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Analysis of Sedimentary Facies and Sand Body Distribution in Yan10 Member of Bai211 Well Area, Nanliang Oilfield

Zixuan Wang[1,2]

[1]College of Earth Science and Engineering, Xi'an Shiyou University, Xi'an, China
[2]Shaanxi Key Laboratory of Petroleum Accumulation Geology, Xi'an, China
Email: 136704720@qq.com

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Abstract

Taking Yan10 member of Bai211 well area of Nanliang oilfield as the research object, the stratigraphic subdivision, sedimentary facies type and sand body distribution characteristics are analyzed by making full use of drilling and core data. The results show that Yan10 formation can be subdivided into Yan101, Yan102, Yan103 and Yan104. Braided channel, core beach and floodplain are the main sedimentary microfacies. The extension direction of Yan10 member sand body is north to south, and the whole channel sand body of the reservoir group is relatively developed, with large thickness, far extension and good connectiveness.

Subject Areas

Sedimentary Petrology, Geology

Keywords

Nanliang Oilfield, Extend 10 Sections, Small Layer Division and Comparison, Sand Body Distribution

1. Introduction

The Jurassic in Ordos Basin includes Anding Formation, Zhiluo Formation, Yan'an Formation and Fuxian Formation, among which Yan'an Formation is divided into 10 reservoir groups from top to bottom [1]. Jurassic Yan'an Formation is considered as an important target stratum because of its good reservoir property and high productivity. However, the reservoir of Yan'an Formation is small in scale, strong in concealment, and difficult in exploration [2]. Based on the reservoir

characteristics of Yan'an Formation, identifying its sedimentary facies and sand body distribution characteristics is more conducive to searching for subtle reservoirs such as strata and lithology [3]. On the basis of previous studies, through the analysis of core and well logging data, the sedimentary system, sedimentary facies type and sedimentary characteristics of Yan10 member oil formation in Bai211 well area of Nanliang oilfield are determined in this paper. By drawing the fine-layered sedimentary microfacies and sand body distribution map of Yan10 member oil formation in the study area, the distribution law and connectivity of sand body are clarified. It is of great practical significance to guide the follow-up exploration and development in Nanliang area.

2. Geological Profile

Ordos Basin starts from Yinshan Mountain in the north, reaches Qinling Mountain in the south, and is bounded by Luliang Mountain and Tengger Desert in the east and west [4]. Nanliang oilfield is located in the southwest part of Yishan slope of Ordos Basin (**Figure 1**). It is a west-dipping monoclene structure with a

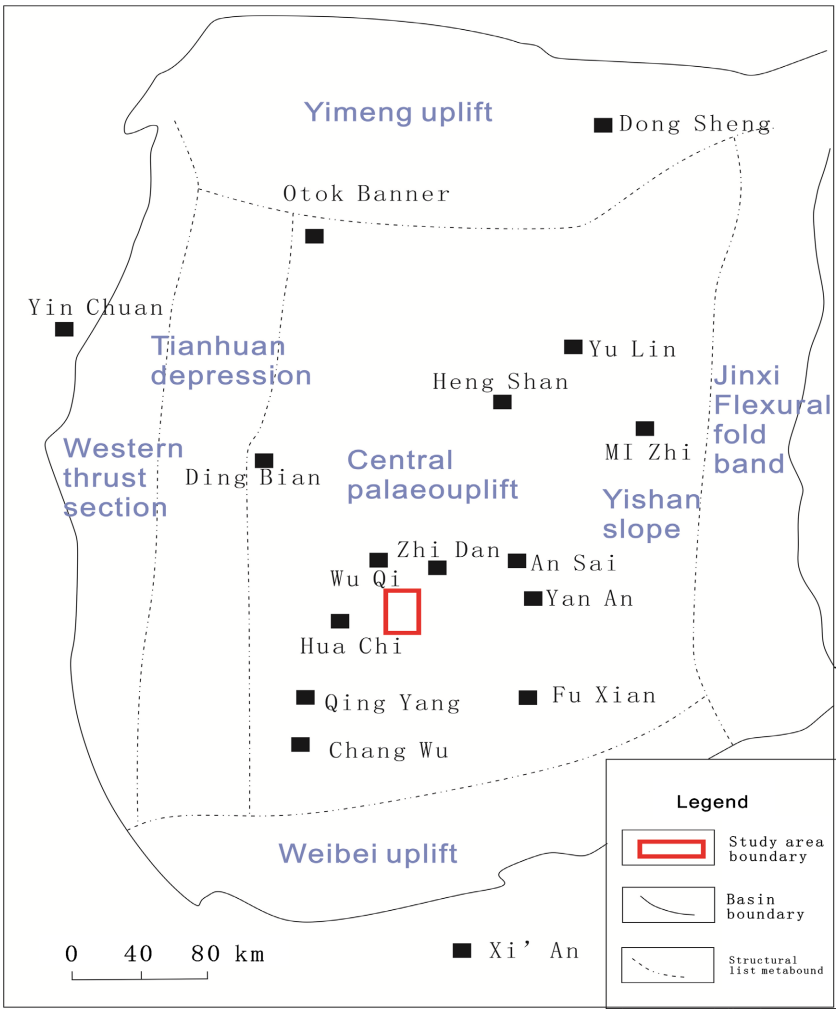

Figure 1. Ectonic location map of Ordos Basin.

dip angle of less than 1˚. The axial NE-southwest-trending rhinocline structure is developed on the slope.

Under the influence of regional tectonic subsidence and sediment source supply, the reservoir group in the Bai211 well area of Nanliang oilfield is mainly a braided river depositional system, which is mainly distributed in restricted valley filling sedimentation because it is formed in a relatively stable stage in a large area [5].

3. Stratigraphic Division and Correlation

At the top of Yan10 member, a top coal seam about 2 m thick is developed, and its electrical characteristics are typical "three high and three low" as the main marker [6], namely, high resistivity value, high compensated neutron value and high sonic time difference value. Low volume density value, low gamma ray value, low lithology density. Yan10 member oil formation itself developed a set of giant thick sandstone. Taking the typical well Jingbai 300-6 as an example, the mud deposits of Yan10 member developed at the top, and three sets of positive cycles were developed inside, with obvious mud interlayers at the depositional interface. It can be divided into four sub-layers, namely extension 10_1, Extension 10_2, extension 10_3 and Extension 10_4. Two phases of small scale channel deposition developed inside $Yan10_1$, and the two phases were intercut and overlapping. Due to the overlying channel erosion, the muddy interlayer was washed away, and the remaining scale was very small, but the natural gamma and spontaneous potential return characteristics were still visible, and the physical cycle was also clearly visible. $Yan10_1$ could be subdivided into $Yan10_1^1$ and $Yan10_1^2$ single-layer.

4. Sedimentary Characteristics

4.1. Division of Sedimentary Facies

Braided channel deposits of Yan10 member of Bai211 well area are mainly channel sand bars and channel retention deposits, which mainly include various gravel transported from the upper reaches and mud gravel formed by river erosion of riverbank or underlying rock formation [7]. Core data show that the lower part of Yan 10 member in the study area is characterized by the development of medium-coarse sandstone, with scour surface developed at the bottom, some mud gravel (**Figure 2(a)**), oblique bedding (**Figure 2(b)**) and massive bedding formed during rapid deposition (**Figure 2(c)**). Most of the spontaneous potential and gamma curves are bell-shaped or compound bell-shaped with medium-high amplitude, which are typical characteristics of braided channel sedimentary logging response.

The main body of braided river deposition in the channel is the core beach microfacies, and the hydrodynamics is relatively weak. The channel is mainly dominated by lateral migration [8]. The core data show that the thickness of Yan10 member sand body in the study area is relatively large, and thin siltstone and mudstone interlayers are mostly found on the flanks of the river channel. The

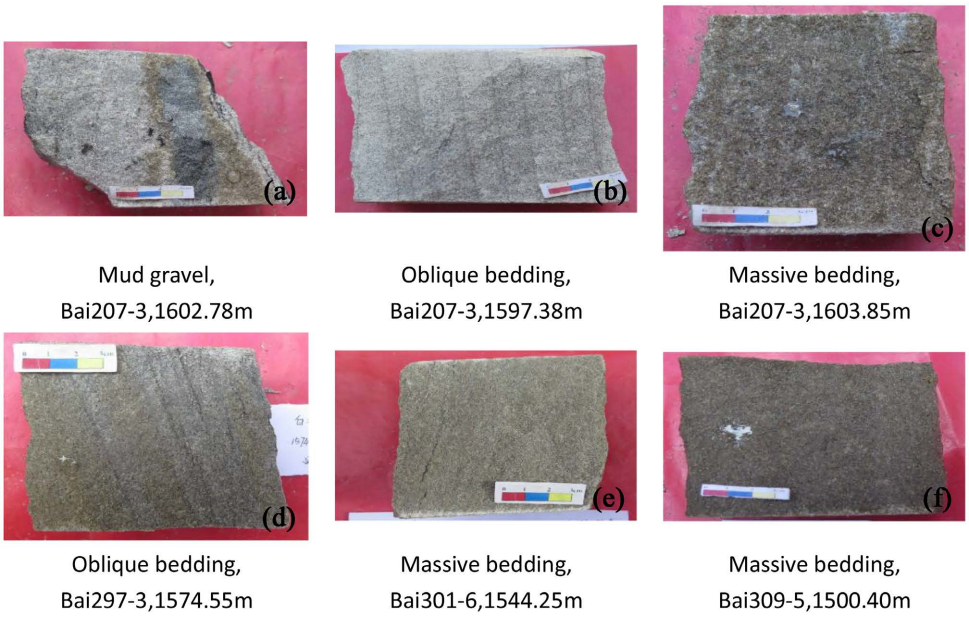

Figure 2. Typical core photos of Yan10 member of Bai211 area.

braided channel and the core beach sand bodies are superimposed on each other, and the vertical superimposed sand bodies are thick. Large cross-bedding is mainly developed, such as oblique bedding (**Figure 2(d)**) and massive bedding (**Figure 2(e)**). The curves of spontaneous potential and gamma ray show obvious box shape or funnel shape, which shows typical logging response characteristics of core beach deposition.

The relatively flat part outside the riverbed at the bottom of the valley is the floodplain [9]. Because the energy of the upper channel of Yan 10 member in the study area weakens to abandonment, the lithology tends to become thinner vertically from bottom to top. Horizontal bedding and massive bedding are mainly developed, and coal seam is developed at the top. The spontaneous potential and gamma curve is a flat segment or a low-amplitude tooth near the mudstone base line. It is a fine-grained deposit with local silty bands.

By combining drilling core data, sedimentary facies identification markers and sedimentary background, the sedimentary facies of Yan10 member of Bai211 well area in Nanliang area are analyzed. It is concluded that braided river deposits are mainly developed in this area, and the sedimentary microfacies are braided channel, core beach and floodplain deposits.

4.2. Single Well Facies Characteristics

The microfacies of single well are analyzed based on the microfacies of Bai211 well area in Nanliang oilfield. Taking Well Bai 301-6 as an example (**Figure 3**), two sets of braided channel deposits are developed in this well from bottom to top. The lithology is mainly light gray fine sandstone, with massive structure, wavy bedding, plate bedding and other sedimentary structures. Among them, the channel sandbodies of $Yan10_2$ and $Yan10_3$ cut and overlap with each other to

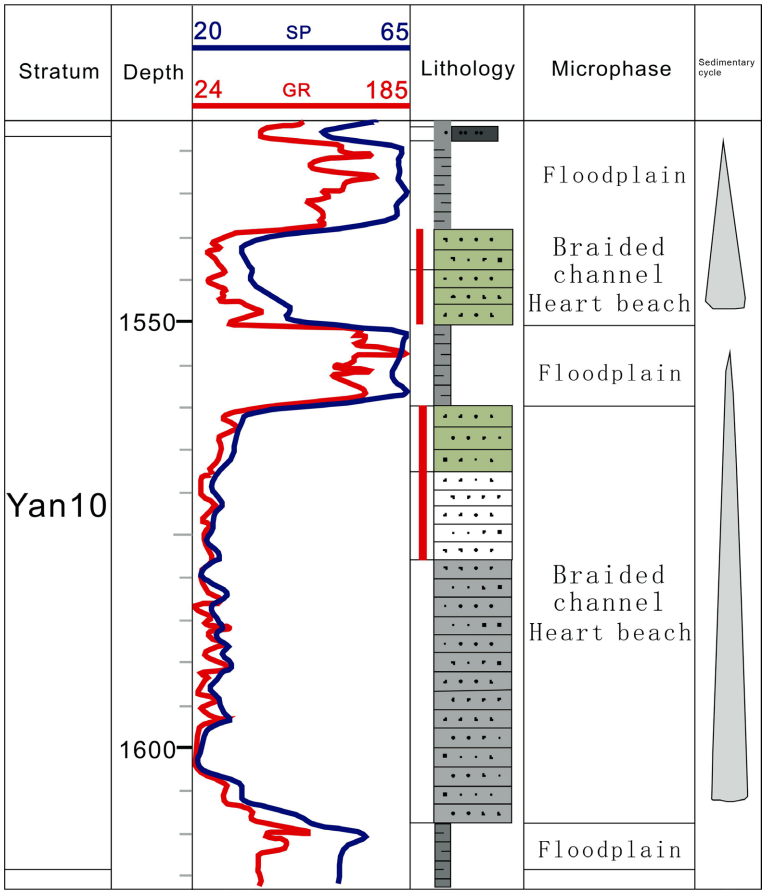

Figure 3. Sedimentary microfacies histogram of Well Bai 301-6, Bai211 District.

form 48m thick sandstone, and the intermediate muddy interlayer has been washed away, and the natural gamma curve has slightly returned. The channel sandbodies deposited between $Yan10_1$ and $Yan10_2$ are separated by the floodplain deposits, whose lithology is mainly dark gray mudstone with a thickness of 8m, while the sandstone of $Yan10_1$ is about 10m thick. The natural gamma was in the shape of a toothed box. Due to the erosion of the overlying sandstone, the argillous interlayer between $Yan10_1^1$ and $Yan10_1^2$ had been washed away, and the natural gamma returned slightly. Due to the weakening of the hydrodynamics, the floodplain mudstone deposits developed on the top of $Yan10_1$.

5. Sand Body Distribution Characteristics

The distribution of sand bodies is mainly controlled by the distribution of sedimentary microfacies, and the distribution characteristics of channel in each period determine the distribution characteristics of sand bodies.

In general, the sand body of Yan10 member is relatively developed on the whole, with wide river channel, large thickness of sand body, far extension and good contiguity. The thickness of small-layer $Yan10_2$ sand body is large (**Figure 4(a)**), and the thickness of main channel sand body is greater than 15 m. The overall development of $Yan10_1^1$ sand body is slightly worse (**Figure 4(b)**). The

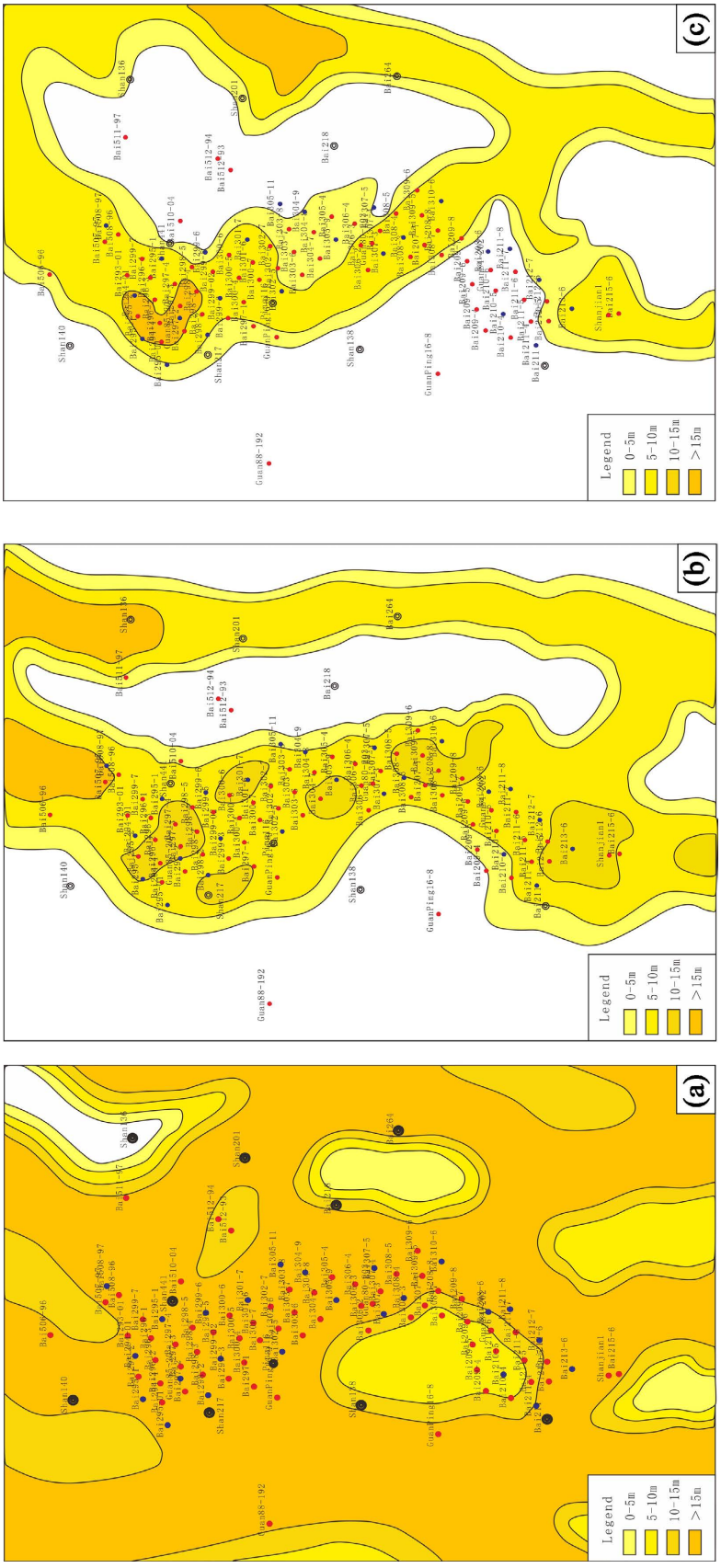

Figure 4. Yan10 sand body layout in Bai211 area.

development degree and distribution of $Yan10_1^2$ sand body is similar to that of $Yan10_11$ (Figure 4(c)). Some wells have relatively thick sand bodies, and the overall sand body size is smaller than that of $Yan10_2$.

The thickness of the sand body of the Yan10 member becomes thinner in the longitudinal direction, and the sediment range of the channel becomes smaller, and the sediment range of the floodplain and the core beach expands gradually. The sand body shows a trend of distribution from south to north, and the inheritance of sand body is greater than the migration.

6. Conclusions

1) Based on the microfacies histogram of a single well, it can be concluded that the coal seam 2 m thick is distributed on the top of the formation of Yan10 member in the study area, and the distribution is relatively stable, with obvious characteristics of marker layer, and the thickness of the formation is about 80 - 100 m. According to the correlation of sedimentary cycles, Yan10 member is divided into $Yan10_1$, $Yan10_2$, $Yan10_3$ and $Yan10_4$ layers. On the basis of a small-layer subdivision, $Yan10_1$ was subdivided into two fine layers, namely $Yan10_1^1$ and $Yan10_1^2$, with a total of five small layers.

2) The strata of Yan10 member are braided river subfacies sedimentary systems, mainly developed braided channel, floodplain and core beach sedimentary facies. Among them, braided river channel sand body is a good skeleton sand body, mainly medium fine sandstone, oblique bedding and massive bedding. During the evolution of sedimentary microfacies from $yan10_1^1$ to 10_2, the range of channel sand bodies gradually increased, and the area of core beach increased from points to planes.

3) Each small layer of the Yan10 oil formation is mainly based on the sand body deposited by the river channel. The overall sand body is relatively developed, the river channel is wide, the sand body is thick, the extension is far, and the jointing property is good. On the plane, the sand body is generally distributed from south to north.

Conflicts of Interest

The author declares no conflicts of interest.

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