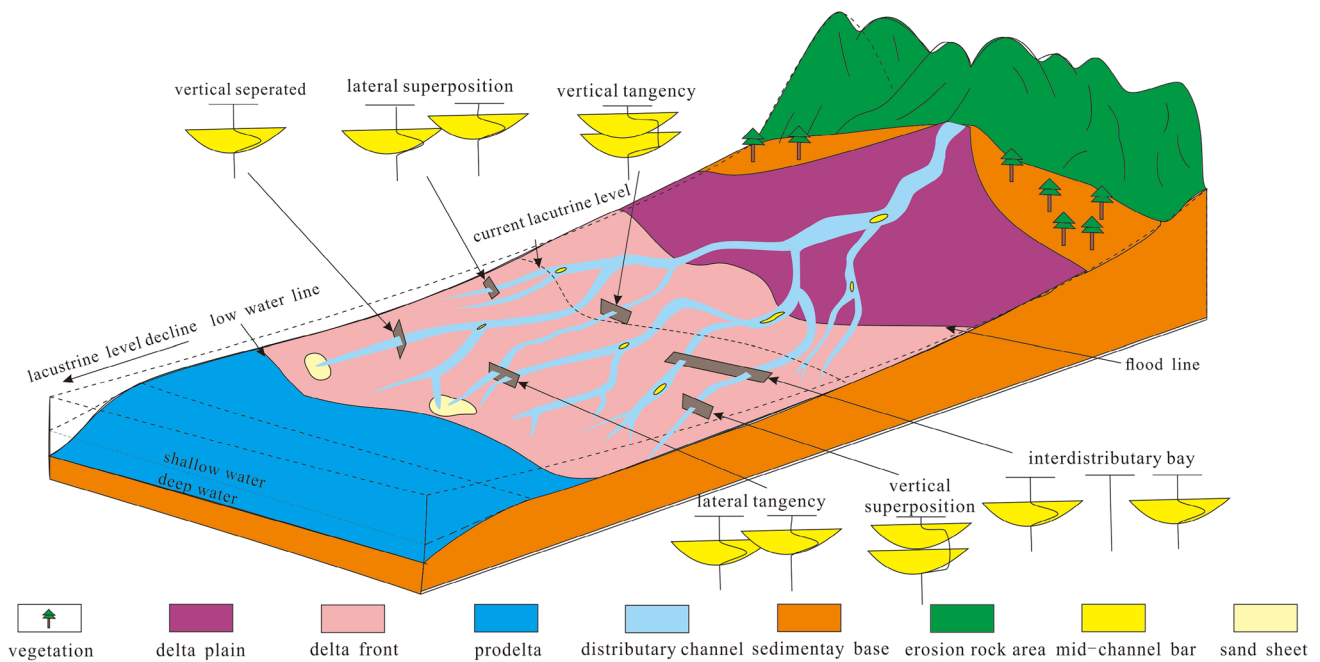


Fig. 12 Sedimentary model of III oil-bearing interval of Sangonghe Formation in Baobei District, Baolang oilfield

sand bodies and thin sand sheet, are also recognized, respectively.

Given the condition of sedimentary background and characteristics of Sangonghe Formation in Baobei District, Baolang oilfield, synthesis effects of climate and gentle slope control the fluctuation of the lake level. Furthermore, the distribution of the facies belt, the position of the river and the distribution of the sand body are determined by the fluctuation of the lake level. The sedimentary model can be concluded as “gentle slope, strong flow, frequent fluctuation of lake level, thick and wide sand body”.

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