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Reservoir Characteristics of Yanchang Formation Chang-6 in the Central East Ordos Basin

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Abstract

The Triassic Yanchang Formation 6 in Ordos Basin is mainly developed with low porosity and low permeability sandstone reservoirs. The development effect in recent years is not ideal, so the Chang-6 reservoir has become a key research object. Through core observation, thin section identification, well logging data and other analysis and testing, the research on the petrology, reservoir space and reservoir physical properties of this layer is carried out. The study shows that the rock type that can be used as a good reservoir is feldspar, the pore type of the reservoir space is mainly residual intergranular pore, the average porosity of the Chang-6-1-2 reservoir is 9.33%, and the average porosity of the Chang-6-2-1 reservoir is 9.65%, belonging to the ultra-low to ultra-low permeability layer. Because the study area was in delta facies during the 6th period of the study, the formation of regional favorable reservoirs is mainly the NE-SW distributary channel, which determines the type of reservoir space and the large area distribution of the plane. The research results provide the exploration direction for the Yanchang Formation 6 reservoir in Ordos Basin, and have important reference significance.

Subject Areas

Geology

Keywords

Reservoir Characteristics, Ordos Basin, Petrological Characteristics, Reservoir Physical Properties

1. Introduction

The Qujiagou oil field studied in this study is located in the middle of the northern slope of the Ordos Basin. This block belongs to Wayaobao Oilfield, adjacent to the Zhongshanchuan oil field, and located in the east of the Zhongshanchuan oil field. Qujiagou oil field is located in the northwest of Zichang Oilfield, the northeast of Ansai Oilfield and the southwest of Zibei Oilfield. The oil region is located in Anding Town, Zichang City, Yan'an City, Shaanxi Province. The scope of this study is about 30 km^2.

The Chang-6 formation in Qujiagou oil area has achieved certain development results through exploitation and water injection development. Qujiagou area was put into development in 1990. After 17 years of production and development, and 5 years of stable production and development, the production capacity has decreased since 2014.

In recent years, there have been many problems in oil and gas exploitation in Qujiagou oil region. The early development time of Qujiagou has passed, and now it has reached the stage of declining production capacity, which makes oil and gas development more difficult. In order to put forward development countermeasures reasonably, it is necessary to study the reservoir accurately to the small layer, so as to improve the precision of water injection development and provide reference significance for the adjustment of water injection development plan. The reservoir sand body in the study area belongs to the tight reservoir. Through the study of various characteristics of the reservoir, the development technology suitable for the tight reservoir in this area can be selected.

2. Regional Profiled

The Ordos Basin developed large inland lakes in the Late Triassic and deposited the Upper Triassic source and reservoir rock series with a thickness of more than kilometers. The sedimentary filling history of the Yanchang Formation recorded the complete evolutionary history of intermittent, oscillating lake transgression and lake regression of the large freshwater lake basin. (**Figure 1**)

During the sedimentary period of Yanchang Formation, the Ordos Basin is characterized by large area, wide water area, shallow depth, flat terrain and weak segmentation. The axis of the basin is NW-SE, and the sedimentary center of the lake basin is south of the 38˚ north latitude line. The distribution of the facies belt is slightly ring-shaped, and the lake shoreline of the southwest margin is in the Shigouyi-Pingliang-Yongshou area, and the nearshore underwater fan deposits are developed along the lake shoreline. The northern lake shoreline is located in the area of Wushenqi-Jingbian-Hengshan-Zizhou. A series of lake delta deposits are developed along the lake shoreline from north to south, from northeast to southwest or from east to west. The shape of the lake basin is asymmetrical, steep in the west and gentle in the east. [1]

The lake basin began to shrink in the Chang-6 period, and the sedimentation compensation was greater than the settlement, which was the peak period of lake delta construction. During the deposition period of the Chang-4+5 oil layer formation, many large deltas formed in the Chang-6 period were swamped in

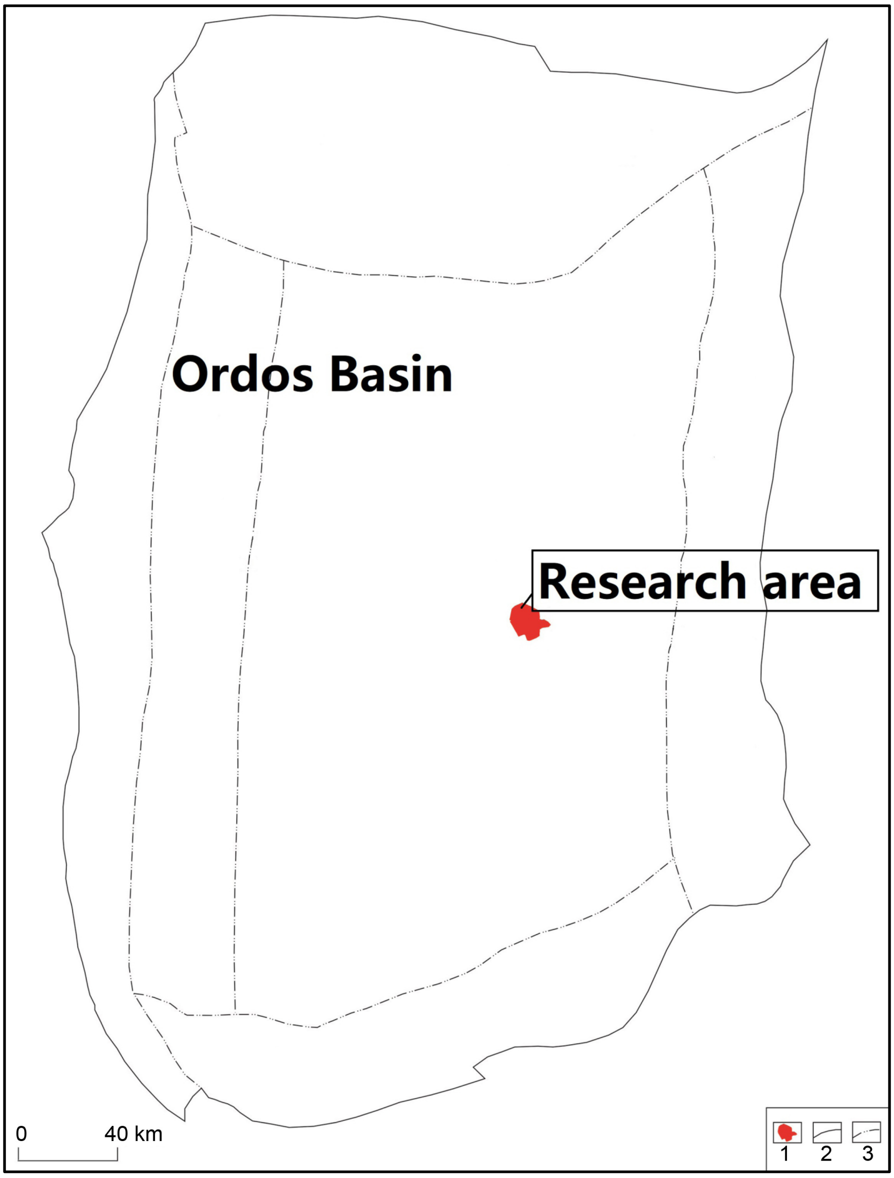

Figure 1. Location of study area.

plain, and delta plain, intertwined river and shallow lake deposits were relatively developed. [1]

Therefore, the sedimentary background of the Chang-6 period in the study area is delta front and delta plain, and the provenance direction is NE-SW. Due to the clastic supply in the source direction, a lot of sand bodies were developed in this period, which served as good reservoirs in the study area. From the Chang-6 period to the Chang-4+5 period, due to the gradual plain and swamping of the delta, mudstone was deposited on the delta front sand body and became a good cap rock.

3. Reservoir Characteristics

This study will research the basic characteristics of the reservoir from the following three aspects.

3.1. Petrological Characteristics

3.1.1. Clastic Composition and Characteristics

According to the identification and statistics of the thin sections of the rocks of the Chang-6 reservoir in the study area and adjacent areas, the main type of sandstone in the Chang-6 reservoir in the study area is feldspathic sandstone, and the feldspar content in the detrital grain composition is relatively high, with an average content of about 53%, and the types are orthoclase and plagioclase. The second highest proportion of clastic particles is quartz, with an average proportion of about 20%. The proportion of rock cuttings is relatively low, with an average proportion of about 16%. Mica is the main type of rock cuttings, with an average content of about 4%.

3.1.2. Characteristics of Filler

The miscellaneous base in the study area is mainly argillaceous, iron-bearing argillaceous and fine silty sand, which is unevenly distributed. The miscellaneous base is filled in intergranular pores, and partially replaced by chlorite and calcite cements. [2] Among them, the average content of heterobase is about 4%, and the proportion of turbidite is the highest, followed by chlorite. The proportion of calcite is the lowest, with an average content of 2.5% and 1.2% respectively.

3.2. Storage Space Type

3.2.1. Pore Type

According to the classification of pore occurrence and pore dissolution, the pore structure types of clastic rocks can be divided into intergranular pores, intragranular pores, micropores, fracture pores and dissolution pores, intergranular dissolution pores and other types. According to the results of identification and statistics of cast thin sections in the study area and adjacent areas, the pores of Chang-6 reservoir in the study area are mainly intergranular pores, accounting for about 2% of the pores, and the residual intergranular pores are the most developed; Among the pore types of Chang-6 reservoir in the study area, the ratio of intergranular dissolved pores is only second to intergranular pores, with an average ratio of about 1%. Among them, turbidite dissolved pores and feldspar dissolved pores are relatively developed, accounting for a large proportion. [2] [3]

1) Intergranular pore: intergranular pore can be divided into complete intergranular pore, residual intergranular pore and fissure intergranular pore according to the amount of filling matrix and cement. Residual intergranular pores were found at the Chang-6-2-1 layer in the study area. The main feature of residual intergranular pores is that there are some interstitial materials in the intergranular pores. In the study area, the interstitial materials are generally composed of chlorite, calcite, quartz secondary enlargement and other materials. At the depth of 1220.86 m of Well 2341-1 in the adjacent area, residual intergranular

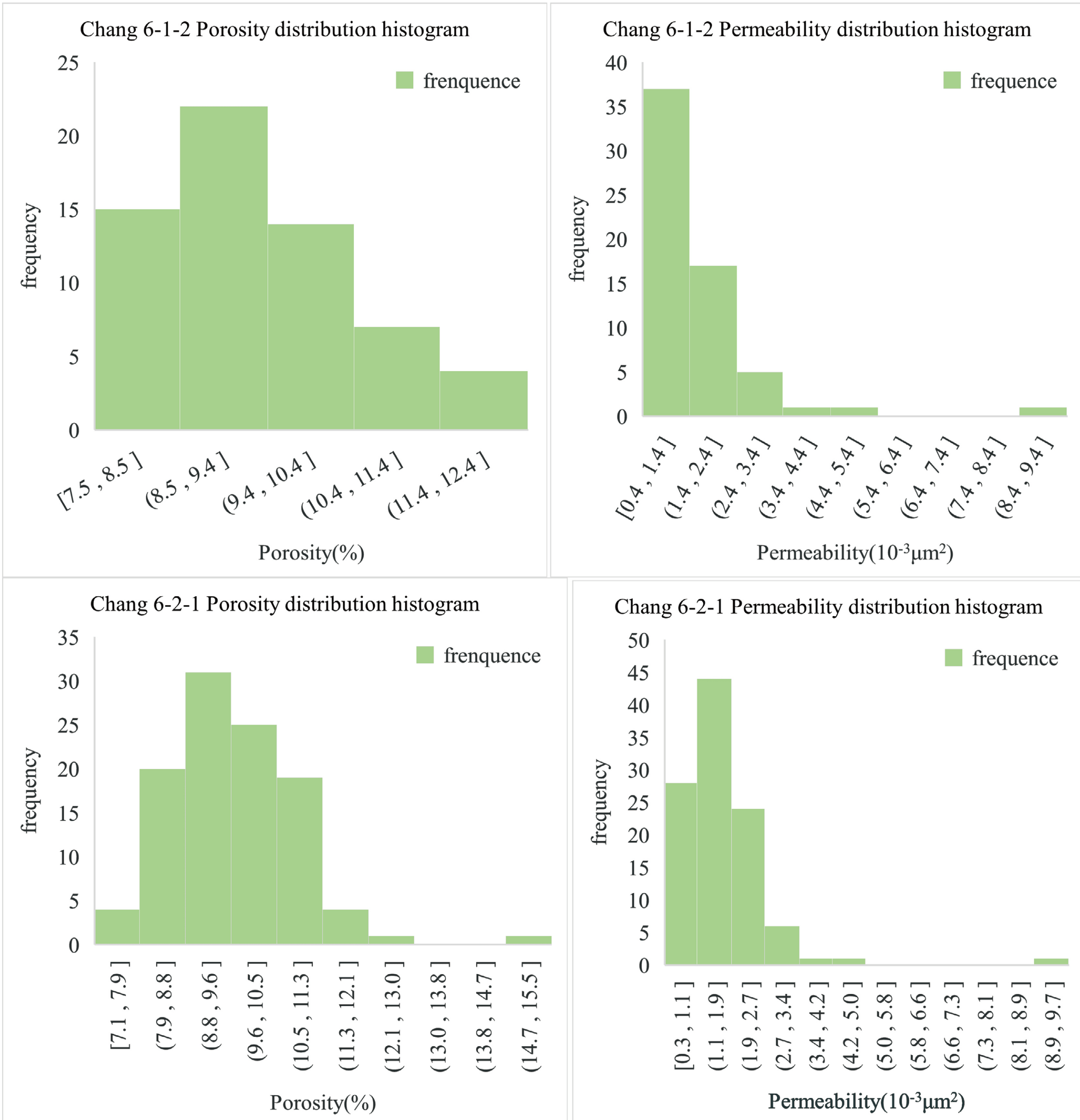

Figure 2. Distribution map of porosity and permeability of Chang-6 in the study area.

pores are found, and chlorite on the surface of particles exists as a filler. It reflects that the intergranular pores in this area are relatively developed, and chlorite is more common as a filler. Another characteristic of intergranular pores is that no matter the particles, interstitial materials or pores, there is no corrosion phenomenon. Such intergranular pores belong to primary pores.

2) Intergranular dissolution pore: Intergranular dissolution pore is a kind of dissolution pore, which is formed by dissolution of soluble components in clastic particles, matrix, authigenic mineral cement or metasomatic minerals. These

soluble components can be carbonate, feldspar and other substances. [2] The intergranular dissolution pore refers to the pore formed by the dissolution of clastic particles on the basis of intergranular pore. In the case that the particles are surrounded by chlorite in the intergranular pores, if there is an acid solution entering the pores, it is easy to cause dissolution of feldspar debris, which is more common in the reservoir pores in the study area.

3.2.2. Characteristics of Micro-Pore Structure

According to the statistics of the average throat radius of Qujiagou oil field and its adjacent areas, the range is 0.2 - 0.3 μm. [3] [4] The average throat radius is the largest, so the throat type in the study area is mainly a fine throat. Through various analyses, it is found that the study area is mainly a small pore and fine throat reservoir.

According to the reservoir classification of the Triassic Yanchang Formation in the Ordos Basin, the reservoir type in the study area is ultra-low to ultra-low permeability, and the degree of reservoir is medium-poor.

3.3. Reservoir Physical Properties

According to 167 rock samples taken in the study area, the results of porosity and permeability measurement can be obtained. Through data analysis and statistics, the average porosity of Chang-6-1-2 reservoir is about 9.3%, and the average permeability is 1.55×10^{-3} μm^2. The average porosity and permeability of Chang-6-2-1 reservoir is 9.65% and 1.65×10^{-3} μm^2. Through the above research, it can also be found that the porosity and permeability of the study area are positively correlated. (**Figure 2**)

Through the observation and analysis of the porosity and permeability histogram, it is found that the porosity of the main reservoir Chang-6-1-2 is mostly between 8.5% and 9.4%, and the permeability is mainly between $(0.4 - 1.4) \times 10^{-3}$ μm^2, belonging to the ultra-low porosity and ultra-low permeability reservoir.

Through the observation and analysis of the porosity and permeability histogram, it is found that the porosity of the main reservoir Chang-6-2-1 is mostly between 8.8% and 9.6%, and the permeability is mainly between $(1.1 - 1.9) \times 10^{-3}$ μm^2, belonging to the ultra-low porosity and ultra-low permeability reservoir.

4. Conclusions

Through the above research, we can find that the rock type that can be used as a good reservoir is feldspar, the pore type of the reservoir space is mainly residual intergranular pore, the average porosity of the Chang-6-1-2 reservoir is 9.33%, and the average porosity of the Chang-6-2-1 reservoir is 9.65%, belonging to the ultra-low to ultra-low permeability layer.

Conflicts of Interest

The author declares no conflicts of interest.

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