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Baoziwan-Majiashan Area of Jiyuan Oilfield Analysis of Reservoir Characteristics and Main Control Factors in Long 4 + 5 Section

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Abstract

Based on the sheet, scanning electron microscope and high pressure mercury analysis method, this paper takes Jiyuan oilfield-Ma Jia mountain district 4 + 5 sandstone reservoir as the research object, from the reservoir petrology, pore type and porosity, permeability, the system analyzed the reservoir characteristics and its control factors. The results show that the sandstone in the 4 + 5 section of Baoziwan-Majiashan area of Jiyuan oilfield is fine in size and high in filling content. The pore types were dominated by intergranular pores and dissolved pores, with a low face rate. The reservoir property is relatively poor, with mean porosity of 11.11% and mean permeability of 1.16×10^{-3} μm^2. In the low porous, low otonic background, the development of relatively high pore hypertonic areas. Compaction and cementation should play a destructive role in reservoir properties, and dissolution should play a positive role in reservoir properties. Compaction adjusts the migration of clay minerals and miscellaneous bases in the original sediment in the study area, greatly reducing the porosity and permeability of the reservoir; the development of the cement cement, carbonate cementation and some quartz secondary compounds reduces the storage space; the dissolution effect, especially the secondary dissolution pores of the reservoir, which obviously improves the properties of the reservoir.

Keywords

Ordos Basin, Jiyuan Area, Reservoir Characteristics, Reservoir Control

Factor, Long 4 + 5 Section

1. Introduction

The Ordos Basin is rich in oil and gas resources, and the Yanchang Formation is one of the most important hydrocarbon source rocks and oil and gas producing layers in the Mesozoic of the Basin. In recent years, major breakthroughs have been made in the exploration of oil and gas in the Yanchang Formation of the Upper Triassic, and a number of low-permeability-ultra-low-permeability (mainly tight sandstones) oilfields, such as the Xifeng, Ji Plateau, and Huajing, etc., have been discovered one after another, and the exploration, development and research on tight oil have made remarkable progress [1].

Up to now, the long 4 + 5 reservoir in Ji Plateau Oilfield has a relatively low level of exploration, and in recent years, it has gradually become an important layer for exploration and development [2]. This paper takes the Baoziwan-Majiashan area of Ji Plateau Oilfield as the research object, and on the basis of fully utilizing the existing petroleum geological analysis data in the research area, and according to the theories of sedimentology, petroleum geology, and reservoir geology as the basis of the research, it utilizes the core casting sheet, scanning electron microscope, nuclear magnetic resonance, and high-pressure mercury pressure experiments, etc., to study the petrological characteristics of the Long 4 + 5 reservoir, and discusses the reservoir characteristics and the main controlling factors of the Long 4 + 5 formation group, which is positively significant for the development of the low-permeability reservoir in Yanchang Group in the research area.

2. Regional Geological Profile

The Ordos Basin is the second largest sedimentary basin in China (**Figure 1**), and the tectonic morphology of the basin is generally a north-south oriented rectangular basin with a gently sloping eastern flank, a steeply narrowing western flank, and an asymmetrical large obliquity [3]-[7].

The Ji Plateau area is located in the west-central part of the Yishan slope in the Ordos Basin, and is a west-dipping monoclinic tectonic structure with a high east and a low west [8]. The Yanchang Formation has developed a set of sedimentary system from lake inlet to lake outlet, with a set of alluvial plain sedimentation in the north and a set of river and lake delta sedimentary system in the south, which is generally thick in the north and thin in the south, and is generally a complete set of sand and mudstone sedimentary sequences (**Figure 2**). The stratigraphy of the Extension Formation is 800 - 1500 meters thick, thin in the north and thick in the south. Its bottom-up can be divided into ten oil layer groups (long 10 - long 1). The Long 4 + 5 oil formation group in the study area mainly consists of the delta front subphase, of which the microphase includes

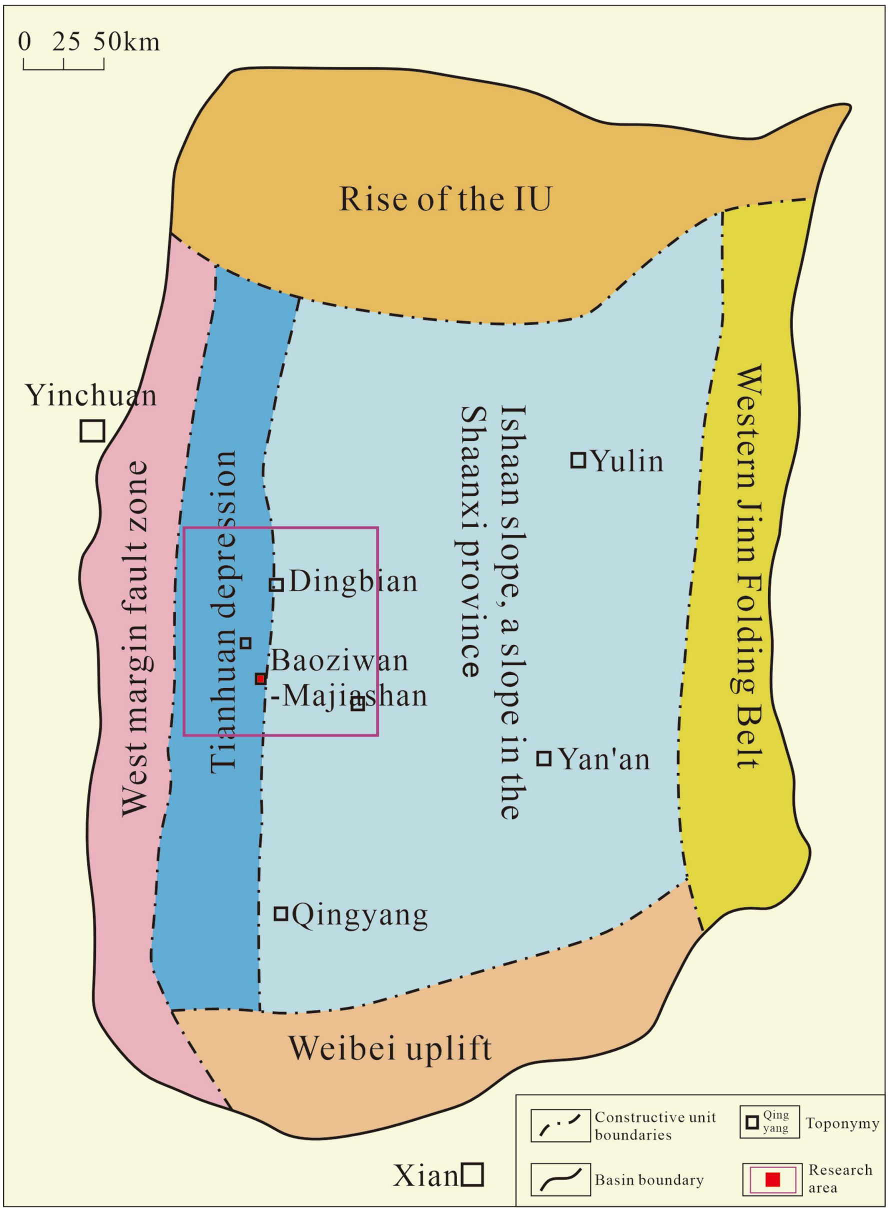


Figure 1. Geographic location and division of tectonic units in the Ordos Basin (modified from Changqing Oilfield Company).

submerged diversion channels, diversion interbays, estuarine dams and submerged natural dikes [9].

3. Reservoir Characterization

3.1. Petrological Type

The rock types of the Long 4 + 5 formation group in the Baoziwan-Majiashan area of the Ji Plateau Oilfield are all dominated by feldspathic sandstones and clastic feldspathic sandstones (Table 1), and the average contents of quartz, feldspar, and clastic are 41.70%, 39.40%, and 19.08%, respectively, and the maturity of the mineral compositions are all low (Figure 3). The sandstone grain

<table>
<tr><th colspan="6">lamination</th><th>thicknesses</th><th rowspan="2">lithology</th><th rowspan="2">symbol level</th></tr>
<tr><th>System</th><th>group</th><th>stage</th><th colspan="3">oil bed group</th><th>（m）</th></tr>
<tr><td rowspan="26">Triple Stacking System</td><td rowspan="25">Extension group</td><td rowspan="3">T_3y_5</td><td rowspan="3">Length1</td><td colspan="2">Length1_1</td><td>0~35</td><td rowspan="3">Dark mudstone, muddy siltstone, siltstone and siltstone of unequal thickness interbedded with carbonaceous mudstone and coal rock</td><td rowspan="3">K9</td></tr>
<tr><td colspan="2">Length1_2</td><td>20~40</td></tr>
<tr><td colspan="2">Length1_3</td><td>20~40</td></tr>
<tr><td rowspan="8">T_3y_4</td><td rowspan="5">Length2</td><td rowspan="3">Length2_1</td><td>Length2_1^1</td><td rowspan="3">47~68</td><td rowspan="3">Gray-green massive fine sandstone with dark mudstone</td><td rowspan="3"></td></tr>
<tr><td>Length2_1^2</td></tr>
<tr><td>Length2_1^3</td></tr>
<tr><td colspan="2">Length2_2</td><td>30~90</td><td>Light gray fine sandstone interbedded with dark mudstone</td><td>K8</td></tr>
<tr><td colspan="2">Length2_3</td><td>55~80</td><td>Gray, light gray fine sandstone interbedded with dark mudstone</td><td>K7</td></tr>
<tr><td rowspan="3">Length3</td><td colspan="2">Length3_1</td><td>30~40</td><td>Light gray, gray-brown fine sandstone interbedded with dark mudstone</td><td rowspan="3">K6</td></tr>
<tr><td colspan="2">Length3_2</td><td>30~40</td><td>Light gray, gray-brown fine sandstone interbedded with dark mudstone</td></tr>
<tr><td colspan="2">Length3_3</td><td>30~40</td><td>Light gray, gray-brown fine sandstone interbedded with dark mudstone</td></tr>
<tr><td rowspan="8">T_3y_3</td><td rowspan="4">Length4+5</td><td rowspan="2">Length$4+5_1$</td><td>Length$4+5_1^1$</td><td rowspan="2">40~55</td><td rowspan="2">Light gray siltstone interbedded with dark mudstone</td><td rowspan="4">K5</td></tr>
<tr><td>Length$4+5_1^2$</td></tr>
<tr><td rowspan="2">Length$4+5_2$</td><td>Length$4+5_2^1$</td><td rowspan="2">40~70</td><td rowspan="2">Light gray siltstone interbedded with dark mudstone</td></tr>
<tr><td>Length$4+5_2^2$</td></tr>
<tr><td rowspan="3">Length6</td><td colspan="2">Length6_1</td><td>35~45</td><td>Brownish gray massive fine sandstone interbedded with dark mudstone</td><td>K4</td></tr>
<tr><td colspan="2">Length6_2</td><td>35~45</td><td>Light gray siltstone interbedded with dark mudstone</td><td>K3</td></tr>
<tr><td colspan="2">Length6_3</td><td>35~45</td><td>Grayish-black mudstone, siltstone, and siltstone interbedded with thin layers of tuff.</td><td>K2</td></tr>
<tr><td colspan="3">Length7</td><td>80~100</td><td>Dark mudstone, charcoal mudstone, oil shale interbedded with thin layers of fine siltstone</td><td>K1</td></tr>
<tr><td rowspan="5">T_3y_2</td><td rowspan="4">Length8</td><td rowspan="2">Length8_1</td><td>Length8_1^1</td><td rowspan="2">40~45</td><td rowspan="2">Dark mudstone, sandy mudstone interbedded with gray siltstone</td><td></td></tr>
<tr><td>Length8_1^2</td><td></td></tr>
<tr><td rowspan="2">Length8_2</td><td>Length8_2^1</td><td rowspan="2">35~45</td><td rowspan="2">Dark mudstone, sandy mudstone interbedded with gray siltstone</td><td></td></tr>
<tr><td>Length8_2^2</td><td></td></tr>
<tr><td colspan="3">Length9</td><td>90~120</td><td>Dark mudstone and shale interbedded with gray fine siltstone</td><td></td></tr>
<tr><td>T_3y_1</td><td colspan="3">Length10</td><td>280~350</td><td>Gray thickly bedded massive medium to fine sandstone, coarse sandstone, pockmarked structure</td><td></td></tr>
<tr><td colspan="5">paper mill group</td><td></td><td>Grayish-purple mudstone, sandy mudstone interbedded with purplish-red medium-fine sandstone</td><td></td></tr>
</table>

Figure 2. Stratigraphic characteristics of the extension formation in the ordos basin (modified from Literature 17).

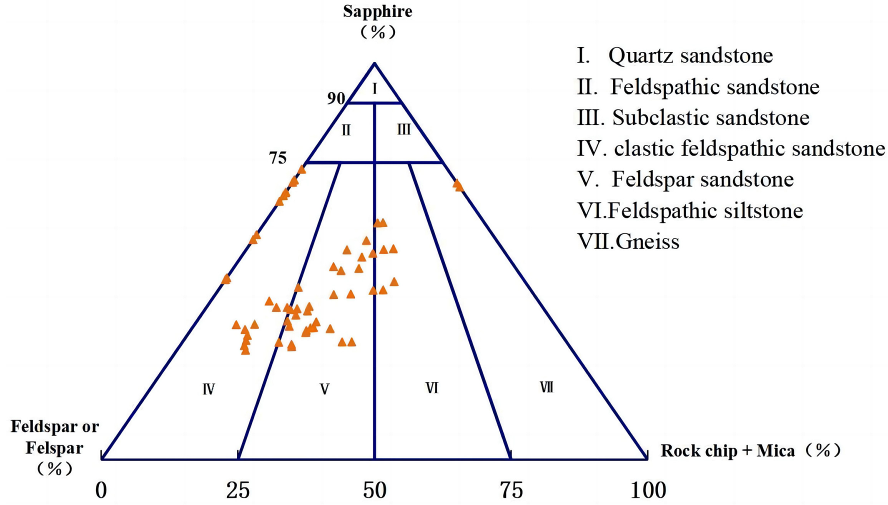


Figure 3. Triangulation of rock types of long 4 + 5 reservoirs in Baotiwan-Majiashan area.

Table 1. Statistics of clastic fractions of long 4 + 5 reservoirs in Baotiwan-Majiashan district (unit: %).

Point	Sapphire (Q)/%	Feldspar or Felspar (F)/%	Scree (R)/%	Q/(F + R)	F/R
Baoziwan-Majiashan	41.70	39.40	19.08	0.72	2.07

size is fine, dominated by fine sand, rounding degree is dominated by sub-angular shape, sorting is medium-good, the contact relationship between particles is mainly line-point and point-line contact mode, a small amount of point-contact and concave-convex-line contact mode. The cementation type is mainly pore-type cementation, with occasional small amount of enlarged-porosity and pore-film type cementation. The high content of rock fills reflects the lower mineral maturity and medium structural maturity of the study area. The highest content of metamorphic clasts in the sandstone clasts composition, and the higher content of mica reflect the lower compaction resistance of the rocks (Table 2).

3.2. Fill and Cement Characteristics

The filler contents of the Long 4 + 5 formation group in the Baoziwan-Majiashan area of the Ji Plateau Oilfield are generally high, mainly kaolinite, mica, chlorite, iron calcite, iron dolomite, siliceous and feldspathic (Table 3), of which kaolinite, mica, iron calcite, and siliceous have the highest contents, accounting for 92% of the overall filler contents, whereas chlorite, iron dolomite, and feldspathic have lower contents. Iron calcite cementation and feldspathic kaoliniteization have resulted in the filling of residual primary intergranular pores in the sandstones and the reduction of pore permeability, especially iron calcite cementation, which has a great impact on the physical properties of the whole study area.

Table 2. Statistical table of rock chip fractions of the long 4 + 5 reservoir in Baotiwan-Majiashan district (unit: %).

Point	Scree (%)			Else (%)	
	Igneous debris	Metamorphic scree	Sedimentary debris	Micas	Chlorite
Baoziwan-Majiashan	3.12	7.21	2.98	6.23	0.31

Table 3. Statistical table of rock chip fractions of the long 4 + 5 reservoir in Baotiwan-Majiashan District (unit: %).

Point	Number of samples	Filler (%)							Overall amount (%)
		Kaolin	Water mica	Chlorite	Calcite	Dolomite	Containing silica	Feldspathic	
Baoziwan-Majiashan	59	4.63	1.46	0.19	4.08	0.26	1.74	0.61	12.97

Scanning electron microscope observation shows that the quartz grains in the sandstone of the Long 4 + 5 oil formation group in the Baoziwan-Majiashan area of the Ji Plateau Oilfield have clear shell-like fractures, and are obviously compacted and tightly cemented (**Figure 4(a)**); locally, a large amount of booklet-like kaolinite is found cemented between grains, and is mixed and cemented with the clay minerals (**Figure 4(b)**); chlorite is in the form of rose petals and is adherent to the surface of the grains (**Figure 4(c)**); and in addition to that, a large amount of needle-filament-like kaolinization can be observed between grains. Intergranular needle filamentous illite with mixed clay-crystalline calcite collodion can be observed (**Figure 4(d)**), which also affects the reservoir porosity to some extent.

3.3. Type of Reservoir Pore Structure

Through the observation of the cast thin section of the long 4 + 5 section in the study area (**Figure 5**), the reservoir develops intergranular pores, followed by dissolution porosity, with an overall low facies porosity (**Figure 6**), and the main types of pore assemblages are intergranular pore-dissolution pore type, intergranular pore-microporous, dissolution pore-intergranular pore type, and dissolution pore-microporous type.The central mechanism for the formation of dissolution pore erosion in rock cores is related to two aspects: the dissolution process of the rock itself and the erosive effect of the fluid. Throughout geological evolution, rocks have been subjected to continuous erosion by dissolved groundwater, especially in areas where the groundwater is rich in dissolved components. In carbonate areas, for example, groundwater is often saturated with carbonic acid, which effectively dissolves the carbonate content of the rock, thus contributing to dissolve pore erosion.

1) Intergranular pore-solution pore type

There are tiny pores between residual particles inside the reservoir, and their surfaces are often covered by chlorite to form a thin film, which results in an extremely heterogeneous pore distribution. In addition, the dissolution pores are also one of the main storage spaces in the reservoir, and they are very unevenly distributed and have good connectivity. These intergranular pores-solution

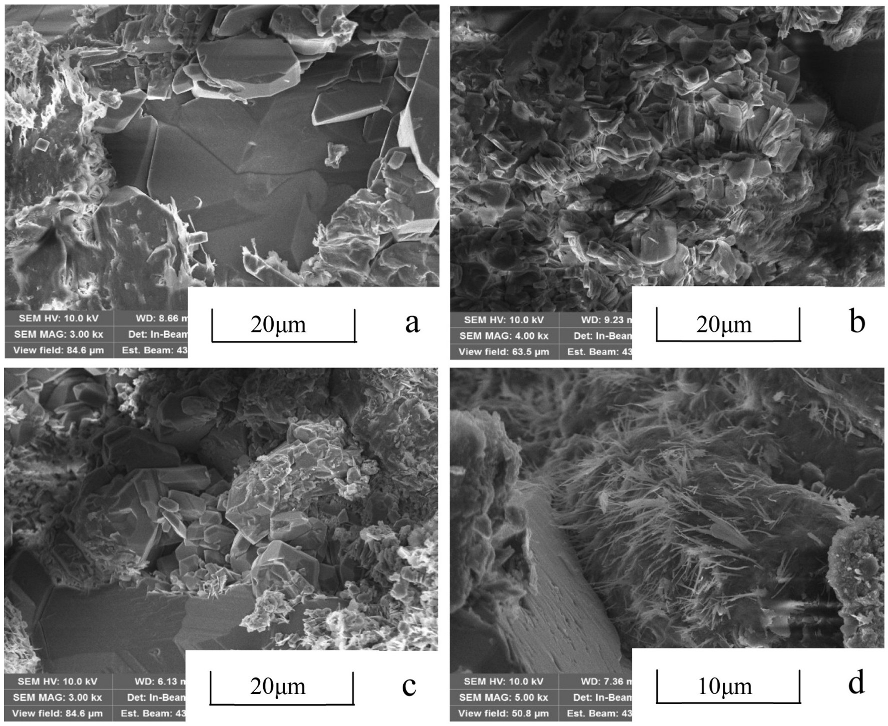
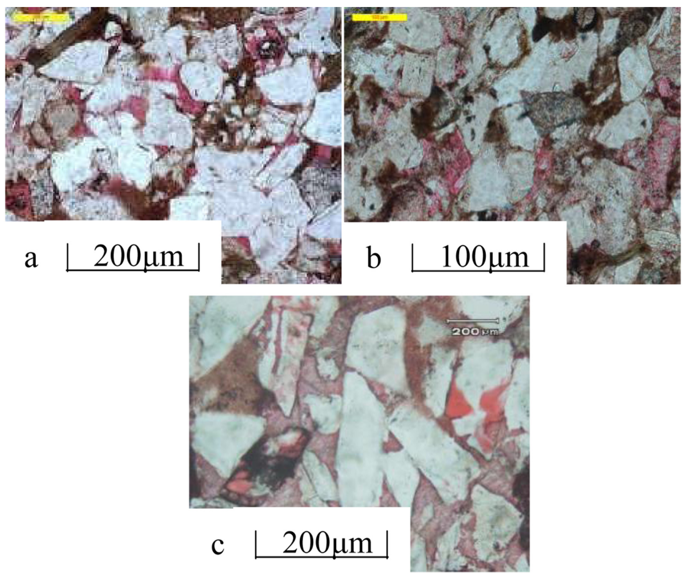


Figure 4. Colluvium type of long 4 + 5 oil formation group in Baotiwan-Majiashan area.



a: G166 Jing, 2477.5 m, Increased intergranular pores and silica;

b: G239 Jing, 2533.7 m, feldspar lysis;

c: G216 Jing, 2320.55 m, microporous;

Figure 5. Pore type of long 4 + 5 oil formation group in Baotiwan-Majia Mountain area.

pores are one of the main types of pore assemblages in the reservoirs of the target section (**Figure 7(a)**).

2) Intergranular pore-microporous type

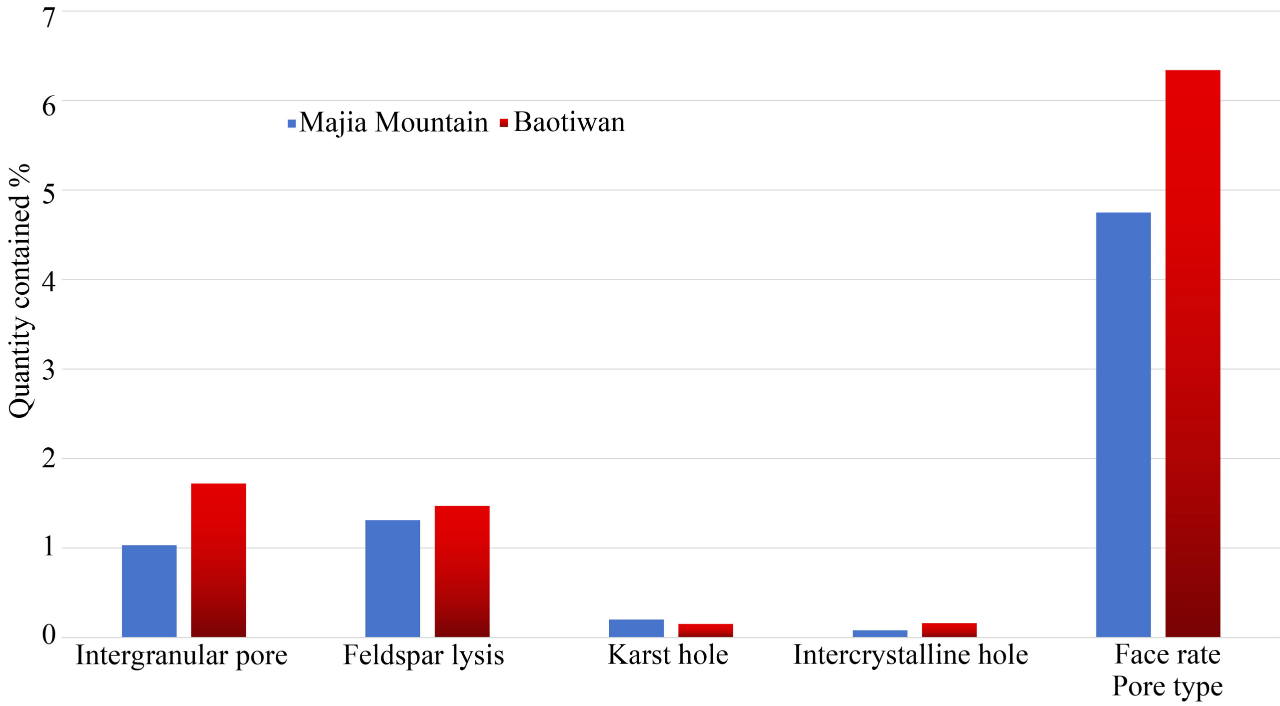
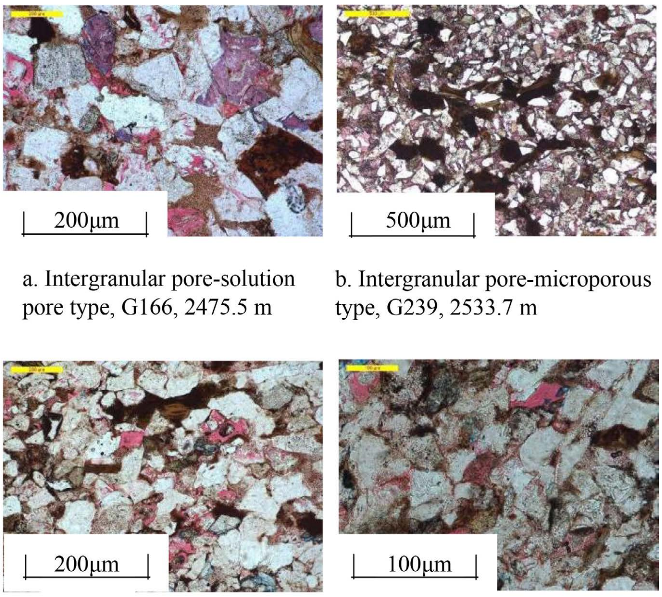


Figure 6. Histogram of pore types of the long 4 + 5 oil formation group in Baotiwan-Majiashan area.



a. Intergranular pore-solution pore type, G166, 2475.5 m

b. Intergranular pore-microporous type, G239, 2533.7 m

c. Solvopore-intergranular pore type, G239, 2535.09 m

d. Dissolved pore and microporous type, G239, 2469.36 m

Figure 7. Pore assemblage type of long 4 + 5 oil formation group in Baotiwan-Majiashan area.

The residual intergranular pores in the reservoir are more developed, and the residual intergranular pores are mostly filled with authigenic clay minerals. The sandstone mainly develops micropores within the filler and authigenic mineral intergranular micropores, and chlorite intergranular pores and yi/montmorillonite mixed-layer mineral intergranular pores are common in the study area (Figure 7(b)).

3) Dissolution pore-intergranular pore type

Pores formed between particles as a result of dissolution, as well as dissolution pores within feldspars and clasts, are visible in the study area. At the same time, the distribution of these pores shows significant heterogeneity and poor connectivity between the pores. In this study area, this type of pore assemblage is more widely developed in sandstone reservoirs with poor physical properties (Figure 7(c)).

4) Soluble pore and microporous type

Inter- and intra-solution grain pores are commonly found in the sandstone, and the distribution of pores is relatively uniform and the pores are well connected with each other. In addition, intergranular microporosity exists in the sandstone reservoirs in the study area, and this form of pore assemblage is one of the main types of sandstone reservoirs (Figure 7(d)).

3.4. Type of Storage Space Structure

According to the observation of the gross pipe pressure curve of the sandstone reservoir in the long 4 + 5 section of the study area, the discharge and driving pressure of the sandstone reservoir in the long 4 + 5 section is generally high, and it is classified into three types of pore structure types with reference to the regional standard (Figure 8):

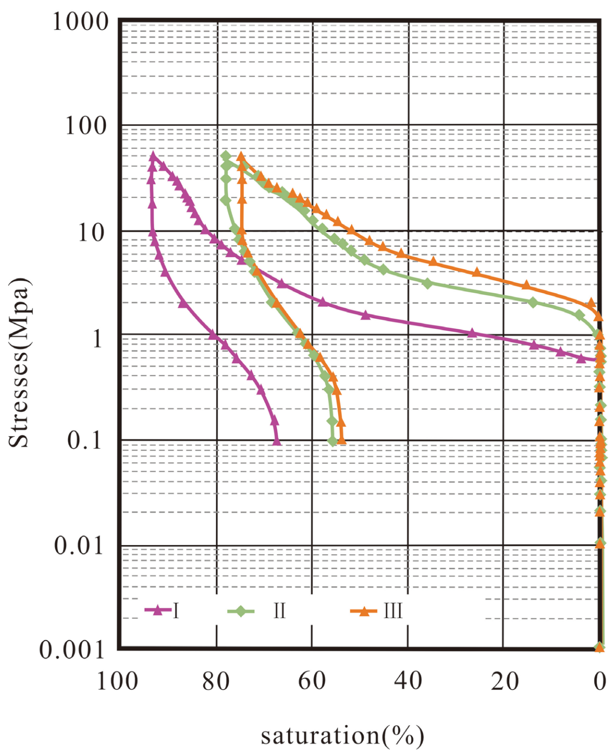


Figure 8. Type of Hg compression curves for long 4 + 5 reservoirs in Baotiwan-Majiashan area.

Class I (low discharge and driving pressure-fine throat, microfine throat type): when the discharge and driving pressure (Pd) is less than 1MPa, and the median mercury saturation pressure (P50) is less than 4MPa, the maximum radius of the pore and throat is smaller, the curve shows obvious platform area, and the mercury saturation is higher. The pore and throat sorting effect is better, indicating that this is a high-quality reservoir.

Class II (medium-discharge driving pressure-microfine throat type): Pd is 1 - 2 MPa, and under this condition when P50 is about 4 - 8 MPa, the curve shows a clear plateau, and the mercury feed saturation is high. The grading of the pore throat is at a medium level, indicating that this is a better reservoir.

Class III (medium-discharge driving pressure-microthroat type): Pd ranges from 1 to 2 MPa, P50 is higher than 8 MPa, the curve shows double porosity characteristics, and the mercury feed saturation is relatively low. The pore-throat sorting effect is poor, indicating that the reservoir belongs to poorer reservoirs.

From the statistics of oil test data, the implementation of I, II type of hole and throat structure is effective, and the proportion of I, II type of long 4 + 5 reservoir is high.

3.5. Reservoir Physical Characteristics

According to the statistics of core analysis data of 618 samples in the study area, in Majiashan-Baoziwan area, the porosity of the long 4 + 5 reservoir has a wide range of variations, with a maximum of 17.22% and a minimum of only 6.06%, and an average value of 11.11%. The porosity is mainly concentrated between 10% and 12% (see **Figure 9(a)**). Correspondingly, the permeability varies greatly, with the highest being 24.2×10^{-3} μm^2 and the lowest being 0.10×10^{-3} μm^2, and the average value is 1.16×10^{-3} μm^2. The permeability is mainly distributed between 1.1×10^{-3} μm^2 and 2.1×10^{-3} μm^2 (see **Figure 9(b)**), which is in the category of low-porosity and low-permeability reservoirs.

4. Reservoir Development Controls

The major influences on reservoir development include sedimentation, diagenesis and tectonic modification [10]-[14]. These factors are interrelated, but in the process of reservoir development. The study area is dominated by submerged diversion channel microphase and submerged diversion interbay microphase, mostly siltstones and fine sandstones with small porosity and low permeability, through which the petrogenesis and tectonic modification effects are analyzed in conjunction with the information of the study area, the degree of their role is different, combined with the data of the study area, analyze the control of sedimentation and diagenesis on the physical properties of the reservoir.

4.1. Sedimentation

The sedimentary phase of the Long 4 + 5 formation group in the study area belongs to the delta front subphase. In this subphase, a variety of sedimentary

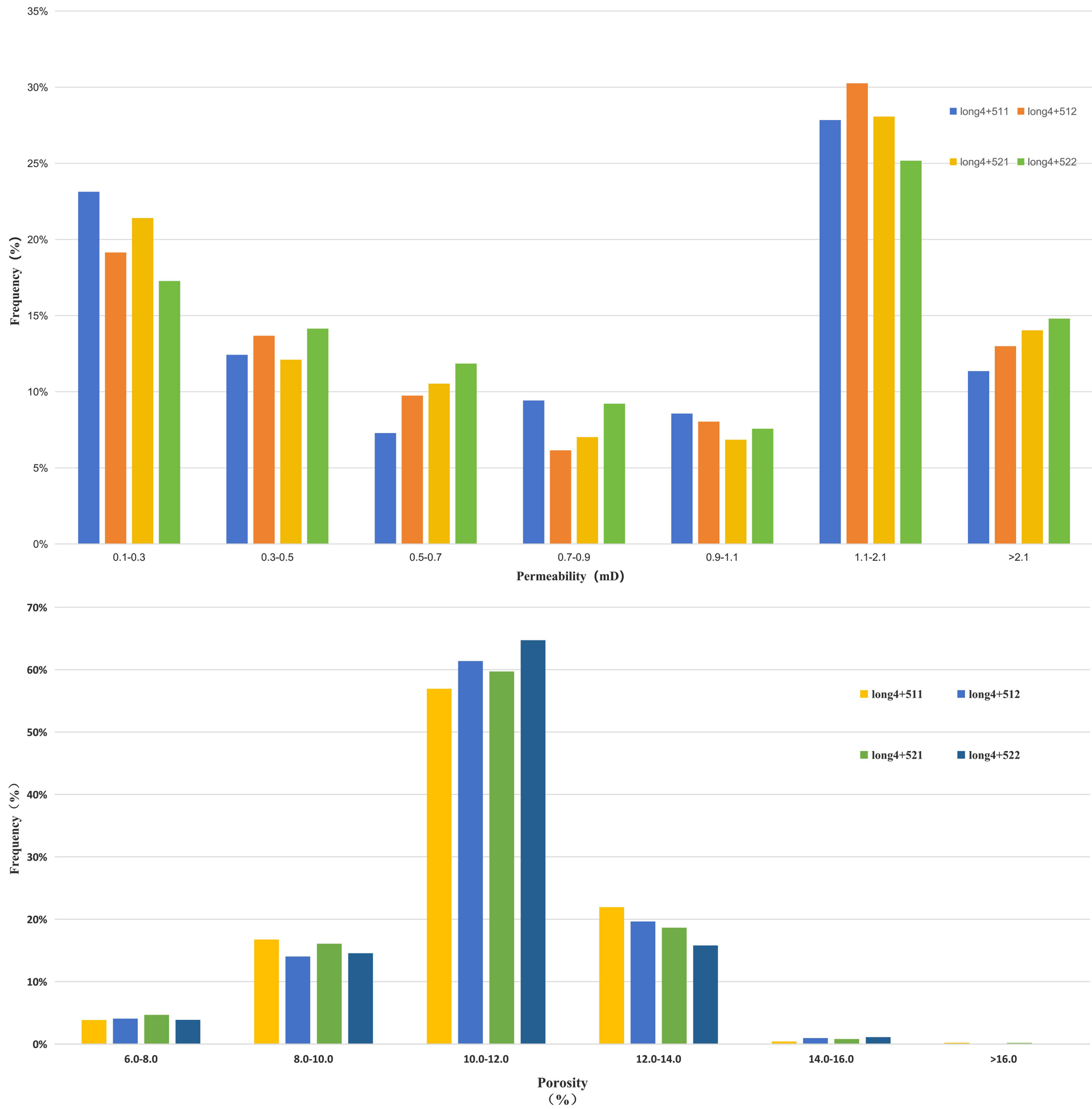
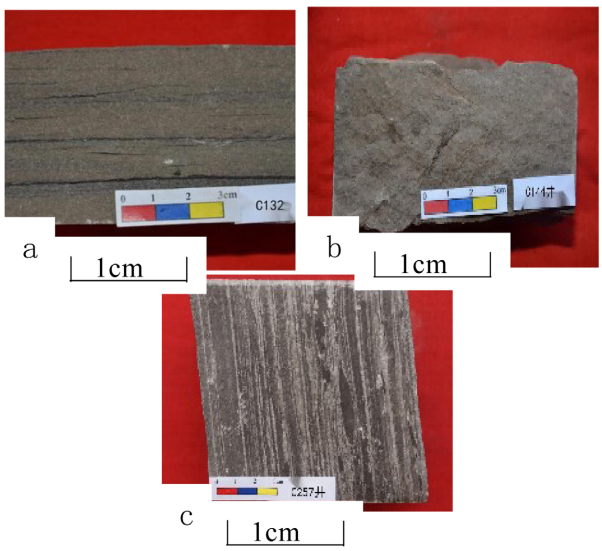


Figure 9. Histogram of porosity and permeability of long 4 + 5 reservoirs in Baotiwan-Majiashan area.

microphases are developed, mainly including submerged diversion channels, submerged natural dikes, tributary interbays and estuarine dams. The sediments consist mainly of light gray, gray, gray-brown, and gray-green fine sandstones and siltstones. The lithology of the underwater diversion channel is mainly light gray medium sandstone and fine sandstone, with low mud content, and the development of small-scale cross-stratification and parallel stratification, etc.; the underwater natural dyke is mainly interbedded with light gray siltstone and grayish-black mudstone, with fine grain size, which is not very conducive to the development of reservoirs, and the development of horizontal stratification and undulating cross-stratification; the inter-bay of tributaries is mainly dark gray and grayish-black mudstone, which is not very conducive to the development of reservoirs, and the development of horizontal stratification, blocky stratification; the estuary dam is mainly composed of light gray, grayish brown, grayish brown, grayish green fine sandstone and fine sandstone. The estuary dam is mainly powder-fine sandstone, with better sandstone sorting and less mud content, which is also favorable for reservoir development, and develops parallel laminations, undulating laminations and horizontal laminations (**Figure 10**). From the existing thin-section identification data and physical analysis data of the long 4 + 5 oil formation group in the Baotiwan-Majiashan area (**Table 4**), it can be seen



a：C132，2340.50m，parallel lamination

b：C144，2280.40m，interlocking strata

c：C257，2405.52m，oblique stratification

Figure 10. Picture of stratified core of long 4 + 5 oil formation group in Baotiwan and Majiashan area.

Table 4. Statistics of porosity permeability data of various types of sandstones in the long 4 + 5 oil formation group of Baotiwan-Majiashan District.

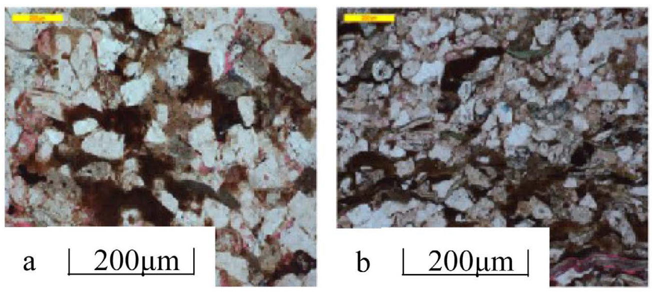
Sedimentary microphase	Main lithologies	Porosity (%)		Permeability (10^{-3} μm^2)	
		interval value	average value	interval value	average value
Underwater diversion channel	Gray fine sandstone	6.87 - 17.22	11.83	0.19 - 41.94	1.34
Estuary dam	Pulverized sandstone	3.45 - 15.08	10.88	0.086 - 10.02	1.17
Underwater Natural dike	Siltstone	1.26 - 10.16	7.24	0.05 - 2.03	0.54

that the physical properties of fine sandstones in general are medium-good, and the physical properties of fine sandstones are poor, while sandstones with high mud content are basically poor or non-reservoirs, which indicates that the physical properties of reservoirs are positively correlated with the grain size of sandstones, and that the grain size of sandstones is also controlled by the depositional microfacies, of which the microfacies that are most favorable for the development of reservoirs is the front of the delta The most favorable microfacies for reservoir development are the delta front and the underwater diversion channels and estuarine dams.

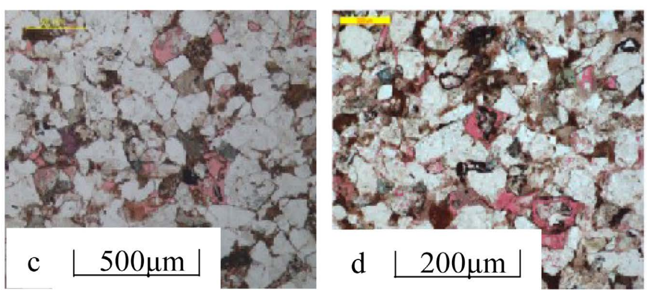
4.2. Rock-Forming Factor

The main lithogenic effects affecting the physical properties of the reservoir are compaction, dissolution and cementation [15]-[19]. Through the observation of various diagenetic components, pore types and authigenic mineral assemblages and other characteristics in the thin section of rock casts, it is concluded that the main diagenetic characteristics of the study area are:

Plastic clasts such as mica in the sandstone generally experienced strong deformation, and some of the muddy clasts formed pseudohybrid bases under pressure. In addition, it can be observed that individual rigid grains have fractured during compaction, and the clastic grains are tightly packed together in linear contact (e.g., **Figure 11(a)** and **Figure 11(b)**). This indicates that the



(a) G166 chang 4+5$_2$ 2444 m, Strong plastic deformation;
(b) G239 chang 4+5$_2$ 2477.68 m, Mica Directional Alignment;



(c) L110, chang 4+5$_2$ 2089 m Granular lines, concave and convex contacts;
(d) G239, chang 4+5$_2$ 2532.09 m Feldspar solution holes and feldspar kaolinization.

Figure 11. Micrograph of compaction action.

studied reservoir sandstones underwent significant changes under compaction. The proportion of primary intergranular pores in sandstones usually does not exceed 50%, and in most cases is in the range of 30% - 45%. In contrast, the proportion of inter- and intra-granular solution pores is usually higher, typically between 40% - 55%. These two types of porosity play a dominant role in the study area and form by very different mechanisms (**Table 5**).

1) Compaction

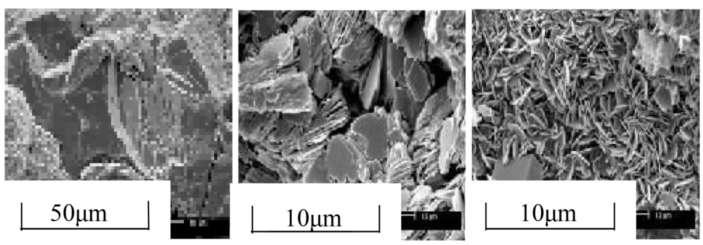
In the study area, due to the high clay mineral content in the original sediments, under compaction, clay minerals and heterogeneous bases lead to a significant decrease in the porosity and permeability of the reservoir through the process of migration and adjustment. At the same time, compaction can also lead to the fracture of friable minerals such as feldspar, which in turn generates feldspar fracture fissures and expands through the process of dissolution and erosion, increasing the permeability of the reservoir (**Figure 11(c)** and **Figure 11(d)**).

2) Cementation

The long 4 + 5 cementation in the study area is mainly manifested as chlorite ring edge cementation and local carbonate cementation, etc. The cementation can fill both primary and dissolved pore space. The colluvium can fill both primary and dissolved pores, greatly reducing the storage space; however, the colluvium formed at the early stage of diagenesis has a certain inhibitory effect on compaction while filling pores, such as chlorite colluvium at the early stage of diagenesis, which makes a certain amount of primary pores to be preserved, and also lays a material foundation for the later acidic dissolution (**Figure 12**).

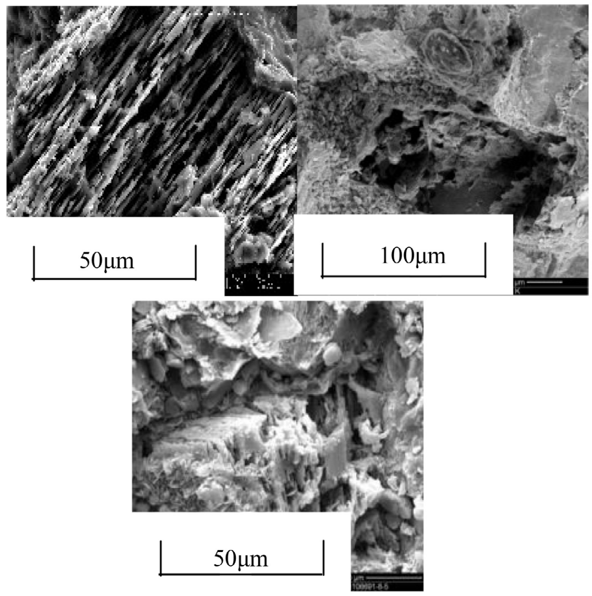
Table 5. Statistics of pore types and contents of long 4 + 5 oil formation group in Baotiwan-Majiashan area.

Shore	Pore type (%)				
	Intergranular pore	Feldspar lysis	Karst hole	Intercrystalline hole	Face rate
Baoziwan-Majiashan	1.40	1.43	0.18	0.13	3.36



From left to right: well B46-37, length 4+5_2, 2279.18 m, carbonate cementation; well B46-37, length 4+5_2, 2279.18 m, kaolinite cementation; G115, length 4+5_1, 2224.9 m, grain-filled chlorite.

Figure 12. Microscopic picture of cementation.



From left to right: G43, length $4+5_2$, 2168.93 m, feldspar grains dissolved; G339, 2231.38 m, feldspar grains dissolved to form lysimeters; CH259, 2454.9 m feldspar with lysimeters to form secondary holes.

Figure 13. Microscopic picture of feldspar solution holes.

3) Dissolving

Previous studies have shown that the long 4 + 5 compositional rock action in Ji Plateau area has gone through the early orogenic A and B phases, and is currently in the middle orogenic A phase [20]. There are two phases before and after the development of the dissolution of the long 4 + 5 in the study area, each time increasing the secondary dissolution porosity of the reservoir, of which the dissolution of the meso-mesozoic phase A is more intense, and the improvement of the physical conditions of the reservoir is obvious. The second period of dissolution action in the middle orogenic stage B has a relatively weak influence, but overall it also plays a certain role in the improvement of the reservoir (**Figure 13**).

5. Reach a Verdict

1) The sandstone of the Long 4 + 5 oil formation group in the Baotiwan-Majiashan area is fine-grained, mainly fine sand, and also contains a few coarse and unequal grains. The grains are well sorted from each other, mainly showing line-point and point-line contacts, but also a small amount of point-contact and bump-line contacts. The content of rock filler is high, dominated by cementation. Iron calcite cementation and feldspar kaoliniteization make the residual primary intergranular pores of the sandstone filled, and the pore permeability is reduced.

2) The long 4 + 5 reservoir in Baotiwan-Majiashan area develops intergranular

pores, followed by dissolution pores, with overall low porosity, and the main types of pore combinations are intergranular pore-dissolution pore type, intergranular pore-microporous type, dissolution pore-intergranular pore type and dissolution pore-microporous type. The average porosity is 11.11% and the average permeability is 1.16×10^{-3} μm^2, which is a low porosity and low permeability reservoir.

3) The distribution of reservoirs in the study area is mainly affected by sedimentation and diagenesis, in which the cracks formed by sedimentary structures can improve the physical properties and pore structure of reservoirs; diagenesis affects the physical properties of reservoirs through compaction, cementation, and dissolution; among them, compaction adjusts the transportation of clay minerals and detritus, greatly reducing the porosity and permeability of the reservoirs, and at the same time, feldspars and other brittle minerals are ruptured, increasing the permeability of reservoirs; cementation increases the permeability of reservoirs; cementation increases the permeability of reservoirs, and the permeability of reservoirs is increased by the transportation of feldspars. Reservoir permeability; cementation reduces the storage space in the study area; the occurrence of dissolution before and after the mesolithic stage increases the secondary dissolution porosity of the reservoir, which plays an obvious role in improving the physical properties of the reservoir.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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